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EARNINGS MANAGEMENT THROUGH THE USE OF DISCRETIONARY R&D SPENDING

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ABSTRACT

This study provides an analysis of why corporate managers use their discretion over research and development (R&D) spending to manage earnings. Quarterly data from corporate entities is examined to determine if managers utilize their discretion over R&D expenditures to avoid the reporting of net losses, earnings decreases, and earnings that fall short of analysts' forecasts. The evidence suggests that firms will be more likely to reduce R&D expenditures in each of the following three scenarios: when a net loss is reported, when a decrease in earnings from the prior period is reported, and when earnings fall short of analysts' forecasts.

KEY WORDS

Earnings Management, R&D, SFAS 2, Discretionary Spending, Accounting

INTRODUCTION

This study provides an analysis of the conditions that may lead corporate managers to use their relative discretion over research and development (R&D) spending to manage earnings. Corporate managers may modify the amount of the firm's discretionary expenditures, such as R&D, in an effort to either create a smooth pattern of earnings or to meet earnings targets. This form of earnings management, referred to as real earnings management, involves the timing of operating and investing decisions to achieve income objectives. Firms may be motivated to report a smoother earnings stream to meet the expectations of capital markets, increase compensation to executives, circumvent lending contracts such as debt covenant restrictions, and create a perception of reduced risk prior to the issuance of debt. This study investigates the degree to which corporate managers utilize their discretion over R&D spending to avoid the reporting of net losses, earnings decreases, and earnings that fall short of analysts' forecasts. An analysis and comparison of these three conditions is made to identify the settings in which firms would be more likely to manage earnings.

The implementation and management of a successful R&D program is predominant to a business that competes in an R&D-intensive industry. In an efficient market, earnings management techniques such as reducing R&D expenditures to inflate the firm's reported income for a period

should have no effect on the corporation's share price. This study examines the phenomenon of why corporate managers will pursue an R&D expenditure policy that may yield sub-optimal economic results for the firm in the long run. In addition to addressing the underlying issues that may lead managers to alter their respective decision-making processes in a counter-intuitive manner, this paper fills a gap in the earnings management literature by analyzing and comparing the conditions that create a more fertile environment for earnings management to exist. This study attempts to further the existing body of literature on earnings management through the use of discretionary expenditures by utilizing unique tests and variables to determine the settings in which managers would be more likely to manage the firm's earnings.

Of the many techniques used to manage earnings that are available to firms in R&D-intensive industries, the adjustment of R&D expenditures may present these firms with the greatest opportunity to manipulate reported earnings. SFAS No. 2, issued by the Financial Accounting Standards Board in 1974, specifies that R&D costs generally should be expensed in the period incurred, rather than capitalized as an asset. Prior studies (Lev and Sougiannis, 1996; Lev and Sougiannis, 1999, Chan et al., 2001) indicate that R&D costs meet the definition of an asset as providing a probable future economic benefit controlled by an entity, as described in Statement of Financial Accounting Concept No. 6. Although these research studies vary in their respective methodological approaches, each of these studies indicates that an increase in the amount and quality of R&D expenditures may result in an increase in future earnings. Therefore, for firms with a high R&D intensity ratio (R&D / Sales), it is intuitive to analyze R&D expenditures as a proxy for earnings management.

This study of *ex post* data investigates the extent to which three different earnings management objectives impact the R&D expenditures of firms in R&D-intensive industries. Logistic regression analysis is utilized to determine if firms that experience a net loss, a decline in earnings, or fail to meet analysts' forecasts will modify R&D expenditures. A sample of firm-quarter observations from 2001 through 2005 is analyzed to determine if a relationship exists between a firm's earnings (adjusted for R&D expenditures) and its unexpected R&D expense. Consistent with prior research by Baber, et al. (1991), this study utilizes the change in expenditures for property, plant and equipment as a control variable since these costs are capitalized and depreciated over a number of periods. Following Perry and Grinaker (1994), this study extends the Baber et al. study by modifying the use of last period's R&D expenditures as the current period's expected R&D. Since this expenditure has displayed a non-stationary nature over the period of the study, the prior period's R&D expense is adjusted by a factor to arrive at a better proxy for expected R&D expenditure.

LITERATURE REVIEW

Earnings management takes place when decisions made by corporate managers are calibrated to achieve a predetermined level of reported earnings. Corporate managers can utilize their discretion over certain expenditures or accrual estimates to assist in achieving a desired level of earnings for the period. Healy and Wahlen (1999) report that earnings management occurs when managers use judgment in financial reporting and in structuring transactions to alter financial reports to either mislead some stakeholders about the underlying economic performance of the

company or to influence contractual outcomes that depend on reported accounting numbers. Alternately, Schipper (1989) describes earnings management as the purposeful intervention in the external reporting process with the intent of obtaining some private gain. The key element in each of these definitions of earnings management is the utilization of management's discretion to affect the firm's reported financial results. In fact, McNichols (2000) states that a fundamental element in any test for earnings management is management's discretion over earnings.

Investors will seek a management team that that will make decisions to generate a maximum amount of wealth for its corporate shareholders. Managers are entrusted to utilize the firm's available resources to maximize its long-term growth opportunities while balancing the risk associated with these opportunities. Since changing economic conditions or other unforeseeable external factors may lead to less than optimal financial results for the business, managers may have an incentive to distort the true picture of the corporation's performance. Opportunistic managers may even resort to employ counter-productive decisions in an effort to disguise the economic performance of the firm. Since the interests of management may not be completely in line with those of the investors, a setting may exist where it would be suitable for a manager to alter his decision-making process in an unintuitive manner. Identifying this setting can be a critical factor for potential investors and current.

The judgment exercised by corporate managers in their respective assumptions and the application of accounting principles is an integral component of the financial reporting process. The use, or abuse, of this latitude by managers to alter financial results can be evident to sophisticated stakeholders such as analysts, regulators, and institutional investors. In addition, auditors are required to assess the accounting principles used and significant estimates made by management. Despite being aware of the scrutiny that their discretionary decisions may be subject to, corporate managers may nevertheless engage in earnings management vis-à-vis real activities. Managers may assume that a level of information asymmetry exists between them and other stakeholders, and even sophisticated users of financial reports may not be able to see through this veil to uncover earnings management techniques. Another perspective is that due to the dispersion of corporate shareholders, investors may lack the incentive to unravel earnings management procedures. Another explanation can be attributable to management's perception that the market anticipates the occurrence of earnings management and already impounds this expectation into current security prices. Finally, managers may place a priority on their own personal benefit, even if it is at a cost to the firm. A summary of the specific factors that may motivate managers to alter earnings is presented in Figure 1 (below). It is important to note that the push on managers to meet earnings benchmarks may come from a combination of these factors, rather than from a single source.

FIGURE 1: EARNINGS MANAGEMENT: MOTIVATIONAL FACTORS

External Factors	Organizational Factors	Individual Factors
♦ Market Expectations	♦ Contractual Obligations	♦ Management Compensation
♦ Access Debt Markets	♦ Meet Performance Budgets	♦ Management Entrenchment
♦ Industry Regulations	♦ Top Management Pressure	
♦ Competitive Forces	♦ Short-Term Focus	
♦ Merger Attractiveness	♦ Conceal Fraud	
	♦ Information Asymmetry	

In the post-Enron era of tighter regulation and increased scrutiny by standard-setters, the use of discretionary expenditures may be a more rational means to manage earnings. Jenkins and Seiler (1990) suggest that managers of companies with short-term executive compensation schemes will decrease the scope of their respective decision-making horizons. Expenditures such as R&D, maintenance, and advertising are prototypical choices for managers to manipulate because although each of these items may contribute to future profitability, the current accounting treatment requires the immediate expensing of these items. Perry and Grinaker (1994) suggest that firms will decrease R&D expenditures when earnings fall short of analyst expectations. Dechow and Sloan (1991) provide evidence that CEO's will cut R&D expenditures to increase their compensation in the final years of their contracts. Bushee (1998) indicates that managers are more likely to cut R&D spending when there is a high turnover of shareholders and less institutional investors. The use of these expenditures as earnings management tools is expedient because these items are subject to the discretion of company management and fall outside the scope of financial reporting standard-setters.

SFAS No. 2 mandates that R&D costs generally be charged as an expense when incurred. Disclosure in the financial statements is required for the total R&D charged to expense for each reporting period. Proponents of this standard can justify the expensing of R&D as a conservative accounting method to reduce the opportunity for managers to capitalize expenditures that are uncertain to yield future benefits to the firm. Other scholars and practitioners have expressed varying degrees of opposition to SFAS No. 2 since its issuance in October 1974. They argue that R&D costs meet the criteria of an asset as specified by the FASB and the omission of these costs from the balance sheet compromises the relevance of the financial statements. Although SFAS No. 2 was issued to reduce the opportunities for a manager to arbitrarily overstate the firm's assets, this standard has created another medium for managers to alter the reported earnings of the firm. An underlying cause of the debate over how R&D costs should be accounted for is whether or not the tenets of the conservatism principle should override those of the matching principle. Proponents of conservatism can allude to the degree of uncertainty about future cash flows that may stem from a given expenditure. The argument about uncertainty, however, can be made for essentially all assets. Accrual accounting purists argue in favor of the matching principle by pointing out that most assets have an indeterminable value to a specific firm but this does not preclude the firm from recognizing the asset's existence on the balance sheet. Bernstein (pp. 367) encapsulates the argument against the immediate expensing of R&D by referring to this treatment as a safe, rather than useful approach that overlooks the history of productivity of many ongoing research efforts as opposed to the uncertainty involved in one-shot research projects.

Although there is risk associated with virtually every R&D project, an abundance of literature indicates that R&D expenditures possess the attributes necessary to be considered an asset. In a recent study, Amir et al. (2007) find that in R&D-intensive firms, R&D outlays contribute to future earnings variability at an even greater rate than capital expenditures. The results of this study are consistent with findings from prior research conducted by Lev et al. (2005) that focus on the contribution of R&D spending to the firm's future return on assets, return on equity, and earnings growth. In this study, Lev et al. construct a model to analyze firms over a period that spans from 1972 through 2002. The results indicate that the conservative reporting of R&D outlays leads to an undervaluing of R&D-intensive firms in the market. Other literature

empirically establishes a linkage between R&D expenditures and subsequent market returns by estimating the period of time that a firm will generally benefit from an R&D outlay (Lev and Sougiannis, 1996; Chan et al., 2001). In these studies, R&D expenditures are estimated to provide a benefit to the company for a period of five to ten years.

Since the issuance of SFAS No. 2 in 1974, the U.S. economy has made a significant shift to the service sector. Walther and Strickland (2002) point out that it is misleading to judge a company solely on its "bricks and mortar" assets because its value is frequently predicated on intangibles linked to technology and intellectual property. This argument supports a position held by Lev and Zarowin (1999) who report that the non-recognition of intangible assets in the balance sheet has led to a decline in the value-relevance and usefulness of the financial statements. Healy et al. (1999) suggest that companies should be permitted to capitalize R&D on a basis similar to the successful-efforts method that may be used in the oil and gas industry for exploration costs. Prior research has provided evidence that a linkage exists between a firm's R&D expenditures and its sales in subsequent periods (Griliches, 1987; Morbey, 1988). Since the benefits derived from R&D outlays may be realized over a number of years, the absence of R&D capital on the balance sheet denies investors the ability to assess a firm's returns on its innovative activities (Lev, 1999). Ratios such as net sales to total assets and return on total assets are less meaningful due to the absence of R&D on the balance sheet.

In addition to establishing a linkage between R&D expenditures and future sales, prior literature has also identified an association between a firm's R&D outlays and its future net income. Sougiannis (1994) indicates that, on average, a one-dollar investment in R&D will yield a two-dollar increase in profit over a seven-year period. Amir et al. (2007) suggest that an association exists between investments in R&D and subsequent earnings variability for firms that operate in an R&D-intensive industry. Other literature deals with examining the association between R&D expenditures and future stock returns. Although Morbey (1988) did not find an association between a firm's R&D expenditures and its future stock price, more recent studies do find a linkage between expensed R&D and stock returns (Lev and Sougiannis, 1996, 1999; Chan et al., 2001). These current findings indicate that investors place a premium on the company's growth potential via R&D expenditures over the risk associated with these R&D projects.

HYPOTHESES DEVELOPMENT

Earnings management practices may occur to avoid the reporting of net losses, earnings decreases, and earnings that fall short of analysts' forecasts. Following Brown and Caylor (2005), Graham et al. (2005), and Degeorge et al. (1999), this study presents an analysis of quarterly earnings to examine the relative significance that each of these conditions has to motivate firm managers to finesse earnings. Since these studies and other prior research including Burghstahler and Dichev (1997) and Dechow et al. (2003) have yielded inconsistent results, the body of literature in this specific area should be updated. Changing economic conditions and the evolution of the financial reporting environment can affect how managers view each of these three quarterly thresholds. The performance of the overall market, the emergence of a global economy, and the issuance of legislation such as the Sarbanes-Oxley Act

and Fair Disclosure Act can affect the motivations of firm managers to influence reported earnings.

Degeorge et al. (1999) report that analysts, investors, senior executives, and boards of directors consider earnings the single most important item in the financial reports issued by publicly held firms. Meeting the threshold of reporting a profit rather than a loss arises from the psychologically important distinction between positive and negative numbers. Firm managers may be motivated to report a net profit since many business decisions are based on clearly defined predetermined thresholds. Employee compensation agreements, bank lending practices, and bond rating criteria may all be influenced by whether or not a business reports a net profit. Surpassing the "bright line" threshold of zero profit may present true economic consequences to the business. Prior research suggests that firms will engage in earnings management practices to avoid the reporting of net losses (Hayn, 1995; Beaver et al., 2003; Roychowdhury, 2006). Empirical studies (Hayn, 1995; Burgstahler and Dichev, 1997; Dechow et al., 2003) have also revealed that many more firms report a small net profit than the amount of firms that report a small net loss. Although this may not constitute evidence of earnings management, the results of these studies suggest that firms are at least aware of the zero profit threshold and may be willing to take action to avoid the reporting of net losses. Burgstahler and Dichev (1997) estimated that 30% to 44% of firms with low unmanaged losses take actions to raise reported earnings to achieve a positive net income. Since firms with a minimal amount of unmanaged net losses may be ideal candidates to engage in earnings management practices to achieve a net profit, the first hypothesis is:

> **H1**: R&D-intensive firms that report a net loss, adjusted for unexpected R&D expenditures, are more likely to reduce R&D spending during this period.

Sustaining a consistent growth pattern of corporate earnings is of principal significance to firm managers. Prior research has suggested that firms with a sustained series of increases in earnings have higher earnings response coefficients (ERCs) and are thus priced at a premium in the market (Kormendi and Lipe, 1987; Barth et al., 1999). DeAngelo et al. (1996) indicate that a break in the pattern of earnings increases may be associated with a decline in the firm's stock price. A decrease in reported earnings from the prior period can send a signal to the market that the firm has hit its peak earnings potential and may be on the decline. Other studies have suggested that publicly held nonfinancial firms report small declines in earnings less often than small increases (Burgstahler and Dichev, 1997; Degeorge et al., 1999). These studies have been extended to the financial sector and similar results were obtained for the banking industry (Beatty et al., 2002) and the property & casualty insurance industry (Beaver et al., 2003). Therefore, the second hypothesis is as follows:

> **H2**: R&D-intensive firms that report a decrease in earnings from the prior period are more likely to reduce R&D spending.

The use of analysts' forecasts by researchers as a proxy for earnings expectations has been pervasive in accounting and finance literature over the years. Shipper (1991) describes analysts as intermediaries who are sophisticated users of financial information and asserts that accountants have a stake in understanding how analysts use this information. To avoid negative earnings surprises, corporate managers may have a strong impetus to report financial results that either meets or surpasses analysts' forecasts. Previous studies (Bartov et al., 2002; Lopez and

Rees, 2002) suggest that the market will penalize firms that fall short of analysts' earnings projections while it may reward firms that exceed these benchmarks. Firm managers are cognizant of this market reaction, as literature in this field (Brown, 1997; Burgstahler and Eames, 2006) indicates that a much higher distribution of companies report small positive earnings surprises than those that report small negative earnings surprises. Matsumoto (2002) suggests that managers may adjust discretionary accruals and expenditures either upward or downward in an effort to slightly exceed the consensus forecast. Profitable firms may not want to exceed analysts' forecasts by too great an amount because it may create a more difficult threshold to obtain in future periods. Since managers may be aware of the significance of beating earnings forecasts, the third hypothesis is:

> **H3**: R&D-intensive firms that do not meet analysts' forecasts of earnings are more likely to reduce R&D spending.

METHODOLOGY

Following Burgstahler and Eames (2003) and Baber, et al. (1991), the sample is comprised of industrial firms from the Standard Industrial Classification (SIC) Codes 2000 through 3999. Using Standard and Poor's Compustat database to compile the data, 255 of the 952 firms selected from the initial sample were identified as reporting an R&D intensity ratio of at least 10% for the 2005 year. Since R&D intensity was used to refine the sample, only firms that reported sales revenues of at least $100 million and R&D expense of at least $1 million were included in the initial sample. The sample selected for this study consists of firms primarily from the biotechnology, computer hardware, pharmaceuticals, machinery and electronics sectors. Because this study may suggest that a deficiency in the accounting treatment of R&D in the US may exist, foreign corporations were removed from the sample. After removing firms that did not report complete data on a quarterly basis for all test variables from 2001 through 2005, the final sample consisted of 2,816 firm-quarter observations.

Three distinct tests (one for each hypothesis) were performed for each of these firm-quarters. Unexpected R&D expenditures is used as the proxy for managed earnings in each of these tests. Unexpected R&D, the dependent variable in each test, is calculated as follows:

$\text{UNEXPEC(R\&D)}t = \text{R\&D}t - \text{EXPEC(R\&D)}t$ and

$\text{EXPEC(R\&D)}t = \text{R\&D}t\text{-}4 \times \text{GF(R\&D)}$ where,

UNEXPEC(R&D)t is the unexpected R&D expenditure for the current quarter.

R&Dt is the actual R&D expenditure for the current quarter.

EXPEC(R&D)t is the expected R&D for the current quarter.

R&Dt**-4** is the actual R&D expenditure for the same quarter of the prior year.

GF(R&D) is the growth factor for R&D and is computed by adding 100% to the average annualized R&D growth rate over the five-year period for each firm in the study.

Adjusting the R&D expenditure of the same quarter from the prior year by a growth factor should serve as a reasonable proxy for expected R&D expenditure. Although many macroeconomic factors, industry-specific conditions and firm-specific variables may affect anticipated R&D expenditures, the average annualized growth rate from the preceding five-year

period is a reasonable estimator of this expenditure, and an improvement over the use of just the prior period's figure alone.

For each hypothesis test, a binary logistic regression model is used to estimate the probability that R&D expenditures have been increased or decreased depending on the values of the independent variables. For each observation (firm-quarter), the amount of unexpected R&D, the dependent variable for each test, is assigned either a 1 for a negative amount or a 0 for a zero or positive amount. Following Bushee (1998), the logistic regression model is selected because the magnitude of R&D decrease may not be relevant to determine if a firm has engaged in earnings management practices. Since some firms nearly miss earnings targets, it would take less of an adjustment in R&D spending to meet the targeted earnings level. It would be an erroneous assumption to claim that a firm engaged in a greater degree of earnings management because it decreased R&D spending by a greater amount. This assertion about the lack of relevance in the amount of R&D change is supported by other studies (Bushee, 1998; Perry and Grinaker, 1994; Dhaliwal et al., 2004). In fact, these studies identify firms that just miss earnings targets by a modest amount as better candidates to manage earnings because a smaller decrease in R&D spending can be leveraged to achieve the desired earnings level.

Binary logistic regression analysis is utilized to determine the percent of the variance in the dependent variable that is explained by the independent variables. Logistic regression tests are also performed to rank the relative importance of the independent variables and assess the interaction among these variables. In logistic regression there is no assumption of homoscedasticity; that is the variance of the dependent variable is constant across all values of the independent variables. It is also not a prerequisite that the predictor variables have a normal distribution. In logistic regression, the dependent variable is transformed into a logit variable. This is the natural log (ln) of the odds of the dependent variable occurring. The probability of a certain event, such as earnings management, can be estimated as follows:

$$\log (\text{odds}) \text{ or } \text{logit}(P) = \ln(P/(1-P)) \quad \text{where,}$$

P equals the probability that a firm will manage its earnings, represented by a decrease in unexpected R&D. This formula can be interpreted as:

$$\text{Logit}(P) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots \beta_i X_i \quad \text{where,}$$

α represents the constant and β represents the coefficient of the independent variable. The odds of the dependent variable being equal to one is calculated by dividing the probability of the dependent variable being equal to one (success) divided by the probability of the dependent variable being equal to zero (failure). The range of these odds is from zero to infinity.

The independent variable in the first hypothesis test is unmanaged earnings for each firm-quarter. Unmanaged earnings is calculated by adding back unexpected R&D expense (see above calculation) to income before extraordinary items as follows:

$$\text{UNMAN(EAR)}t = \text{EAR}t + \text{UNEXPEC(R\&D)}t \quad \text{where,}$$

$\text{EAR}t$ represents earnings before extraordinary items. Unexpected R&D expense is added back to earnings to arrive at unmanaged earnings. Rather than adding back the entire R&D expense to earnings, as shown in Perry and Grinaker (1994), earnings is adjusted only for the unexpected portion of R&D expenditure. This represents a good indicator of what earnings would have been if no management of R&D expenses had taken place. Each firm-quarter will be classified as

reporting either a negative or non-negative unmanaged earnings amount and logistic regression will be used to identify if a relationship exists in either of these two groups to unexpected R&D.

As a proxy for earnings increases or decreases, the independent variable in the second hypothesis test will be the change in unmanaged earnings. Following Brown and Caylor (2005), the change in unmanaged earnings is calculated by deducting unmanaged earnings from the same quarter in the prior year from the current period's unmanaged earnings as follows:

$$UNMAN(EAR)CHG_t = UNMAN(EAR)_t - UMAN(EAR)_{t-4}$$

Each firm-quarter is classified as reporting either a decrease or no decrease in unmanaged earnings from the prior period and logistic regression will be used to identify if a relationship exists in either of these two groups to unexpected R&D.

The testing of the third hypothesis focuses on the relationship between firms that fail to meet analysts' forecasts and the management of earnings. Following Brown and Caylor (2005) and Burgstahler and Dichev (1997), the most recent earnings forecast prior to the earnings announcement date is used to represent analysts' forecasts. The most recent forecast is more closely related than is the mean consensus forecast to the stock price reaction to earnings announcements (Brown and Kim 1991). This forecasted data was compiled from First Call database. Earnings surprises are calculated by taking the difference between actual reported earnings per share (EPS) for the current period and the latest forecasted EPS. As in each of the first two hypothesis tests, all actual EPS results are adjusted for any unexpected R&D as follows:

$$SURPRISE(EPS)_t = UNMAN(EPS)_t - FORECAST(EPS)_t \quad \text{where,}$$

SURPRISE(EPS)$_t$ is the difference between the unmanaged actual EPS and the forecasted EPS for each current firm-quarter.

UNMAN(EPS)$_t$ is the actual EPS, adjusted by the effect of unexpected R&D on this ratio.

FORECAST(EPS)$_t$ is the most recent analysts' forecast of EPS prior to the earnings announcement date.

Each firm-quarter is classified as reporting either a negative or non-negative earnings surprise and logistic regression is used to identify if a relationship exists in either of these two groups to unexpected R&D.

Data on capital expenditures for property, plant and equipment was compiled for each firm-quarter. These expenditures are less attractive vehicles for earnings management practices as they are capitalized and expensed over future periods. For control purposes, additional tests are run using the change in capital expenditures the dependent variable. These test results are compared to the results from the initial tests that utilized unexpected R&D as the dependent variable. Figure 2 (below) summarizes the logistic regression tests performed in the study.

FIGURE 2: LOGISTIC REGRESSION TESTS

1	Likelihood Ratio Test Hosmer-Lemeshow Test	Measures of goodness of fit
2	Wald Statistic	Test of statistical significance for each coefficient
3	Odds Ratio	Measures the relative effect of independent variables
4	Cox & Snell R-squared Nagelkerke R-squared	Measures how well the model predicts the values of the dependent variable
5	Leverage Statistic h	To detect outliers in the sample

The likelihood ratio test is performed to test the model for goodness of fit. Using a backward stepwise method, all three independent variables are entered into the equation and those that do not significantly affect the results are eliminated. The log likelihood (LL) is the probability that the observed values of the dependent variable may be predicted from the observed values of the independent variables. Since the range of this probability is from zero to one, the log of this probability ranges from zero to negative infinity, as the log of any number less than one is negative. This number is then multiplied by negative to yield the goodness of fit. The likelihood ratio test is defined as:

-2LL (model without all variables) - -2LL (model with all variables)

The Wald statistic is used to measure the statistical significance of each coefficient (β). This test is suitable for this study because there are many cases (firm-quarters) in the sample. The statistic represents the ratio of the coefficient to its standard error and is defined as:

$Z = \beta/SE$

When Z is squared a chi-square distribution results. The odds ratio test is utilized to measure the relative effect that each independent variable has on the dependent variable. A unit change in $\exp(\beta)$ for each of the three independent variables is associated with a β change in the log odds of the dependent variable, unexpected R&D. Confidence levels of 95% are established for this test. R-squared tests, Cox & Snell and Nagelkerke, are used to evaluate how well the model predicts the values of the dependent variable. The leverage statistic h is also evaluated to determine if any observations in the study have a large effect on the predicted values.

RESULTS

The final sample consisted of firms that represented the following sectors: pharmaceutical / biotechnology 25.6%, semiconductors and electronic components 25.0%, machinery 18.9%, laboratory instruments 18.2%, communications equipment 10.2%, other 2.1%. Quarterly R&D expenditures for firms in the sample ranged from $640 thousand to $7.1 billion, with a mean of $96.5 million. 47% of the firm-quarters reported negative unexpected R&D expenditures. For the following independent variables: 41% of the firm-quarters reported negative unmanaged earnings, 39% of the firm-quarters reported a negative change in unmanaged earnings, and 84% of the firm-quarters reported a negative surprise EPS. The leverage statistic h indicated that no observations in the study have a large (outlier) effect on the predicted values.

The likelihood ratio test for goodness of fit yielded a significance level of less than 5% for the baseline model that included the constant (α) as the only variable in the equation (see Table A). The null of this model, logit (P) equals the constant, can thus be rejected. This indicates that the independent variables in the overall model do make a difference in predicting either an increase or decrease in unexpected R&D. The Hosmer-Lemeshow test produced consistent results for goodness of fit as a significance level of under .05 was attained (see Table B).

Test results indicate that the null hypothesis should be rejected for each of the three hypotheses. For the first hypothesis, observations with negative unmanaged earnings are more likely to report a negative unexpected R&D amount than observations with positive unmanaged earnings. The

null of this hypothesis is rejected as the Wald statistic reported a significance level of below 5% (see Table C). The odds ratio test, represented by the Exp(β) statistic, revealed that firm-quarters reporting a negative amount for unmanaged earnings are 1.931 times more likely to report a negative unexpected R&D amount than firm-quarters that reported non-negative unmanaged earnings. Within a 95% confidence interval, the Exp(β) statistic falls between 1.629 and 2.290.

For the second hypothesis, firm-quarters that reported a decrease in unmanaged earnings are more likely to report a negative unexpected R&D amount than firm-quarters that reported an increase in unmanaged earnings. The null of this hypothesis is rejected as the Wald statistic reported a significance level of below 5% (see Table C). The odds ratio test, represented by the Exp(β) statistic, revealed that firm-quarters reporting a decrease in unmanaged earnings are 1.228 times more likely to report a negative unexpected R&D amount than firm-quarters that reported an increase in unmanaged earnings. Within a 95% confidence interval, the Exp(β) statistic falls between 1.037 and 1.455.

For the third hypothesis, observations with a negative amount for earnings surprise are more likely to report a negative unexpected R&D amount than firm-quarters with a positive earnings surprise. The null of this hypothesis is rejected as the Wald statistic reported a significance level of below 5% (see Table C). The odds ratio test, represented by the Exp(β) statistic, revealed that firm-quarters reporting a negative amount for earnings surprise are 1.573 times more likely to report a negative unexpected R&D amount than firm-quarters that reported a positive earnings surprise amount. Within a 95% confidence interval, the Exp(β) statistic falls between 1.262 and 1.962.

Identical statistical tests were run for all firm-quarters with the change in capital expenditures replacing unexpected R&D as the dependent variable. The likelihood ratio test for goodness of fit yielded a significance level of 29.1% for the baseline model that included the constant (α) as the only variable in the equation. The null of this model can not be rejected, indicating that the independent variables in the overall model do not make a significant difference in predicting either an increase or decrease in the change in capital expenditures. For both tests of R-squared, Cox & Snell and Nagelkerke, the reported figure was lower with the change in capital expenditures as the dependent variable. This indicates that the independent variables serve as better predictors when unexpected R&D is the dependent variable. With the change in capital expenditures as the dependent variable, the Wald statisitc reported a significance level of above 5% with the change in unmanaged earnings as the predictor variable.

CONCLUSIONS

Evidence from this study indicates that decisions to invest in R&D are influenced by corporate managers' concerns about reported earnings. These results are consistent with prior studies (Burghstahler and Eames, 2003; Baber, et. al., 1991) which indicate that managers will alter discretionary spending to manage earnings. This conclusion is further supported by the test results with the change in capital expenditures as the dependent variable. The ranking of importance for each of these three predictor variables on unexpected R&D is as follows:
    First: Manage earnings to avoid reporting a net loss.

Second: Manage earnings to avoid falling short of analysts' estimates.
Third: Manage earnings to avoid reporting a decrease in income from the prior period.

The results from this study suggest that firms will place a premium on attempting to report a net income rather than a net loss. This is intuitive because firms that fail to meet this benchmark may suffer actual economic consequences that are directly tied into reporting a net loss. Contractual agreements that include as employee compensation arrangements, bank lending practices, and bond rating criteria may all be influenced by whether or not a business reports a net profit. The implications from this study could affect the decision-making process of investors, analysts, auditors, and standard-setters.

TABLES: STATISTICAL TESTS – UNEXPECTED R&D

A) Likelihood Ratio Test: Constant Only

	B	S.E.	Wald	df	Sig.	Exp(B)
Step 0 Constant	.138	.038	13.344	1	.000	1.148

B) Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	17.688	4	.001

C) Wald Statistic, Odds Ratio, Confidence Intervals

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1(a)	EAR01	.658	.087	57.364	1	.000	1.931	1.629	2.290
	CHGEAR01	.206	.087	5.644	1	.018	1.228	1.037	1.455
	SURP01	.453	.113	16.180	1	.000	1.573	1.262	1.962
	Constant	-.584	.097	36.237	1	.000	.558		

a   Variable(s) entered on step 1: EAR01, CHGEAR01, SURP01.

D) R-Squared Tests

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	3748.654	.049	.066

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AN ANALYSIS OF OPERATING FACTORS ON THE CHANGES OF CASH FLOWS

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Abstract

Decisions regarding activity levels often focus on their impacts to the bottom line such as cost-volume-profit (CVP) analysis. However, a production level contributing positively to the bottom line might not be a sustainable one if an organization does not have adequate cash to support the decision. Operating factors such as lead times, cost structures, and trade terms create a time lag between earnings and cash flows. This study first shows the conditions where negative correlations exhibited between the changes of earnings and cash flows and between the changes of cash flows in successive periods using a simple demand pattern. This phenomenon was proved under certain trade credit terms and cost structures in [2] using a random walk demand process. Here, we provide an alternative proof allowing for broader considerations of various operations factors. A simulation study is developed to first verify the results obtained from the analytical approach and second to study the correlation behavior under more general demand patterns, cost structure and trade terms. The simulation model generates earnings and cash flow forecasts allowing decision makers to see the means and standard deviations of future earnings and cash flows as a result of their decisions.

Keywords: Trade credit terms, Cash flows, Supply chain, Simulation

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1. Introduction

Since cash is the lifeline precious to a company's survival and growth potentials, it is imperative for organizations to understand the cash impact of their operational decisions. Cash pressure from customers and suppliers on better credit terms, coupled with a tightened credit line from its bank can succumb a company with enough orders and positive earnings [6]. As a result, when making activity level decisions such as production volume, decision makers need to consider not only the growth opportunities for earnings but also the sustainability of the growth in terms of cash resources, especially for cash constrained companies.

Under the revenue recognition and matching principles of GAAP, the accrued basis accounting system creates a time lag between earnings and cash flows. Revenue recognition is also a major contributors to fraudulent financial reports. As such, FASB Statement No. 95 issued in 1987 added the statement of cash flows as one of the required financial statements. As earnings are more subject to manipulation, DeFond and Hung [3] found that when analysts are suspicious about a company's financial statements, they tend to generate cash flow forecast in addition to earning forecast. Almeida, Campello, and Weisbach [1] showed the cash constrained companies tend to reserve more cash when their operating cash flows are higher for potential future needs of cash. Dechow et al. [2] showed that because the changes of cash flow between periods often exhibit a negative correlation, using current net cash flows to predict future cash flows does not produce as good result as using current earnings to forecast future cash flows.

There are a great number of studies intended to demystify the relationship between earnings and cash flows. The purpose of this study is to better understand the behavior of net cash flow changes as a result of operations decisions through both analytical and simulation approaches. The first part of this paper applies an analytical approach to identify the conditions when the negative correlation exists. We focus on a basic model with less complexity to observe the main interactions between cash flows and earnings mediated by key operations decisions. In the simulation study, more operational and risk factors are introduced to move the model closer to real practice. The purpose is to better understand
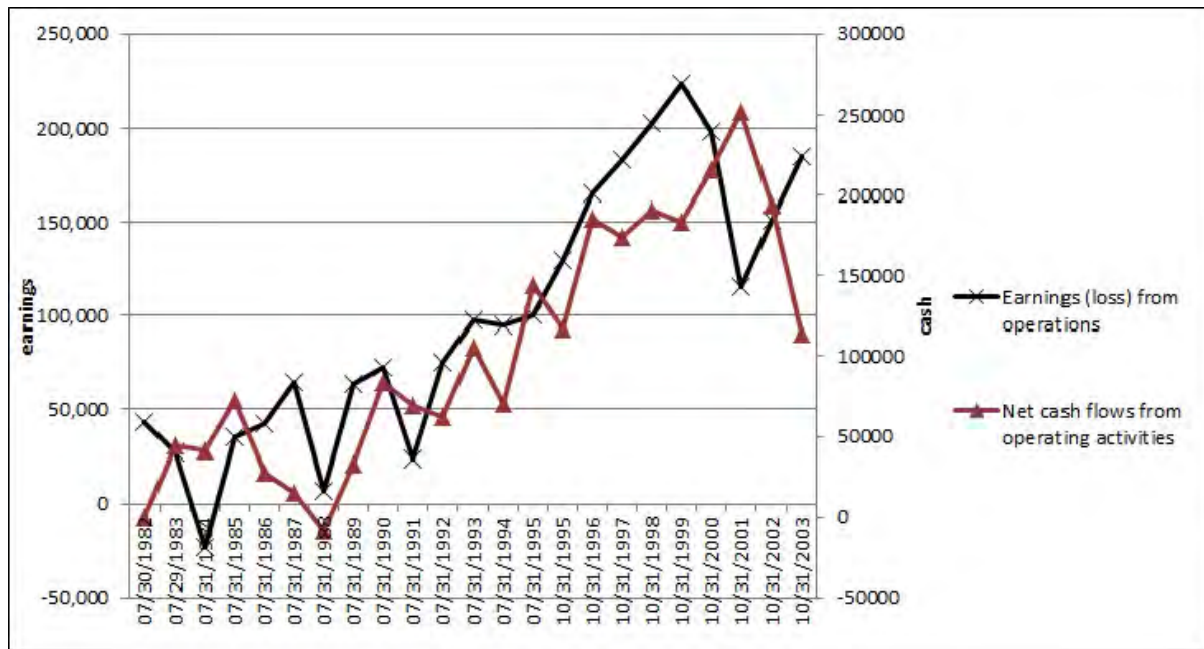
Figure 1: Earnings and Cash flow - Toro Company

the interdependent relationships between activity level, cost structure, and operating cash flows.

2. An Analytical Approach of Relationships between Cash flows and Earnings

In [2], the authors used an indirect method to calculate operating cash flows from earnings and show that under most conditions, the correlations between net cash flow changes of two successive periods are negative. As a result, predicting future cash flows from current cash flows are not as good as predicting future cash flows from current earnings, which tend to be more stable as a result of the revenue recognition and matching principles. As indicated in Figure 1, Toro Company's earnings in the past exhibits a steady increase. However, the cash flow line has a greater fluctuation and a time delay as compared to the earnings line. For example, earnings peaked in 1999 while cash flows reached its peak two years later. This wider fluctuation and the time lag are the two main reasons why a decision maker needs to look into future cash flows in addition to earning forecasts when making activity level

decisions.

This study uses a direct approach to link cash flows with operational activities. The analytical process adopts a random walk demand pattern from [2] where the demand in time period t, D_t is a random variable determined by

$$D_t = D_{t-1} + \epsilon_t \quad \forall t, \; \epsilon_t \to N(0, \sigma) \tag{1}$$

which can be viewed as a special case of the model in [7]

$$D_i = \beta_0 + \beta_1(i) + \rho D_{i-1} + \epsilon_i, \quad i = 1, 2, \ldots \tag{2}$$

where $\beta_0 = \beta_1 = 0$ to eliminate the linear trend and $\rho = 1$ to make (1) a special case of (2).

Operating factors considered include a production lead time, an accounts receivable trade credit term, an accounts payable trade credit term, and a cost structure consisted of an external cost pay to vendors and an internal conversion cost. In the absence of a trend factor, the relationship among cash flows, earnings, and operations factors of interest can be better observed.

2.1. Assumptions

To simplify the indices of variables, we assume physical flows occur at the beginning of each period, fulfilling orders and receiving materials, while cash flows, cash payments and receipts, happen at the end. Other assumptions include

1. Sales: At the beginning of period t, the demand in period t, D_t, is realized (shipped). Based on D_t, the forecast for a future period $t + i$ is made by $E[D_{t+i}|D_t] = D_t$ and $Var[D_{t+i}|D_t] = i\sigma^2$. Actual sales is defined as $S_t = Min\{D_t, PU_t + INV_t\}$ where PU_t and INV_t are units completed the production process and beginning inventory respectively at the beginning of time period t. We assume the safety stock level is significantly higher than σ so that stock out rarely happens in the analytical approach. Hence, in the analysis of sales revenue, we make no distinction between sales and demands. Payment received by the end of time period t receives a discount of c_r and

full payment is due at the end of period $t + r$, where r is the number of periods in an accounts receivable credit term.

2. Production quantity: Given D_t, the production quantity Y_t of time t is determined through the following steps when there is an l-period lead time. Production of Y_t starts from t and completes in $t + l - 1$. Thus, Y_t is available for sale at the beginning of $t + l$ and is denoted as PU_{t+l}.

- The manufacturer adopts a produce-up-to policy where the produce-up-to quantity in time t, S_t, is the expected lead time demand plus a safety stock (see [4] for details). Assume the safety stock level does not change from period to period. Thus, $S_t - S_{t-1} = \sum_{k=1}^{l}(E[D_{t+k}|D_t] - E[D_{t-1+k}|D_{t-1}])$.

- Under these assumptions, the manufacturer determines the production volume, Y_t, after D_t is realized by

$$
\begin{aligned}
Y_t &= D_t + (S_t - S_{t-1}) \qquad\qquad\qquad (3) \\
&= D_t + \sum_{k=1}^{l}(E[D_{t+k}|D_t] - E[D_{t-1+k}|D_{t-1}]) \\
&= D_t + l\epsilon_t
\end{aligned}
$$

As seen in (3), the production quantity Y_t consists two parts, a part to replenish the depleted inventory, D_t, drawn in time t and the other part to update the produce-up-to quantity, S_t, from S_{t-1}.

3. Operations Costs: Total operational cost to produce Y_t is a fixed proportion of Y_t. It contains an external procurement cost of $\alpha_1 Y_t$ paid to the vendors and an internal conversion cost of $\alpha_2 Y_t$. In order to maintain a positive gross profit, we assume $0 \leq \alpha_1,\ \alpha_2 \leq 1$ and $\alpha_1 + \alpha_2 < 1$.

- Materials required for Y_t, $\alpha_1 Y_t$, must arrive at the beginning of t to be ready for the production of Y_t. There is a v-period accounts payable credit term. Accounts payable from materials received at the beginning of t is due by the end of time $t + v$ and an discount is offered if paid in t. Assume there is no lead time for ordering materials.

- The conversion cost $\alpha_2 Y_t$ is incurred evenly throughout the l-period lead time with $\alpha_2 Y_t / l$ paid in each period.

2.2. Correlations between Changes of Earnings and Cash Flows

In this section, we analyze the correlations between

1. changes of net cash flows and changes of net earnings (C-E)
2. changes of net cash flows in successive time periods (C1-C2)
3. changes of cash inflows and changes of cash outflows (I-O)

in a future period $t + i$ under four different scenarios.

Since net earnings are determined under the revenue recognition and matching principles, it is not affected by the trade terms or lead times and coincides with the physical flow of finished goods and materials. Based on the assumption, it is always,

$$E_t \quad = \quad (1 - \alpha_1 - \alpha_2)D_t \tag{4}$$

On the cash flow side, the inflow, outflow, and net flow are characterized as follows.

$$I_t \quad = AR_{t-r} \quad = Min\{D_{t-r}, \ PU_{t-r} + INV_{t-r}\} \tag{5}$$

$$O_t \quad = \quad \alpha_1 Y_{t-v} + \frac{\alpha_2}{l} \sum_{k=0}^{l-1} Y_{t-k}$$

$$\quad = \quad \alpha_1 [D_{t-v} + l\epsilon_{t-v}] + \frac{\alpha_2}{l} \sum_{k=0}^{l-1} D_{t-k} + \alpha_2 \sum_{k=0}^{l-1} \epsilon_{t-k} \tag{6}$$

$$C_t \quad = \quad I_t - O_t \tag{7}$$

Equation (6) shows that due to the lead time, l, there are l batches, $Y_{t-l+1}, \ldots, Y_t$ under production in time period t.

Table 1 presents the analytical results of the three types of correlations under the four different scenarios where we assume $I_t = D_{t-r}$. Case 1 is used as a baseline for comparison where $l = r = v = 0$. The remaining three cases each has one factor different from Case 1. In Cases 2, 3, and 4, we flip each of the three factors, l, r, and v, from 0 to 1 to study the impact of the factor on the correlations.

$$\Delta E_t = (1 - \alpha_1 - \alpha_2)\epsilon_t$$

$$Var(\Delta E_t) = (1 - \alpha_1 - \alpha_2)^2 \sigma^2$$

$$\bar{\alpha} = \alpha_1 + \alpha_2$$

Cases	Case 1	Case 2	Case 3	Case 4
	$l = r = v0$	$l = 1, r = v = 0$	$r = 1, l = v = 0$	$v = 1, l = r = 0$
$C_t = I_t - O_t$	$D_t - \bar{\alpha}D_t$	$D_t - \bar{\alpha}(D_t + \epsilon_t)$	$D_{t-1} - \bar{\alpha}D_t$	$(1 - \alpha_2)D_t - \alpha_1 D_{t-1}$
ΔC_t	$(1 - \bar{\alpha})\epsilon_t$	$(1 - 2\bar{\alpha})\epsilon_t + \bar{\alpha}\epsilon_{t-1}$	$\epsilon_{t-1} - \bar{\alpha}\epsilon_t$	$(1 - \alpha_2)\epsilon_t - \alpha_1\epsilon_{t-1}$
$Var(\Delta C_t)$	$(1 - \bar{\alpha})^2\sigma^2$	$5\bar{\alpha}^2 - 4\bar{\alpha} + 1$	$1 + \bar{\alpha}^2$	$\alpha_1^2 + (1 - \alpha_2)^2$
$Cov(\Delta C_t, \Delta E_t)$	$(1 - \bar{\alpha})^2\sigma^2$	$(1 - 2\bar{\alpha})(1 - \bar{\alpha})\sigma^2$	$-\bar{\alpha}(1 - \bar{\alpha})\sigma^2$	$(1 - \bar{\alpha})(1 - \alpha_2)$
$Corr(\Delta C_t, \Delta E_t)$	1	$\frac{1 - 2\bar{\alpha}}{\sqrt{5\bar{\alpha}^2 - 4\bar{\alpha} + 1}}$	$\frac{-\bar{\alpha}}{\sqrt{1 + \bar{\alpha}^2}}$	$\frac{1 - \alpha_2}{\sqrt{\alpha_1^2 + (1 - \alpha_2)^2}}$
$Cov(\Delta C_{t-1}, \Delta C_t)$	0	$\bar{\alpha}(1 - 2\bar{\alpha})\sigma^2$	$-\bar{\alpha}\sigma^2$	$-\alpha_1(1 - \alpha_2)$
$Corr(\Delta C_{t-1}, \Delta C_t)$	0	$\frac{\bar{\alpha}(1 - 2\bar{\alpha})}{5\bar{\alpha}^2 - 4\bar{\alpha} + 1}$	$\frac{-\bar{\alpha}}{1 + \bar{\alpha}^2}$	$\frac{-\alpha_1(1 - \alpha_2)}{\alpha_1^2 + (1 - \alpha_2)^2}$
$Cov(\Delta I_t, \Delta O_t)$	$\bar{\alpha}\sigma^2$	$2\bar{\alpha}\sigma^2$	0	α_2
$Corr(\Delta I_t, \Delta O_t)$	1	$\frac{2}{\sqrt{5}}$	0	$\frac{\alpha_2}{\sqrt{\alpha_1^2 + \alpha_2^2}}$

Table 1: Correlation analysis of changes of cash flows and operating profits

In Table 1, the correlation between net cash changes and net earnings changes, $Corr(\Delta C_t, \Delta E_t)$, in Case 2 has a coefficient of 2 in the numerator. It also appears in the correlation between net cash flow changes in successive periods, $Corr(\Delta C_{t-1}, \Delta C_t)$, in the same case. That is due to the replenishing and adjusting factors mentioned earlier, whenever there is a lead time. From Table 1, $Corr(\Delta C_t, \Delta E_t)$ and $Corr(\Delta C_{t-1}, \Delta C_t)$ are positive if $\alpha_1 + \alpha_2 < 0.5$, which is a tough goal to achieve. In Case 3, due to the negative sign in the numerators of $Corr(\Delta C_t, \Delta E_t)$ and $Corr(\Delta C_{t-1}, \Delta C_t)$, they are always negative. It is due to the delayed cash receipt from the AR credit term. Since Case 2 and Case 3 are both impacted by α_1 and α_2, we use the two cases to study the impact of the overall cost structure on the correlations. Fig 2 shows that, in Case 2, when there is a one-period lead time, the correlations between cash-earnings (C-E) correlations, $Corr(\Delta C_t, \Delta E_t)$, and cash-cash (C1-C2) correlations, $Corr(\Delta C_{t-1}, \Delta C_t)$, decrease from positive to negative numbers as cost ratios rise above 0.5. In Case 3, when there is a one-period AR credit term, the cash-earnings and cash-cash correlations also decrease as cost ratios increase and, as seen in Table 1, the correlations are all negative. Higher cost ratios move the correlations more to the negative territory which reduce the predictability of future cash flows.

In Case 4, the impact of α_1 and α_2 are separate. As a result, we use this case to study the changes of compositions between the two cost components while fixing $\alpha_1 + \alpha_2$ to 0.9. Composition 1 has $\alpha_1 = 0.1$ and $\alpha_2 = 0.9$. In each of the subsequent composition, α_1 is increased by 0.1 and α_2 is reduced by 0.1. The value 0.9 was chosen using the historical average cost ratios of Toro Company. From Table 1, we observe that $Corr(\Delta C_t, \Delta E_t)$ is always positive and the lower the internal conversion cost ratio the higher the correlation due to the AP credit period given to $\alpha_1 Y_t$. On the other hand, $Correl(\Delta C_1, \Delta C_2)$ is always negative and the higher α_1 is, the more negative the correlation is. Fig 3 shows that both cash-earnings and cash-cash correlations exhibit a decreasing trend over the changes of the cost compositions. However, cash-earnings correlations fall in the positive territory while cash-cash correlations are in the negative territory. The delay of payment from the AP credit term made $Corr(\Delta C_{t-1}, \Delta C_t)$ more negative as α_1 increases from 0.1 to 0.9. When
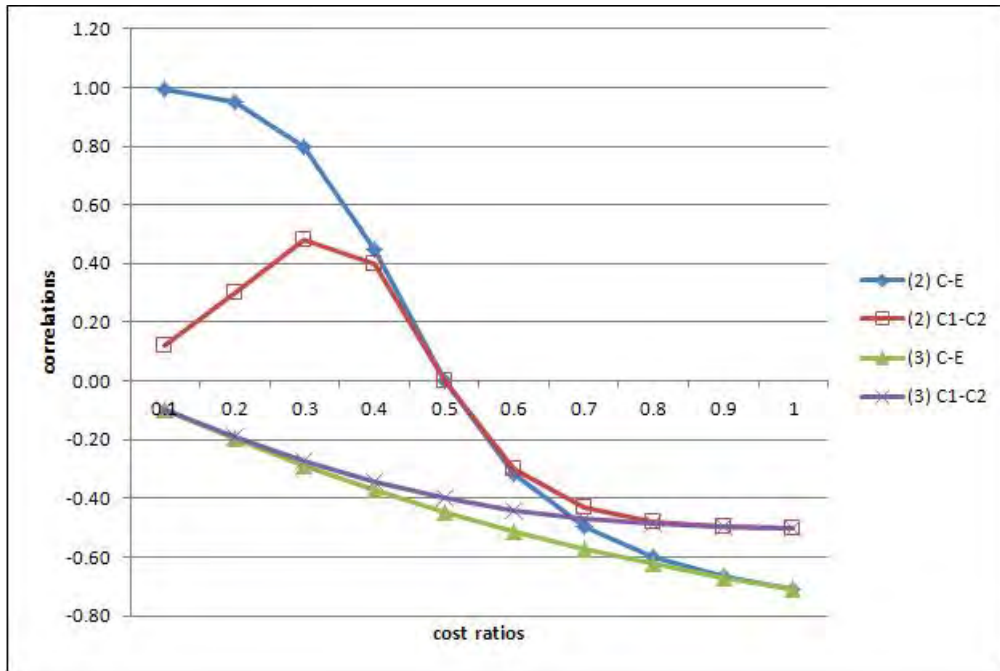
Figure 2: Correlations - Cas2 2 and Case 3

there is a high portion of cost in procurement, the correlation become lower because of the credit term offered by vendors.

3. Simulation Studies

We use Palisade's @Risk 5.7 [5], an Excel Add-In program, to implement the simulation test. To setup the simulation environment based on predetermined simulation parameters, we wrote an Excel Macro in Visual Basic to read the parameters, calculate a few constants, and write Excel and @Risk formulas and functions on the spreadsheet. After executing the Macro, we have a spreadsheet model ready for @Rsik to run its simulations and collect summary data.

3.1. Verifications

The first simulation experiment implements the four scenarios mentioned in the analytical approach to verify the accuracy of the simulation setting using $\alpha_1 = \alpha_2 = 0.45$. Table
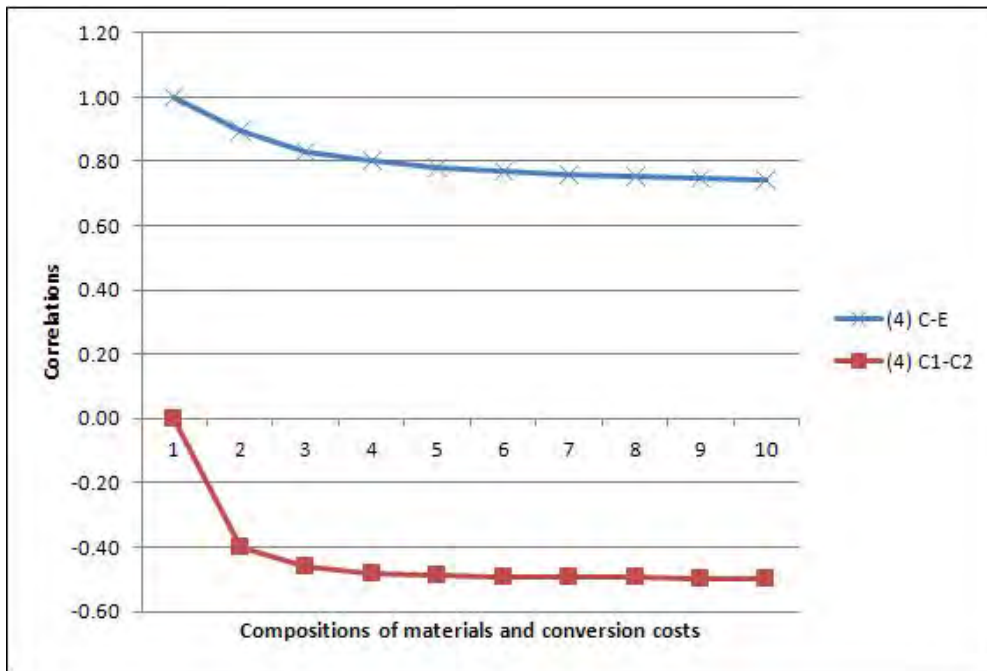
Figure 3: Correlations - Case 4

2 compares the results obtained from the analytical approach in Table 1 and the results obtained from averaging the results of 1000 simulation iterations. The two sets of numbers are very close to each other.

3.2. Random Walk Demand Pattern

In the next round of test, we use a random walk demand pattern $D_t = D_{t-1} + \epsilon_t$ where $\epsilon_t \to N(0, 10)$, which provides a relatively stable level of demands. In addition, we allow for a more general credit term where $r = 2$ (AR credit period), $v = 1$ (AP credit period), and a 3-period lead time ($l = 3$). In order to focus on cash flows and earnings comparison, we assume no early cash payment and receipt options are taken. The simulation model first generates 30 periods of historical data. Based on the historical data, future demands are simulated for period 31 and after. Subsequent data are calculated and collected in each of the 1000 simulation iterations where the means and standard deviations of key statistics are calculated. In the first stable demand scenario, S1, the cost structure remains at the

Correlations	Approaches	Case 1	Case 2	Case 3	Case 4
C-E	Analytical	1.000	-0.664	-0.669	0.774
	Simulation	1.000	-0.669	-0.676	0.782
C1-C2	Analytical	0.000	-0.497	-0.497	-0.490
	Simulation	0.010	-0.508	-0.517	-0.516

Table 2: Correlation comparison between analytical and simulation approaches

previous level of $\alpha_1 = \alpha_2 = 0.45$. In the second stable demand scenario, S2, we lower the cost ratios to $\alpha_1 = \alpha_2 = 0.40$ to observe the impact of a different cost structure.

Figure 4 shows that S1 has a slightly wider range covered by the expected cash flow plus-minus one standard deviation range. Excluding period 31 which is heavily influenced by the realized demands before period 31, S1 has an average standard deviation of 26.4 while S2 has a smaller standard deviation of 23.5. This shows that an improved cost structure can reduce cash flow risks. And, as expected, the one standard deviation ranges of earnings in both S1 and S2 are much narrower than those for cash flows, a proof of the fact that cash flow predictions are harder due to the higher level of uncertainties. The demand levels are deliberately set at two different levels so as to compare the two scenarios on the same figure without too much overlapping.

3.3. Trend

In this simulation, we use the same credit terms and lead time as those appeared in Scenarios S1 and S2. However, the demand pattern incorporates a trend factor. In Scenario T1, we set $\beta_0 = 100$, $\beta_1 = 5$, and $\rho = 0.1$ in equation (2). In Scenarios T2, we increase the trend factor β_1 from 5 to 10 to observe the impact of a steeper sales growth.

Figure 5 again shows that the one standard deviation range of earnings is much smaller than that of the cash flows. The first few periods in the planning horizon are influenced by past demands. The figure clearly indicates that cash flows, in spite of an increasing trend, is lagging behind the earnings trend. In addition, there are two periods in T2 and one period
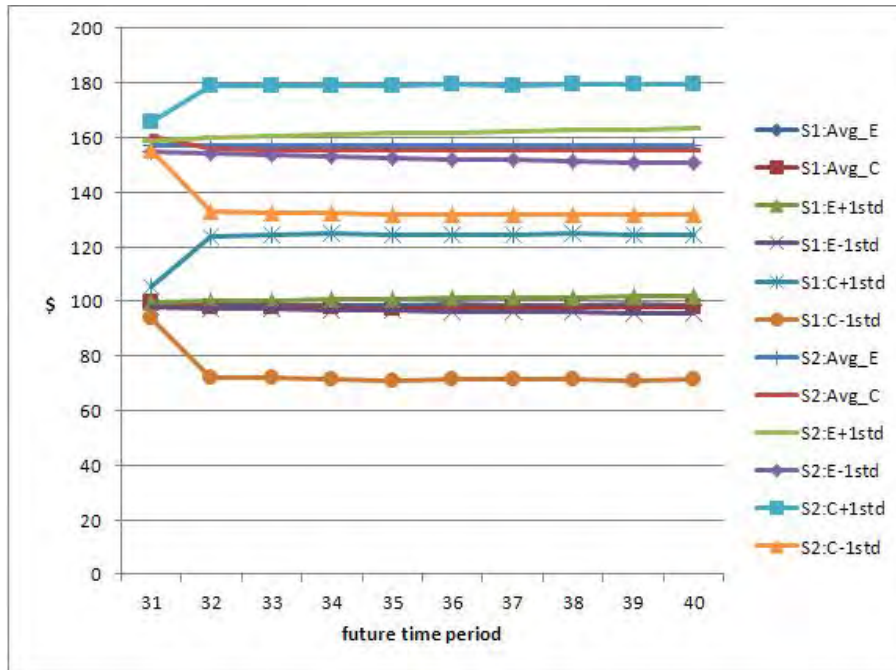
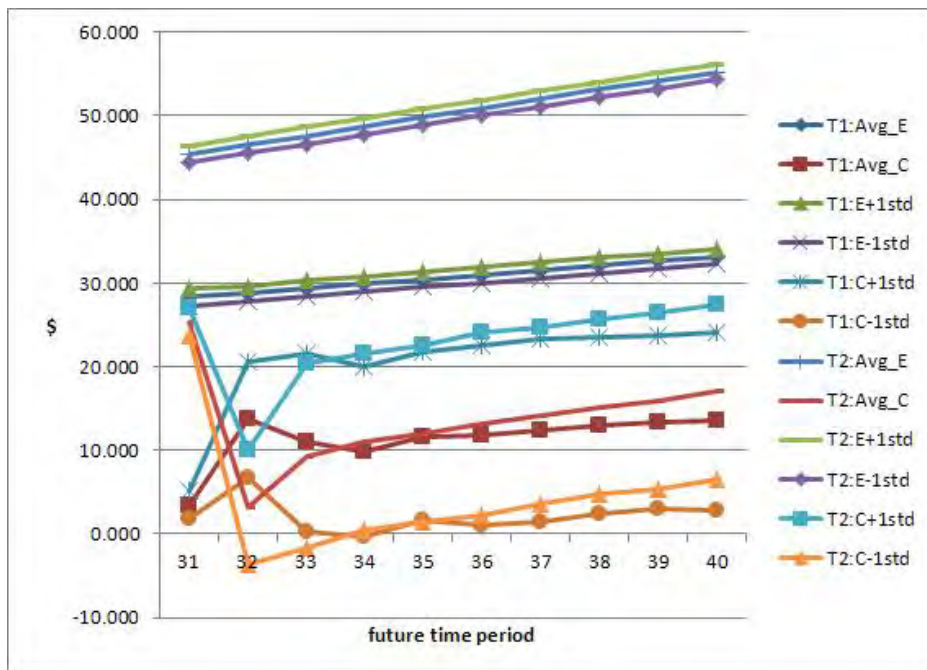Figure 4: Two scenarios under random walk demand pattern

Figure 5: Two scenarios under trend factors

Correlations	C-E	C1-C2
S1	-0.133	-0.289
S2	-0.197	-0.243
T1	0.004	-0.563
T2	0.062	-0.580

Table 3: Correlation comparison between analytical and simulation approaches

in T1 that the one standard deviation below the average cash flow lines are in the negative territory, threatening the organization with a chance of not having enough cash to support sales growth opportunities.

4. Conclusion

This study provides a tool for decision makers to better assess the cash flow impacts when making activity level decisions in addition to earnings. The first insight of those impacts are observed through the analytical approach on a simple demand pattern. It is consistent with the result in [2] that for most reasonably realistic cost structures, the correlation is negative for net cash flow changes between two consecutive periods. The simulation study on four scenarios, S1, S2, T1, and T2, indicates that the correlations between changes of net cash flows and changes of earnings are relatively small (see Table 3). However, the correlations of cash flow changes in successive periods are all negative. With the trend factor, the correlations are more negative and the magnitude grows as we increase the growth rate of sales. This, together with the results observed in the previous section, indicates that when there is a rapid growth opportunity, an organization needs to pay more attention to cash flow forecast before making a decision to raise its activity level.

In the future, the author would like to conduct more experiments to establish a sensitivity analysis.

5. References

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A CONTECTUAL EVALUATION OF COMPOSITE FORECASTS OF EARNINGS

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ABSTRACT

This study evaluates the impact of various contextual factors on the usefulness of composite forecasts of annual earnings. The evaluation is based upon the predictive accuracy of composite forecasts versus each of the individual forecast sources used in its construction: analysts' forecasts, time-series forecasts, and price-based forecasts. The contextual factors examined include (1) firm-years of relatively small vs. large size; and (2) firm-years of relatively low vs. high analyst coverage. The results of the study show that each of the three forecast resources provides unique information, incremental to that in competing forecasts. In addition, composite forecasts are more accurate than each of the individual forecasts. When the sample is partitioned based upon the two contextual factors, we found that the composite forecasts are significantly more accurate than any of the individual forecasts for smaller firms and for firms with lower analyst coverage. Among larger firms and firms with higher analyst coverage, composite forecasts outperform time-series and price-based forecasts, but not analysts' forecasts.

Keywords: Earnings forecasts, composite forecasts, firm size, analyst coverage.

AN ACTIVE LEARNING METHOD FOR TEACHING XBRL AND MAPPING CONCEPTS TO ACCOUNTING INFORMATION SYSTEMS STUDENTS

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ABSTRACT

The accounting information systems course curriculum exposes students to different computing technologies and systems used to demonstrate internal controls and processing of data affecting financial reporting. This paper presents an active learning method for students to learn about eXtensible Business Reporting Language (XBRL), a standard for electronically tagging financial and business data required by the Securities Exchange Commission. Topics presented include why accounting students should learn about XBRL, how to acquire the free software and tutorial, how to use the accompanying assignment to support the learning concepts from the tutorial, teaching notes for the assignment and exercise problems, and best practices for conducting the tutorial assignment with students.

INTRODUCTION

In a recently implemented mandate [1], publicly-held companies using the U.S. stock exchanges are now required by the Securities Exchange Commission (SEC) to file their financial reports using Extensible Business Reporting Language (XBRL), a standard for electronically tagging financial and business data.

XBRL requires the use of header tags to label each individual element of data to enable them to be identified by other software applications (such as the SEC's interactive reader). For example, when using XBRL to electronically file their 10-K and 10-Q statements, a company would attach a tag labeled "usfr-pte:CommonStockParValuePerShare" to its U.S. GAAP Common Stock Par Value Per Share figure on its interactive data balance sheet submission to signify that the data following the tag is the numerical amount of the Common Stock Par Value Per Share from their financial statement.
This tagged data is commonly distributed in the form of electronic XBRL instance documents, consisting of financial and business data and its respective standard XBRL tag. The XBRL mandate is intended to provide a common classification of financial statement information to improve the filing process and the ability to compare financial data between companies.

Companies can consider one or more implementation methods [2, 3,4] to fulfill the SEC's XBRL filing requirement, with the chosen implementation method evolving as more is learned about the process. One method is to use a stand-alone software application to tag financial statements at the end of the reporting process as an extension to the traditional process in order to convert the statements from the original source document (e.g. Microsoft Excel or Word documents) to an XBRL format. This method can be performed internally or outsourced to a third-party vendor (e.g. their financial printer), whereby the organization provides them with their financial and business data and the third-party returns the tagged documents for the organization to proof and approve. Another method is for the organization to use software applications with built-in algorithms that generate XBRL tagged data as part of the financial reporting process, from which electronic XBRL instance documents can be created.

And a third method is for the organization to integrate XBRL, embedded in the accounting records of their value chain as part of their electronic reporting process, which enables financial and business data to be stored in tagged format for easy retrieval and use across their business reporting value chain.

Accountants and auditors should have an understanding of XBRL because their job responsibilities may include mapping financial statements with XBRL taxonomies, proofing and approving XBRL mappings from third-party vendors, participating on a project team that selects and implements accounting information systems with built-in or embedded XBRL capabilities, or auditing financial statements that are filed using XBRL. Students studying accounting and auditing should learn about XBRL since this is now the standard for financial reporting in the U.S. and many global financial communities (see xbrl.org).

BACKGROUND

Recent pedagogical publications teaching XBRL concepts include interactive exercises providing students with a foundation in XBRL by (a) examining the current taxonomy for U.S. Generally Accepted Accounting Principles and (b) teaching students how to analyze financial information using the SEC's free interactive financial statement viewer to display and export financial statement data to other software tools [5], and (c) an exercise showing students how to create XBRL instance documents using a trial version of a stand-alone software application called Dragon Tag® by Rivet Software [6].

In 2012, Dragon Tag® by Rivet Software was no longer available as a free trial version; therefore, Grant and Sharifi's XBRL exercises could not be done without a significant financial cost to the students or the university. A search was done to find an educational alliance willing to provide XBRL software at a low cost or free. Advanced Computer Innovations, Inc. was willing to provide all of the university's students with a free trial version of their stand-alone software application called EDGARSuite. The vendor supplied an installation file for the university to host on the school's course content webpage. The installation file includes the installation procedure, the executable software, and a step-by-step tutorial for the students.

This paper describes an exercise developed for students and is based on the XBRL tutorial provided with EDGARSuite, which requires the students to map income statement elements from Microsoft Excel and Word documents to the XBRL taxonomy using the mapping software tool in EDGARSuite, and then creating the instance documents that would be sent to the SEC. The students are also required to answer questions about XBRL and the tutorial as part of the assignment.

PROCEDURE

The assignment is explained to students for a half hour of one class session, during the course lecture about the general ledger and financial reporting system. The students work on the tutorial as a homework assignment. The deliverable of the assignment is to complete the hands-on tutorial exercise and to answer the questions on the hand-out document.

Technical Requirements
The university's computing lab has the software installed but most of the students choose to install the software on their personal computer so they can do the assignment at their convenience.

EDGARSuite is only compatible with computers running the Microsoft Windows 7, XP, Vista, 2003, 2000, or NT operating system. Students with Apple Mac-based operating systems running a Windows partition have been successful with the installation, but it depends on the student's ability to troubleshoot problems that may arise from the two operating system platforms co-existing on the same computer. Some international students had issues with the installation on their foreign-issued laptops, which were never resolved, and other students reported that they had to disable their firewall software during the installation process because the firewall was not allowing the installation file to be uploaded to their personal computer.

LESSONS LEARNED

Since the mapping software is a stand-alone application, and not client-server based, there is no way for the instructor to ascertain whether the student actually completed the hands-on tutorial exercise. Several checks are built into the hand-in questions, for example, the students are instructed to enter their first and last name into the Company Name field and their unique student id number into the "Shares Outstanding" field. They are also required to take a screenshot of the Proof page that is generated after they click on the Proof button at the end of the tutorial and paste the screenshot into the hand-in document to prove that they actually did steps in the tutorial.

It takes the average student 2-3 hours to complete the hands-on tutorial part of the assignment. It is recommended that the students complete the assignment at one time, but if a student needs to shut down his/her computer in between, he/she should be advised to stop the assignment at the end of a "session" and start the assignment at the next "session" when resuming. If the student is able to complete the assignment at one time, they can ignore the tutorial instructions that instruct them to close EDGARxbrl and reopen the previously saved filing and mapping.

The software installation process creates files in two different folders on the computer. The folder labeled ACI Programs on the C: drive, contains a folder labeled EDGsuite. This folder contains the tutorial instruction file, labeled qks.pdf. This file contains the step-by-step instructions to complete the hands-on part of the tutorial (see http://www.sec-edgar-filing.com/). The tutorial instructs the students to create a folder and copy two specific folders into the file they just created. These files contain a partial income statement used as input for the mapping. Some students have trouble finding these files and need to be specifically instructed as to their whereabouts. If possible, provide the qks.pdf file as a hardcopy and the xyz.xls and xyz.doc files to the students on your course content website for them to access. Another folder labeled EDGARsuite, is created on the desktop and contains the executable program to run the tutorial, labeled EDGARxbrl™. The student is instructed to double-click on this label, and the main window of the application should then appear in the left portion of the screen. The students can then proceed with the step-by-step instructions for loading the XBRL taxonomy and mapping the income statement data.

Student Feedback
Graduate and undergraduate students of accounting information systems over three semesters have completed the hands-on exercise and assignment. An anonymous survey was completed by 70 students during one semester one month after they submitted the assignment. The results are currently being analyzed and will be reported at the conference presentation.

COURSE MATERIAL

Course material is available upon request to the author.

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APPENDIX A

Instructions

Go to Advance Computer Innovations website http://www.sec-edgar-filing.com/ to review the training/demo video and to download the XBRL mapping software trial program. Look around on the web page to see what it's all about, then go to the Downloads icon to access the files for the trial and the demo.

You should not have to provide your contact information, but if the download does not start downloading, you may have to provide the information. The trial software download file is EDGARsuite Software and the demo is XBRL Demo Video, but you may NOT want to download the demo and view it online instead (since the demo download uses over 200 meg of space!)

Alternatively, the software vendor has provided our university with a zipped file containing the software installation and supporting files, which can be uploaded from our course content website to your Windows-based computer for installation.

Once you download and execute the installation of the trial software, you need to look in the folder where you designated the files to be loaded into and look for a pdf file called qks.pdf. This file contains the tutorial you are required to do. Follow the step-by-step instructions (which correspond to the demo video). Note: the tutorial is divided into "sessions"; you do not need to stop at each session if you have time to keep going during one sitting. If you need to stop working on it for the day, then stop at the end of a session and the next time you work on it, resume where you left off starting at the next session.
Two changes from the tutorial instructions:

     1. For the registrant name, enter your full name (e.g. DEB SLEDGIANOWSKI) instead of XYZ Corporation.
     2. In the spreadsheet that you are required to load for the mapping, change the value of the following element to your student id number (your 700 number) (see example below):
   Diluted weighted average shares outstanding   700123456   700123456

Note: In the spreadsheet that you are required to load for the mapping, the document is of an Income Statement, NOT a Balance Sheet as is indicated in the tutorial (it is a typo in the instructions).

DELIVERABLES

The deliverables for this exercise are to answer the questions below then email them to me and to email me a Word document containing a print screen of the output generated after you Save your work and invoke the Proof button (the output of the Proof should look something like the right-hand side below) (email both documents in the same email message). Notice that my name is displayed as the registrant name and 700123456 is the number of shares outstanding:

EDGARxbrl™ - Trial Mode

C:\Documents and Settings\Acsdas\My Documents\ACCT208\distance learni   Select Filing Folder

Main | XBRL | Contexts | Units | Facts | Footnotes | Extension | Reports | Preferences |

EDGARxbrl™

[explain this tab]

Create a new filing using one of these standard taxonomies (check the checkboxes to additionally read optional taxonomy elements [explain]):

- US-GAAP (corporate filings)
  - ☑ Full taxonomy (all industry entry points) [explain entry points]
- Mutual Funds Risk/Return Summary (form N-1A)
  - ☑ Full taxonomy
- Nationally Recognized Statistical Rating (for NRSROs)
  - ☑ Full taxonomy
- IFRS complete (standard & SMEs) for non-US issuers
  - ○ IFRS Standard (does not include SMEs)
  - ○ IFRS for SMEs only
- Other Voluntary Filings
  - ○ Schedule of Investments
  - ○ Investment Management
  - ○ ICI Risk/Return

Open an existing file:

- Open an existing Extension Taxonomy (create a new filing from it)
- Open an existing Instance Document
- Continue working on last filing (xyz-20100930)

Map & Capture Summary

Heading Line Items (Abstract Concepts)	2
Data Line Items (Non-abstract Concepts)	19
New Reporting Facts Added	33
Existing Reporting Facts Updated	2
Facts Referencing Footnotes	0
Line Item Footnotes	0

Buttons: Help, About..., Purchase, Sort, Find, Details, Windows, Delete, Map, Footnote, Clear Fields, Save Fields, Save Profile, Load Profile, Merge Profile, Default Profile, Clean, Validate, Proof, Create Instance, Assemble Submission, Clear, Paste

EDGARxbrl™ Proof   Print

Dollar figures are in Millions. Shares figures are exact.

Document and Entity Information

	Jul 1, 2010 to Sep 30, 2010
Entity Registrant Name	
Document Type	10-Q
Document Period End Date	2010-09-30
Amendment Flag	false
Entity Central Index Key	0001234567
Current Fiscal Year End Date	12/31
Entity Common Stock, Shares Outstanding	1,106,803,531
Entity Public Float	1,424
Entity Filer Category	Non-accelerated Filer
Entity Current Reporting Status	No
Entity Voluntary Filers	No
Entity Well-known Seasoned Issuer	No
Document Fiscal Year Focus	2010
Document Fiscal Period Focus	Q3

Condensed Consolidated Statements of Earnings

Income Statement	Jul 1, 2009 to Sep 30, 2009	Jul 1, 2008 to Sep 30, 2008
Net sales	3,933	3,706
Costs and expenses		
Cost of goods and services sold	966	855
Research and development expense excluding process cost	370	324
Selling, general, and administrative expense	1,368	1,318
Impairment of Intangible Assets (Excluding Goodwill)	78	—
Restructuring charges	62	96
Certain litigation charges	444	—
Purchased in process research and development charges	101	—
Non operating income expense	(96)	(151)
Interest expense, net	66	47
Total costs and expenses	3,372	2,791
Income loss from continuing operations	561	915
Income tax expense benefit	116	192
Net earnings	445	723
Basic earnings per share	0.40	0.64
Diluted earnings per share	0.40	0.64
Basic weighted average shares outstanding	700,123,456	700,123,456
Diluted weighted average shares outstanding	700,123,456	700,123,456
Cash dividends declared per common share	0.205	0.188

start | Micr... | Nov... | 15 M | 2 F... | 2 I... | 3 W... | Inb... | Win... | 2 A... | Micr... | EDG... | 100% | 5:55 PM

QUESTIONS

1. What are the specific steps using the software to enable the user to map an element that is not part of the XBRL taxonomy? What is this process called? Describe what the X in XBRL stands for? (provide an explanation as why an organization would need to map an element that is not part of the existing taxonomy)

2. What is/are the label of the line item(s) of the income statement that XYZ company created as an extension?

3. From which website(s) can the XBRL taxonomies be downloaded? Provide me with a working link to one of the websites? How many different taxonomies are available? Why are there different taxonomies?

4. What is the taxonomy's definition of "income loss from continuing operations" which appears below the list of taxonomy tag names in the left window when you click on the IncomeLossFromContinuingOperations concept?

5. List the exact names of the files generated from the mapping software that are provided to the SEC for XYZ company (not "income statement", "balance sheet", etc).

6. Surf the Internet to find names of other XBLR mapping software tools provided by software vendors. Provide me with the website link and name of two others.

Accounting Compensation Modeling Supporting the Sarbanes-Oxley Act

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Abstract

The Sarbanes-Oxley Act (SOA) of 2002 included a wide range of reforms for issuers of publicly traded securities, auditors, corporate board members, and lawyers. It was aimed at deterring and punishing corporate and accounting fraud with severe penalties for wrongdoers, and protecting the interests of workers and shareholders. The SOA along with the economic downturn of 2008 and the subsequent passing of the Dodd-Frank Act has focused additional attention to executive compensation especially for CEOs. This paper proposes that the Analytic Hierarchy Process (AHP) may be useful in developing input to compensation contracts in ways that support regulations and the interests of investors and stockholders. AHP is suggested as a framework to explore when considering the factors that can be used to measure the performance of a CEO. Seven reasons for using AHP for this purpose are presented in this report: (1) emphasizes objectivity and consistency, (2) creates an audit trail for compensation agreements, (3) improves understanding between CEOs and compensation committees, (4) supports review and updating CEO compensation contracts, (5) augments CEO selection, (6) supports SOA and Dodd-Frank Act, and (7) may attract investors.

One of the most sweeping reforms to business practices was the Sarbanes-Oxley Act

(SOA) of 2002, which was signed into law by George W. Bush and became effective on July 30,

2002 (Zameeruddin, 2002). This act included a wide range of reforms for issuers of publicly

traded securities, auditors, corporate board members, and lawyers. It was aimed at deterring and

punishing corporate and accounting fraud with severe penalties for wrongdoers, and protecting

the interests of workers and shareholders. The Sarbanes-Oxley Act has the following major

features: (1) it creates a Public Company Accounting Oversight Board to enforce professional

standards, ethics, and competence for the accounting profession, (2) it strengthens the

independence of firms that audit public companies, (3) it increases corporate responsibility and

usefulness or corporate financial disclosure, (4) it increases penalties for corporate wrongdoing,

(5) it protects the objectivity and independence of securities analysts, and (6) it increases

Securities and Exchange Commission resources. There is no consensus in the literature with

regard to the overall success of SOA (Basu & Dimitrov, 2010). The purpose of this paper is to

examine the role of SOA in executive compensation and propose the use of the Analytic

Hierarchy Process as a method to identify factors for input into an executive compensation

package. To accomplish this purpose, this report identifies the goals of the SOA, reviews the

effectiveness of the SOA's claw back provision, presents current issues in executive

compensation, provides an overview of the AHP model, and advocates the use of AHP as a

starting point for developing executive compensation factors.

Goals of the SOA

One of the six goals for the SOA is to increase corporate penalties for corporate

wrongdoing. Section 304 of the Sarbanes Oxley Act of 2002 is known as the "claw back"

provision because it authorizes a company to get back certain executive bonuses and stock

profits. The claw back rule provides that any accounting restatement due to the material

noncompliance with financial reporting requirements the chief executive officer and the chief

financial officer shall reimburse bonuses or other incentive-based or equity-based compensation

received from the issuer during the 12-month period following the first public issuance or filing

of the document (University of Cincinnati College of Law, 2002). A review of the record of

enforcements between July 1, 2002 and June 30, 2006, revealed that over 1,121 publicly traded

companies filed a total of 1,786 restatements125 were made for reporting fraud or other

accounting errors (List, 2008). This data represents the number of restatements filed since

Sarbanes-Oxley went into effect. By December 2007, the SEC had brought Section 304 actions

in only five cases. More disturbing is that the SEC itself noted in a press release on May 31,

2007, that this was its "first time" using Section 304 (List, 2008). Only two instances of

enforcement of the claw back provision were found in the literature. The SEC recently

announced a settled enforcement action in which it obtained a "claw back" of prior compensation

and stock sale profits from a CEO pursuant to Sarbanes-Oxley Section 304 in SEC v. McCarthy,

No. 1:11-CV-667-CAP (N.D. Ga. March 3, 2011). This case marks the second time the SEC has

obtained this type of relief without alleging that the CEO in question personally engaged in any

wrongdoing (Carlin, 2011).

SOA Effectiveness and Role in Executive Compensation

The role of executive compensation and its enforcement under SEC 304 of the SOA

raises the issue of how to fairly assess and reward the work of a CEO for a publically traded

organization. Although there are a number of theories that describe the underlying precepts of

how a compensation model should function there are no testable mathematical models to assess

the objectivity and fairness of the methods. One well-researched notion is the "principal/agent"

theory which argues that compensation committees of Boards of Directors are principals who

negotiate with their agents (CEOs) to establish executive compensation (Bebchuk & Fried,

2004). Under this approach, these principles through their objectivity are able to negotiate cost

effective contracts that motivate the CEOs to manage the organization in a way that ultimately

increases the wealth of the principals. The focus of this paper is to identify a framework that

could be used to develop criteria that could be implemented in a compensation contract that

could serve the needs of the organization, its principals, and its CEO in a more transparent and

objective methodology. By making the development of these contract assessment factors more

objective, the approach supports the SOA by increasing corporate responsibility and disclosure.

Current Issues in Executive Compensation

Over the last 10 years, a lot has been written about structuring executive compensation

and connecting pay to performance. Because of the economic conditions of 2008, many

companies carefully reviewed their structuring of compensation measures for their executives. In

2009 the G-20 Conference echoed the need for effective governance of compensation including

oversight and engagement by stockholders. In July 2010, the *Dodd-Frank Wall Street Reform*

and Consumer Protection Act (Dodd-Frank Act) became law. Among the investor protection

provisions of this law are sections that address executive compensation and corporate

governance. These issues were included in the Act because of the widespread perception that

executive pay practices contributed to the financial crisis. This view asserts that some executives

took excessive risks to realize short-term gains at the expense of long-term shareholder value and

financial stability in their organizations. The Dodd-Frank Act requires greater accountability by

the board to shareholders about executive compensation. Section 951 of this regulation requires

that shareholders of public companies have a non-binding vote on executive pay packages and

golden parachutes. The goal of this practice is to encourage compensation policies that connect

compensation incentives to a company's financial performance. Under this law, compensation

committees are required to be independent of management and that they have the resources to

use the expertise of independent consultants (Pagnattaro & Greene, 2011).

The growing momentum toward executive compensation reform movement brings with it

new responsibilities for shareholders. Shareholders of public companies in the United States and

of many listed companies in the European Union must be prepared to vote at the annual meeting

with an understanding of the pay practices at issue (Pagnattaro & Greene, 2011). With the

increased closure of pay arrangements shareholders will need to focus on the relationship

between the CEO's paycheck and his or her performance. This paper argues that one approach

for assisting the shareholder and compensation committees is through the application of the

Analytic Hierarchy Process. The next section provides an overview of AHP.

The Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a methodology that aids decision makers who

are faced with problems that are composed of conflicting and often subjective criteria (Ishizaka

& Labib, 2009). A number of successful applications of this approach have been documented in

the literature (Forman & Gass, 2001; Ho, 2008; Kumar & Vaidya, 2006; Liberatore & Nydick,

2008; Omkarprasad & Sushil, 2006). Saaty (1972) is generally regarded as a pioneer in this

methodology because of his early publication on the subject.

Saaty (2008) explains the AHP as a method in which priorities are created by

decomposing the decision into four steps. First, the problem needs to be defined to determine the

type of information that is sought in the process. Second, develop a structure with goal of the

decision at the top followed by the objectives. These objectives will range from intermediate

levels which identify the criteria to the lowest levels which represent the alternatives. Third,

construct sets of pairwise comparisons in which higher level elements are compared directly with

elements in the level below it. Fourth, apply the priorities gained from the comparisons to assess

importance of lower level elements. After analyzing each element, then combine the weighted

values from the level below to obtain its overall priority. This process is continued until the final

priorities of the alternatives are obtained. A more detailed list of steps is provided in Table 1.

Table 1

Analytic Hierarchy Process Methodology

Step	Activity
1	Develop a statement of the problem to be solved
2	Expand the statement from Step1 to include all objectives and the desired outcomes
3	Identify the criteria that would influence the outcomes identified in Step 2
4	Structure the problem to include the goals, criteria, and alternatives developed in the previous steps
5	Compare each element with other elements on its level using the structure developed in Step 4. This step will require $n(n-1)/2$ comparisons where n is the number of elements under consideration.
6	Calculations are performed to find the maximum eigenvalue, consistency index, consistency ratio, and normalized values for each alternative
7	The calculations performed in Step 6 are repeated until the consistency index and consistency ratio based on the normalized values lie within the desired range

In reviewing the four steps listed above it can be seen that AHP begins with a problem

that is decomposed into a hierarchy of criteria so as to be more easily analyzed and compared.

The development of this hierarchy enables the decision maker to systematically assess the

alternatives by making pair-wise comparisons for each of the chosen criteria. This comparison

may use data from the alternatives or subjective judgments as a way to input the information.

AHP transforms the comparisons into numeric values that are further processed and compared. Each factor's weights allow the assessment of each one of the elements inside the defined hierarchy. This ability to convert empirical data into mathematical models is the main distinctive contribution of the AHP technique when contrasted to other comparing techniques. After all comparisons have been made, and the relative weights between each one of the criteria to be evaluated have been established, the probability of each alternative is calculated. This probability represents the likelihood of an alternative to fulfill the desired goal. The higher this probability is, the greater are its chances to satisfy the final goal of the decision maker (Vargas, 2010). The solution of AHP computations is typically provided through software tailored to complete the calculations. The next section identifies several resources for software that will support the user in applying this approach.

AHP Software Resources

Table 1 identified a number of calculations that are required in the last three steps of the AHP process. Fortunately, there are a number of both commercial and free software resources available to carry out these computations specific to the AHP methodology. In the paid area of AHP software, *Expert Choice* is popular choice and is available online. Free software includes the use of *Excel* for completing the calculations as well toolbox implementations in Matlab (Jun, Xin-sheng, & Li, 2008). The availability of software to perform the calculations for the AHP model supports the application of the approach to a wide variety of problems including the development of input for executive compensation agreements. Examples of application areas to which AHP has been applied are discussed in the following section.

AHP Application Areas

AHP has been used for decision making in a number of areas. Omkarprasad and Sushil (2006) reviewed a total of 150 AHP application papers. Their work provides a reference on AHP and an informative summary. One fact noted by these authors is that AHP is its flexibility to be integrated with different techniques like linear programming, quality function deployment, and fuzzy logic. Consequently users of AHP can obtain the benefits from all the combined methods, and achieve the desired goal in a better way. To gain an appreciation for both the types of problems and areas of application in which AHP has been used the information in Tables 2 and 3 are presented. Table 2 reveals the kinds of problems to which AHP has been applied based on Omkarprasad and Sushil review. Table 3 displays the variety of application areas in which the AHP methodology has been used from Omkarprasad and Sushil's study.

Table 2

AHP Use by Types of Problems[1]

Problem Type	Quantity
Selection	32
Evaluation	26
Cost-Benefit	7
Priority	20
Development	18
Resource allocation	10
Decision making	21
Forecasting	4
Medicine	5

[1] Omkarprasad, V., & Sushil, K. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research, 169*(1), 1-29.

Table 3

AHP Use by Application Areas[1]

Application Area	Quantity
Personnel	26
Social	23
Manufacturing	18
Political	6
Engineering	26
Education	11
Industry	15
Government	13
Other	12

[1] Omkarprasad, V., & Sushil, K. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research, 169*(1), 1-29.

Ho (2008) found that the AHP can be combined with other techniques, such as mathematical programming (including linear programming (LP), integer linear programming (ILP), mixed integer linear programming (MILP), and goal programming (GP)), Quality Function Deployment (QFD), meta-heuristics, SWOT, and Data Envelopment Analysis (DEA) because of its simplicity and flexibility. Comparatively, the combined AHP and GP and AHP and QFD were the two most commonly used tools that were found to be integrated with AHP. Ho also noted that the integrated AHPs can be applied to a wide variety of fields and problems successfully. The ease in which AHP can be combined with other techniques is another advantage for this methodology.

Input to AHP

Executive compensation generally consists of a combination of four elements: (1) annual base salary, (2) annual incentive or bonus plan generally tied to short-term performance measures, (3) long-term incentives (including restricted stock, stock options and other long-term performance plans tied to total shareholder return or financial performance), and (4) benefits plan (Deloitte Development, 2012). In general, the base salary constitutes 30% of total compensation, the annual incentive another 20%, the benefits about 10% and long-term incentives for about 40%. As compensation committees sought to achieve pay for performance, one trend was to place more emphasis on performance vested restricted stock for CEOs. Any of these inputs may be used as alternatives in the AHP model. In addition, organizations can develop their input categories or refine the contents of each of these major four elements for use in the AHP model. One newer area for input into executive compensation that could also be included in the AHP methodology is sustainability. Xcel Energy included incentive awards for executives to sustainability performance metrics, including greenhouse gas reduction; Alcoa added sustainability performance in its executive bonus plan in 2010, linking 20 percent of the bonus to nonfinancial metrics, such as carbon dioxide reduction, safety and diversity (Environmental Leader, 2012).

Seven Reasons to Use AHP for CEOs, Corporations, and Accountants

The heightened concerns about executive compensation along with the requirements of the Sarbanes-Oxley Act and the Dodd-Frank Act are strong forces that provide a justification for an approach to modeling how CEOs are rewarded for their work. There are number of cogent arguments that can be made to support the use of AHP in this process. Each of the following seven reasons are described in this section: (1) emphasizes objectivity and consistency, (2)

creates an audit trail for compensation agreements, (3) improves understanding between CEOs

and compensation committees, (4) supports review and updating CEO compensation contracts,

(5) augments CEO selection, (6) supports SOA and Dodd-Frank Act, and (7) may attract

investors.

Emphasizes Objectivity

The objectivity advantage of the AHP model for executive compensation refers to its

clearly defined steps as listed in Table 1. In addition, the results of the calculations in the AHP

approach will consistently produce the same results for the same sets of criteria for the same

evaluator. Anyone using this process would be required to the same steps with the same

calculations. Consequently, the AHP brings with it a fair and objective approach to identify the

most important considerations for identifying each organization's and CEO's perceived

important factors for executive compensation.

Creates an Audit Trail

The choices and alternatives identified by each organization's compensation committee

for CEOs could be readily documented by many implementations of the available AHP software.

These factors along with their perceived importance can be reviewed by auditors and

shareholders. The audit trail available through the use of AHP software can be useful in

reviewing the consequences of the choices in subsequent financial reports. This AHP advantage

is in line with Sepe's ((2011) recommendation for measures that would help to remove equity-

compensation biases include requiring coordination between the compensation committee and

the disclosure of evaluation activity and compensation approval in an organization's publicly

available reports.

Improves Understanding in Compensation Decisions

An organization's compensation committee can use the AHP methodology to develop its own list of important factors for connecting CEO performance to reward. This committee can compare its list with factors identified by their CEO. By analyzing these two lists, both the committee and the CEO can use the results of the AHP technique to learn about the similarities and differences in the perceived importance of various factors. One of the by-products of the AHP methodology is its potential to improve understanding between senior executives and compensation committees.

Supports Review and Updating of Compensation Contracts

On an annual or quarterly basis, an organization can review its performance data to examine how well its operating results correlates with the factors identified in the CEO compensation agreement as revealed through the AHP methodology. The performance factors created through AHP for the CEO can be compared with the actual performance data for the business. A high correlation may indicate that there is a relationship between the performance of both the CEO and the organization which is led by the CEO. Lower correlations may provide sufficient incentive to update or re-think the factors used. Consequently, the AHP method can assist in monitoring the relationship between an individual executive performance and the actual results of a company's operations. These results may be used to update new contractual agreements with the same CEO or serve as a learning experience for evaluating a new CEO.

Augments CEO Selection Decisions

Another advantage of the AHP process is its usefulness in the procedure of selecting a CEO. As part of the interview process, the applicant can be asked to apply the AHP method to identify their perceived list of important items for compensation. The resulting list obtained from

the CEO-applicant can be compared to a similar list prepared by the hiring committee using the

AHP model. Differences between these identified factors can be useful in determining the fit of

the applicant with the organization. These differences can also be used as a basis for discussion

with each interviewee in subsequent steps of the hiring process. If there are too many

differentiators between the list produced by the applicant and the hiring committee, then that

individual may be eliminated from further consideration.

Supports SOA Goals and Dodd-Frank Act Requirements

The AHP supports the goals of the SOA and the Dodd-Frank Act for improving

disclosure and financial responsibility. The SOA made CFOs along with CEOs explicitly

responsible for the integrity of financial reports and, while the Securities and Exchange

Commission's (SEC) 2006 proxy statement revisions required that the CFO's compensation be

disclosed along with that of the CEO and the next three highest paid executive officers (Balsam,

Irani, & Yin, 2012). All of the discussion in this paper in which the CEO was referenced would

also apply to other senior executives in the organization.

May Attract Investors

The use and disclosure of the results of the AHP method may also draw investors to an

organization. The list of factors perceived as important to the CEO as derived through AHP can

provide additional insight into the nature and leadership expectations for an organization that

may be of interest to stockholders. The inclusion of these results in a prospectus or financial

statement notes may add to the transparency of an organization and thus increase interest by

investors. For example, an investor interested in sustainability as a corporate goal may be drawn

to an organization in which the CEO is rewarded for improving the company's movement toward

this goal. Although there is no evidence that the application and publication of the results of

AHP could be useful in attracting investors to an organization, this relationship could be explored in future studies.

Conclusion

With the passage of the SOA, the Dodd-Frank Act, and the economic downturn of 2008 interest in executive compensation packages have received extraordinary attention. After reviewing key provisions of these regulations, this report identified the Analytic Hierarchy Process as a methodology that would be useful to apply to determining the inputs for CEO compensation agreements. An overview of AHP along with areas to which this approach has been applied was also discussed. Seven reasons for the adoption of AHP in executive compensation contracts were identified. These reasons included: (1) emphasizes objectivity and consistency, (2) creates an audit trail for compensation agreements, (3) improves understanding between CEOs and compensation committees, (4) supports review and updating CEO compensation contracts, (5) augments CEO selection, (6) supports SOA and Dodd-Frank Act, and (7) may attract investors. This paper demonstrated the potential utility in the application of the AHP in executive compensation agreements. Additional research is needed to determine if the advantages of AHP can be demonstrated through real applications.

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CLOSING THE U.S. TAX GAP: LEGISLATIVE EFFORTS COUNTING CROSS-BORDER ANTI-TAX AVOIDANCE PRACTICES

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ABSTRACT

As globalization gives rise to increased cross-border transactions, tax avoidance schemes pervades the international tax landscapes. The International Financial Centre Review reports that an estimated $11.5 trillion in financial assets are held in offshore tax haven. Of that total, approximately $1 trillion is attributed to U.S. Citizens (Wang, 2012). For the U.S., this equates to $100 billion per year in tax revenue concealed in foreign bank accounts (Wang, 2012). This paper examines, comparatively, the anti-avoidance tax policy initiatives employed by the U.S., the U.K., Japan, and Canada with the aim of determining the effectiveness and limitations of these initiatives.

INTRODUCTION

As the globalization process gives rise to increased cross-border transactions, tax avoidance schemes have pervaded the international tax landscapes. The International Financial Centre Review reports that an estimated $11.5 trillion in financial assets are held in offshore tax haven. Of that total, U.S. approximately $1 trillion is attributed to U.S. Citizens (Wang, 2012). For the United States, this equates to $100 billion per year in tax revenue concealed in foreign bank account (Wang, 2012). The pervasiveness of offshore tax evasion schemes has, for the United States and other developed nations, been the impetus for several anti-tax avoidance initiatives undertaken by the United States and other developed nations. These initiatives are of increased importance, particularly in light of the adverse fiscal ramifications of the great recession and the resulting urgency for countries to revive their respective economies.

This paper provides a comparative review and analysis of anti-avoidance initiatives undertaken by the United States, Japan, the United Kingdom and Canada, and Germany to counter anti-avoidance schemes employed by multinational entities and individual taxpayers. The various

legislative and regulatory initiatives are examined from a policy perspective to determine the extent of their effectiveness and to identify limitations that exist. Proposals for strengthening anti-avoidance initiatives through cooperative and uniformed efforts by these and other countries are discussed. In addition, observations of the economic and profit-shifting implications of the world-wide tax system versus the territorial tax system on the anti-avoidance objectives are provided.

RESEARCH METHOD

The traditional legal research method, otherwise described as normative legal reasoning, is employed. Monsma (2006) explains that legal research is classified as normative "because [it] seeks to influence legal decisions and make legal predictions." Monsma (2006) confirms that "law is revered not for its ability to ferret out objective truth but for its reflection of societal concerns, its sustenance of the ideal of justice." This research approach is applied in this investigation evidenced by the process of critical study of legislative and regulatory schemes; and application of legal reasoning techniques to the same for purposes of interpretations and inferences relevant to the tax policies under examination. Legal reasoning techniques are likewise used in arriving at inferences and prescriptions as to the shaping of future international tax policy aimed at curtailing offshore tax evasion activities.

COMPARATIVE ANTI-AVOIDANCE INITIATIVES

This paper provides a comparative review and analysis of anti-avoidance initiatives undertaken by the United States, Japan, the United Kingdom and Canada to counter anti-tax avoidance schemes employed by multinational entities and individual taxpayers. Table 1, below, reflects a visual overview of significant anti-tax avoidance initiatives currently in play within the respective jurisdictions. Detailed discussions, on a country-by-country basis, will be provided in final draft of this paper.

	TIEAs	JITSIC	FATCA	GAAR	DPTAS	TAARS	QI Program
United States	X	X	X	X			X
Japan	X	X					
United Kingdom	X	X		X	X		
Canada	X	X					

TIEA: Tax Information Exchange Agreements
JITSIC: (Joint Int'l Tax Shelter Information Center) (Agreements between tax agencies)
FATCA: Foreign Account Tax Compliance Act)
GAAR: (General Anti-Avoidance Rules): Anti-abuse law and alternative ways of writing

legislation.
DPTAS: Disclosure Tax Avoidance Schemes)
TAARS: (Targeted approach to drafting anti-abuse legislation)
QI Program: Qualified Intermediaries/FFIs)

FINDINGS

While the anti-avoidance measures reviewed play an important role in the effort to thwart off-shore tax evasion through income shifting, the author offers that some measures, such as the Tax Information Exchange Agreements, are inherently limited in their effectiveness. Other measures are flawed from the perspective of enforcement mechanisms. The existence of ongoing bank secrecy laws by some tax-haven countries pose a critical threat to anti-avoidance progress attributable to inter-country collaborative efforts toward information-exchange and transparency. Countries that uphold strict bank secrecy law are likely to attract offshore investors who had formerly invested in jurisdictions that have abandoned secrecy laws and have adopted information-reporting agendas. The author proposes the strengthening of anti-avoidance initiatives through cooperative and uniformed efforts across international jurisdictions. The current network of anti-avoidance initiatives is akin to a patch-work approach to tackling international tax evasion. From the United States' perspective, and even that of other developed nations, significant success in curtailing leakage of tax revenues to off-shore jurisdictions is heavily dependent on enactment of comprehensive international tax reform. The pairing of such significant reforms with the anti-avoidance initiatives targeted at illegal offshore tax avoidance schemes would help to reduce loopholes.

Anti-avoidance efforts would be further enhanced by cross-country harmonization of principal tax policies. The absence of harmonization creates loophole opportunities for taxpayers who persist on engaging in income shifting. Considerations for harmonization efforts would potentially include the U.S. adoption of a territorial tax system, in place of its current world-wide tax system. In addition to bringing the U.S. system more in line with tax systems of its international trading partners, a territorial tax system may likely cause reduction in cross-border income shifting.

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EXPERIENCING BIG DATA ANALYTICS: ANALYZING SOCIAL MEDIA DATA IN FINANCIAL SECTOR AS A CASE STUDY

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ABSTRACT

Big Data today is highlighted as new capability for driving business value. Companies are creating the opportunities as well as confronting challenges to deal with a larger volume and wider complexity of data. This paper builds a platform of social media analytics and then applies it to a financial sector as a case study. We also attempt to design a simple dashboard for providing more useful intelligence tool. We conclude that the field of *Big Data Analytics* is still a fledgling stage and rarely studied. So this field is much potential to develop a sound base of theory and methodology.

Key Words: Big Data, Mobile Computing, Social Media, Business Analytics

INTRODUCTION

The Internet is the backbone of our society, while mobile cloud computing is a central source of social change. With the popular use of mobile devices (i.e., smartphones) and social media, the world is changing and becoming more intelligent and interconnected. People are becoming to enjoy this intelligent digital life. These phenomena have become a driving force towards new digital era.

Nowadays *Big Data* is highlighted as a key area in IT industry. It is a new, growing and evolving market. It accelerates a new business model to develop new services. However, it is challenging for managing large amounts of data including storage and tools.

Social media has created *Big Data* which is beyond the ability of typical database software tools to capture, store, and analyze. Businesses firms are challenged by Big Data because it grows so large that they become awkward to work with using on-hand database management tools. However, it has big potential that it can generate significant value across sectors, such as healthcare, retail, manufacturing, public sector, etc.

The richer applications of mobile devices (called 'mobile apps') are one of the fastest growing fields in the IT industry. Unlike traditional cellular phones, today's smartphones are mainly used for Infotainment which is to share information (i.e., social media and geographic location services) and to enjoy entertainment (i.e., games and sports).

This paper presents the richer understanding of Big Data and its Analytics as a new frontier in data management. We also attempt to build our own social media analytic platform and then apply it to the financial sector as a case study.

New Paradigm in IT

There are fundamental shifts in the IT industry including mobile cloud computing and smart devices with social media. Mobile Cloud Computing is new generation of business infrastructure environment [1]. It supports new business models, such as user-driven purchase and click install on any device [2]. It also creates new service deployment models by enabling lower total own cost (TCO), scalability and short time-to-usage. This platform uses the concept of Grid [3]. The Grid [4] is to build virtually a supercomputer to connect many networked computers and then to aggregate resources (i.e., CPUs, storage, power supplies, network interfaces, etc) for utilizing them collectively.

Mobile Cloud Computing has been made possible by the shift to Internet technologies that are built on web-based standards and protocols [5]. It is a form of virtualization which involves data outsourcing with no up-front cost and provides just-in-time services. It is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of computing resources [6]. So it can be rapidly provisioned with minimal management effort or service provider interaction. It also provides resources over the Internet on demand and eliminates the cost for in house infrastructure. The key drivers for cloud computing are bandwidth increase in networks, cost reduction in storage systems, and advances in database.

Mobile Cloud Computing has three typical types of business models [7]; Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). In SaaS, customers can use applications, but cannot control operating system, hardware or network infrastructure which are running. In PaaS, customers can use hosting environment (i.e., servers) as well as their applications, but still cannot control operating system, other hardware and network infrastructure. In IaaS, customers can use the fundamental computing resources, such as processing power, storage, network components. And also they can control operating system, storage, deployed applications and possibly networking.

Another area of distinctive growth in IT ecosystem is social media [8][9][10][11] with smart devices, such as smartphones and tablets. It is becoming a new way of life to the people, such as multi real-time access behavior of customers.

Social media today is emerged as a new communication platform [12]. According to IBM [13], more than two billion Internet users and 4.6 billon mobile phones are in the world. Facebook has more than 500 million users and created 30 billion pieces of content every month. And about 340 millions of data every day in Twitter are exchanged.

Today, there are many types of social media services (SMS) [14], such as personal, status updates, location, content-sharing, and shared-Internet services. First, the Personal SMS allows users to create online profiles and connect with other users, with focusing on social relationships (i.e., friendship). It often involves users sharing information, such as one's gender, age, interests, and employment. Second, the Status SMS provides users to post short status updates in order to communicate with other users quickly like Twitter [15] and are designed to broadcast information quickly and publicly. Third, the Location SMS is designed to broadcast one's real-time location, either as public information such as Foursquare and Google Latitude, using GPS-

based networks. It is growing in popularity. Fourth, the Content-sharing SMS is designed as platforms for sharing content, such as music, photographs and videos example YouTube and Flickr. Fifth, Shared-interest SMS is to share information within a specific group of people. These incorporate features from other types of social media but are slanted toward a subset of individuals, such as those with similar hobbies, educational backgrounds, political affiliations etc. An example of this type of site is LinkedIn, which is geared towards professional network.

Big Data and Analytics

Bid Data as New Norm

Nowadays Big Data is newly spotlighted with the popular use of social media, such as Twitter, Facebook, and Flickr, in the business world. Then, what is *Big Data*? There is no single definition of *Big Data* until now. Manyiaka et al. [16] defines that Big Data refers to datasets whose size is beyond the ability of typical database software tools to capture, store, manage, and analyze. IDC [17] defines Big Data that Big data technologies describe a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling high-velocity capture, discovery, and/or analysis.

As for me, Big Data is the tidal wave of data from the cloud computing and social media. It is a dataset whose size is beyond the ability of typical database software tools to capture, store, manage, analyze, and visualize. Related to the size of database of Big Data, its definition varies by industry sectors from few dozen tera bytes (TB) to multiple peta bytes (PB). Big Data volume is expanding due to the increase of social media, online data collection and location data. It is also accelerated with the usage of sensor-enabled devices.

There are some myth and truth of Big Data as follows. First, related to its definition, Big Data refers to a really large scale data. Yes, it may be right. Bur more important thing is that Big Data refers to a really difficulty of data processing instead of amount itself. Another thing is that more large data can get more insight. However, instead of that, the good choice of meaningful data is more important. I often hear that Big Data analysis refers to the analysis of social data. But social media analysis is a key part of Big Data analysis, not a whole.

Big Data Analytics

Big Data Analytics [18][19] is newly spotlighted that the field can be a clue to solve the economic and social issues. Positioning system functions in the path or destination to move to the smartphone, Internet search history or search pattern can be analyzed and used to investigate the history of the credit card, it is possible to analyze individual consumption patterns. Computational capacity and a wide range of smart devices and the Internet penetration is increasing, ranging from the activities of the individual to society as a whole, the data became available, collect data analysis methodology development coupled with a rapidly growing trend. The IT companies Such as Google, Amazon, Facebook and IBM, are entering competitively in this market. According to McKinsey study [16], Big Data Analytics with metrics has huge potential such as impressive as 60% improvements in Retail operating margins, 8% reduction in (US) national healthcare expenditures, and $150M savings in operational efficiencies in European economies.

A Case Study of Social Media Analytics

Background

This case study focuses on social media data within the financial services markets context. The amount of information publically available from social media makes it a very rich source for analysis. For the purposes of our study we will be focused on collecting data from three primary sources, Facebook, Twitter, and YouTube. Each of these sites has an open API that will allow us to collect information and store it in a database for analysis.

Social media analytics is a field to collect, analyze and report social media for better decision-making. For example, the company will capture consumer data from social media to understand trends, to predict customer behavior, and to identify the primary influencers within specific social network channels. In this section, we will build a simple platform for social media analysis, and then apply it to the US financial sector.

If you're building an in-house social media capability—whether in an agency or corporate environment—your needs for social media monitoring and analysis are a bit different from other companies. The basics of collecting data and generating metrics and reports are the same, but hands-on workgroups have special requirements.

On some level, many social media analysis companies can help you build your own capabilities. The nearly ubiquitous interactive dashboard is a hands-on tool for clients who want to interact with the data, but they're a better fit for individual analysts. Some companies really focus on developing platforms for companies building their own capabilities.

Building a Platform for Social Media Analytics Platform

Figure 1 show our own platform for analyzing social media. It includes a viewer (presentation layer), an analytic layer (i.e., analytic tools), a database layer (i.e., data warehouse), and a data collection layer (i.e., data grabber).
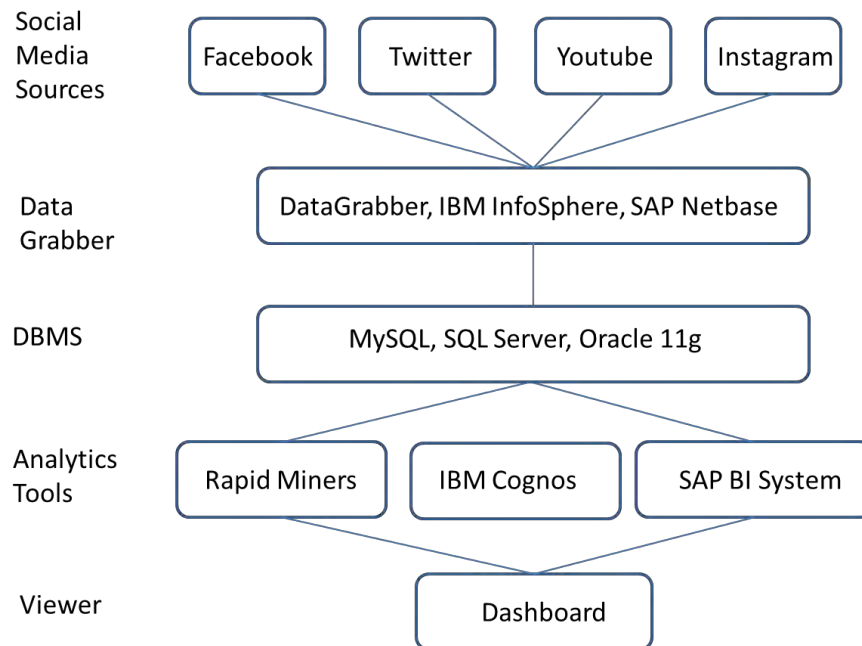

Figure 1: Social Media Analytic Platform

Analytic Tools and Data Collection

We are using social media dashboard software known as BlitzMetrics [20]. This software allows us to begin the capture of information from the identified sources and create a dashboard for simple metrics. The system captures information reported by social media sites and stores them into a database. The portal then displays the information in an easy to use dashboard.

Individual data from posts, likes, shares and interactions, as well as tweets, followings and replies are collected and reported daily. This data can then be aggregated and analyzed across a number of industries, groupings and predefined segments. In some cases, highly granular information regarding the individuals (e.g. gender, location, age) who interact with the entities can be extracted; however, this granularity is dependent on the information provided by the user in their profiles.

Since the system collects data using pre built code in C# and records the information in an open source database, MySQL, we are able to query data for more detailed analysis and import the information into statistical packages such as RapidMiner [21] and R. By utilizing this direct access we are able to perform time based analysis, i.e. examine interactions over a period of time, as well as perform textual and sentiment analysis of the content posted by users. Furthermore, we intend to conduct a network analysis using a tool such as Gephi, which will enable us to examine the role of influencers within a given network.

Currently, the database provided by Blitz contains over a terabyte of information, but our current financial dashboard is a very small fraction. As time progresses, we will continue to collect data Figure 2 shows its sample for collecting 19 financial companies in Fortune 500 companies in US. We daily are monitoring and capturing social media data from Facebook, Twitter, and Youtube from our partner.
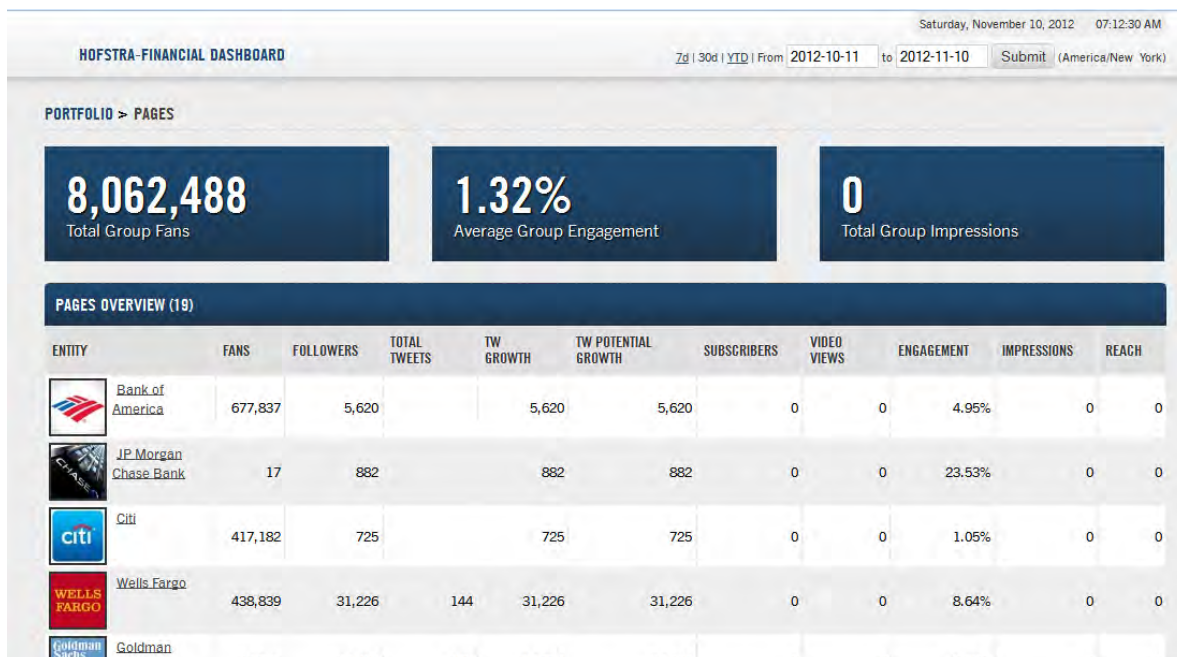
**Figure 2: A Dashboard of Financial Sector**

Figure 3 shows the detailed message data we captured using data grabber we developed. In the future, we will analyze these data using text mining technique.
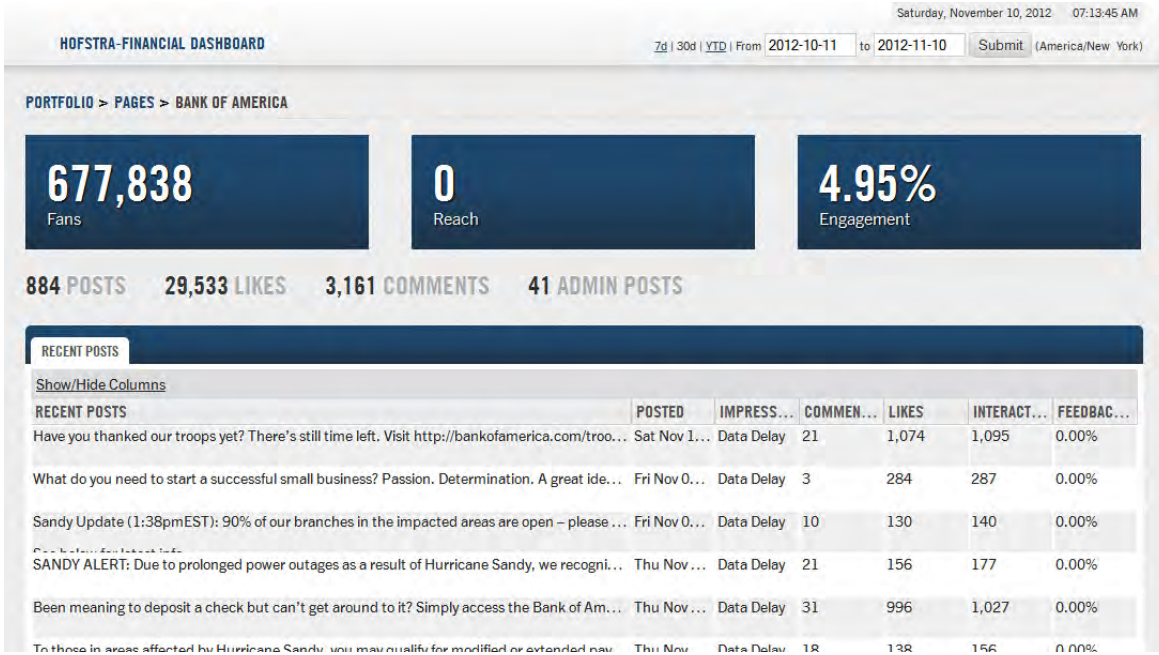
**Figure 3: Social Media Message Data**

Analyzing Social Media Data

Figure 4 shows the analysis of social media data we collected. It is the high-level analysis result that how many fans, likes, and engagement have each financial company. In the first graph (a), Capital One and American Express show distinctive peaks in 'Fans'. In the second graph (b), Bank of America and Wells Fargo show the highest in 'Likes'. Finally, in the third graph, Citi, Chase, and Morgan Stanley show much attractive in 'Engagement'. Although this graph is just shown a comparison diagram using raw data, we can get some meaningful information. That is, these three components (fans, likes, and engagement) are not much correlated. However, we need to drill down and analyze these graphs for more better information. We are still working for developing a model to analyze in depth.

Fans   Likes   Engagement
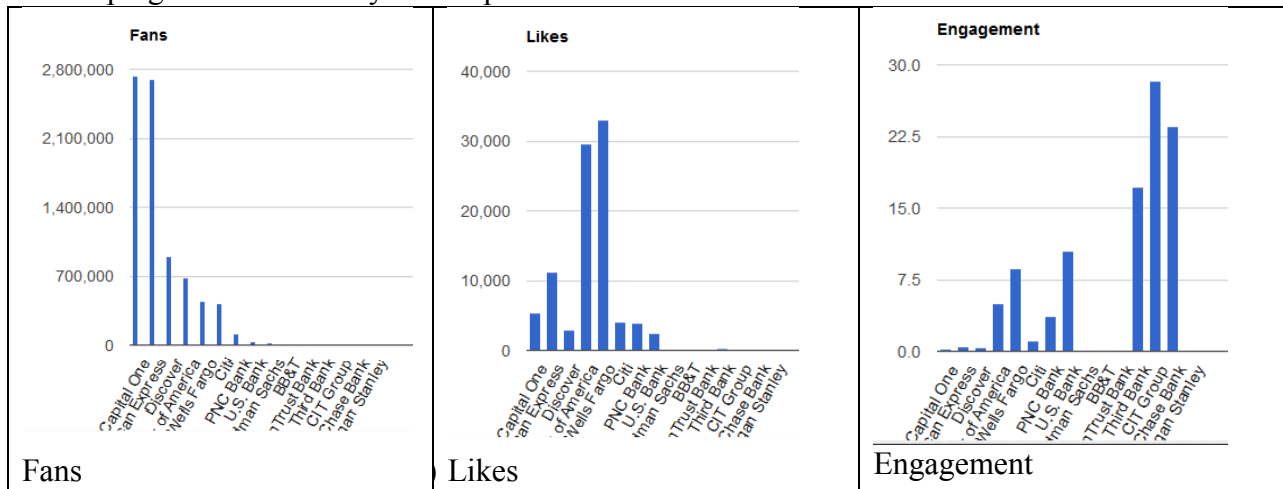
Figure 4: Analysis of Social Media Data

Figure 5 shows another visualization of 'Engagement Rate' in the 19 financial companies.
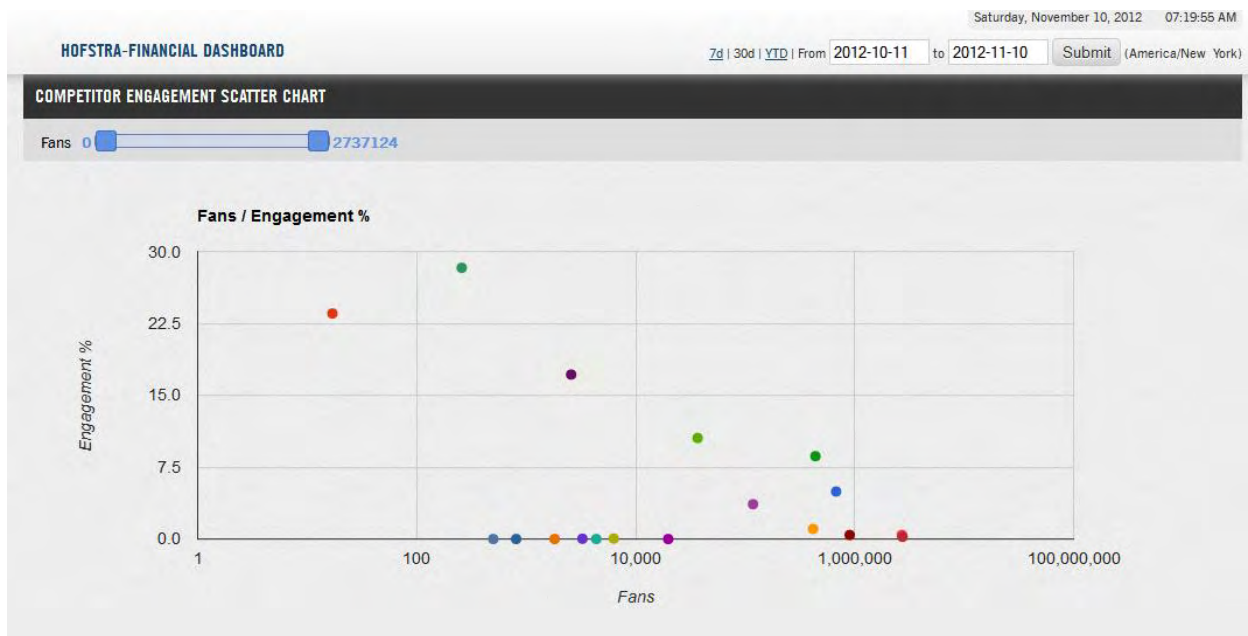
Figure 5: Analysis of Engagement in Financial Sector

CONCLUSIONS

Until now, we discuss new business environment including cloud computing, social media, and *Big Data*. We also attempted to build a simple social media analytic model and then applied it to a financial sector as an empirical test.

Big Data integration and predictive analytics can help overcome the challenges of managing in an environment where increasing rates of change and business model innovation are the new normal. An effective strategy will recognize the importance of Big Data and include an investigation of the requirements to ingest, index, and integrate structured and unstructured, streaming and static data from a variety of sources.

The future research will develop a theory of data analytics and build a generalized model for analyzing *Big Data* (unstructured data) in several industry sector, and then integrated with traditional data (structured data) . This process will contribute for better decision-making.

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A SNAPSHOT OF ANALYTICS CAPABILITY AND ITS EVOLUTION THROUGH AN IBM LENS

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ABSTRACT

The purpose of this study is to understand and assess the current level of development in analytics within organizations and their future aspirations. An analysis of how the current and future aspirations across the several areas comprising analytics evolve over time is also presented. It is based on data obtained from a series of intensive workshops held by IBM with potential clients over 2009 - 2011. The results show significant differences across industries and geographies, and demonstrate an evolutionary path from information foundation, through trusted information and data governance, culminating in analytics and optimization.

INTRODUCTION

Analytics is a strategic business area within IBM as expressed by their Smarter Analytics approach that offers a broad, integrated portfolio of information and analytics capabilities, spanning software, hardware and services. The indicated benefit for organizations is better and faster decisions, and process automation.. Since 2009, IBM has offered workshops for organizations to analyze, strategize, and plan for investments in analytics. Initially, these workshops were called Information Agenda Roadmap Workshops. Starting in 2011, essentially the same workshop was also offered, targeted at functional divisions of an organization, and these were called Functional Assessment workshops. Through each engagement, IBM gathered extensive details on their clients' current maturity capabilities and future goals, as well as their recommendations for clients' information agenda. For each workshop, a summary presentation was prepared for the client and saved. From these documents, a data base was developed that contains data related to a capability analysis and assessment for each workshop. The purpose of this research is to analyze the analytics capability assessment data to determine if there are differences across organizations in terms of geography, industry, and time, and to see if it yields any insight into the evolution of analytics strategy over time of organizations in this area.

DATA COLLECTION AND METHODOLOGY

The data captured for each workshop contains a record index number, the organization's Account name, the Workshop type, an Industry code (16 categories), a Geography code (7 categories), the Year of the workshop, 12 numerical values on a 0 to 10 scale evaluating the

current (As Is) maturity level, aspirations (To Be, or 2B), and the difference between these (Gap) in four areas: Define and Govern (DG), Analytics & Optimization (AO), Trusted Information (TI), and Information Foundation (IF). For short we will call these the 12 Capability Measure values. A series of questions was used to determine the As Is, or maturity scores, over the four capability areas. The subcategories defining each of the four areas are given as Table 1: The data were collected from organizations all over the world over a three-year time frame (2009 – 2011). The data formats were standardized and researchers gathered as much as possible in the English language.

A total of 771 records were collected, with 393 having usable data for the analysis. Extensive procedures were followed to clean and validate the data prior to analysis. It is important to note that the data set is a *representative sample* of organizations working with IBM and is *not a random sample* of organizations in the marketplace. However, given the sample size and the diversity of the organization size, industries, and geographies represented, the data present a good picture of the current state of analytics.

After some preliminary analysis, the 16 industry codes were reduced to ten industry sectors: Banking, Insurance, Telecom, Government, Healthcare, Industrial, Retail, Consumer Products, Travel & Transportation, and Energy & Utilities/Media & Entertainment. Similarly, the seven geographic codes were reduced to six geographies: North America, Western Europe, Central & Eastern Europe & Middle East & Africa (CEE/MEA), Latin America, Japan, and Asia Pacific.

Univariate analysis was employed to understand the basic relationships across the data, followed by regression analysis. All analyses were performed using IBM SPSS software.

Table 1: Subcategories Defining Each of the Four Analytics Capability Areas

Define & Govern
- **Strategy** - capture, integrate, process information
- **Architecture** – document standards, policies & principles
- **Stewardship** – data governance and definitions
- **Processes** – data flow and quality control

Analytics & Optimization
- **Business Intelligence & Performance Management** – access to analyze, tailor & deliver timely, reliable forecasts, plans, reports, queries
- **Advanced Analytics** – statistical modeling and data mining to find patterns & probabilities to make predictions on future events

Trusted Information
- **Information Integration** – extract, capture changed data, transform information
- **Information Quality** – monitor, standardize, match, accurate data
- **Master Data Management** – consistent view of entity, authoritative & trusted source of information
- **Business Process Management** – automate response to business events
- **Records Management** – retain, archive or delete data for compliance

Information Foundation
- **Data Management** – access, scale, flexibility and optimal query performance

- **Metadata Management** – establish, publish, maintain central repository of data
- **Content Management** – capture, store, manage, deliver unstructured data
- **Records Management** – retain, archive or delete data for compliance

UNIVARIATE ANALYSIS

Workshop Type

A one-way ANOVA was performed to determine if the differences between the mean values of each of the 12 capability categories are statistically significant between the two types of workshops (Information Agenda Roadmap and Functional Assessment, with 324 and 69 records, respectively). The results show (not reported here) that they *are not* for any of the 12 categories (using a cutoff of $p = 0.10$). In other words, in all 12 categories, the means are not significantly different, suggesting that the workshops have comparable capability measure values, and so it makes sense to combine all of the workshops and analyze them together. Thus, we conclude that the Workshop Type does not seem to have a significant effect on the Capability measure values.

Differences by Year

Table 2: 12 Capability Measure Comparisons by Year

Year Modified		DGAsIs ***	AOAsIs ***	TIAsIs ***	IFAsIs	DG2B	AO2B *	TI2B **	IF2B **	DGGap	AOGap **	TIGap	IFGap
2009	Mean	2.715	3.098	2.46	2.534	6.445	6.47	6.170	6.478	3.67	3.433	3.810	3.830
	N	55	53	53	54	41	40	40	41	41	40	40	41
	Std. Dev.	1.2297	1.2741	1.004	1.0978	1.1901	1.224	1.2447	1.2308	1.322	1.3534	1.3498	1.4122
2010	Mean	2.550	2.083	1.75	2.129	6.648	5.81	5.193	5.653	4.09	3.745	3.468	3.543
	N	92	90	92	91	91	89	91	90	92	90	92	91
	Std. Dev.	1.4295	1.3386	1.145	1.2619	1.9269	1.747	1.8892	1.9768	1.882	1.8157	1.8281	1.8666
2011	Mean	2.723	2.145	2.02	2.328	6.798	6.26	5.515	5.714	4.07	4.123	3.498	3.385
	N	243	243	243	244	243	243	243	244	243	243	243	244
	Std. Dev.	1.4699	1.2362	1.280	1.3661	1.6319	1.863	1.9033	1.8172	1.535	1.6335	1.4287	1.3932
Total	Mean	2.681	2.262	2.01	2.310	6.723	6.18	5.507	5.783	4.03	3.958	3.524	3.472
	N	390	386	388	389	375	372	374	375	376	373	375	376
	Std. Dev.	1.4274	1.3063	1.230	1.3106	1.6678	1.786	1.8560	1.8159	1.607	1.6658	1.5277	1.5254

*Column variable means were significantly different at the 0.10 level.
**Column variable means were significantly different at the 0.05 level.
***Column variable means were significantly different at the 0.01 level.

Our finalized data had one record with a year of 2012, and it had a date of January 4. Since there was only one record, and it was only 4 days after 2011, we combined it with the 2011 workshops, calling the adjusted variable "YearModified".

Table 2 shows the means of the 12 Capability measures values for each year (2009, 2010, and 2011), and the columns where the three means are significantly different at the 0.01, 0.05, and 0.10 levels are marked with asterisks, based on a One-Way ANOVA. Figure 1 shows these means graphically. When a transition from 2009 to 2010 is statistically significant, the 2009 bar is dark, and when a transition from 2010 to 2011 is significant, the 2011 bar is dark. In all of the results described below, if numbers are used, they correspond to changes that were statistically significant at the 0.10 level (using t-tests).

Figure 1: Capability Measure Means by Year
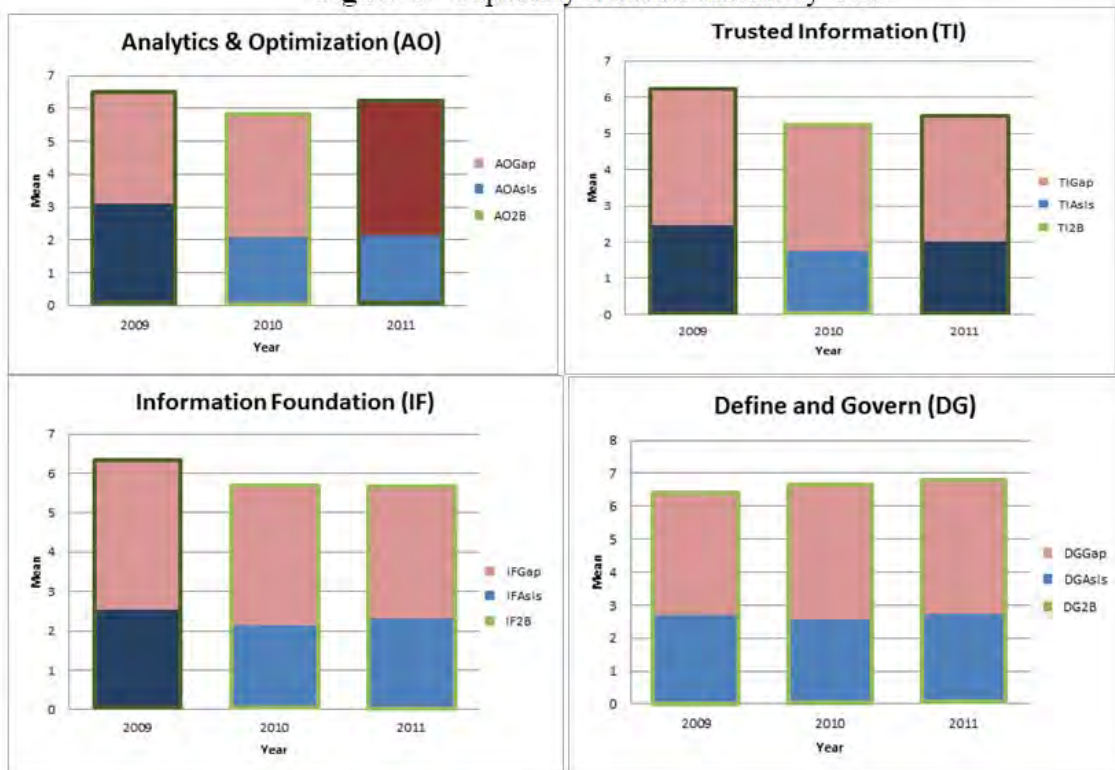
Each of the four areas displayed different patterns over the 2009 – 2011 time frame. In Analytics and Optimization, self-reported As Is maturity dropped 33% from 2009 to 2010, then came back up a little (for an overall decrease of 31% from 2009 to 2011), while To Be aspirations dropped 10%, then bounced back up 8% (for a slight decrease from 2009 to 2011), resulting in the Gap increasing some, then by 10%, for a total increase of 20% from 2009 to 2011.

For Trusted Information, we observed a pattern similar to that of Analytics & Optimization, except that the gap changes were not significant. In particular, As Is maturity dropped 29% (2009 to 2010), then increased 15% (2010 to 2011), for an 18% decrease from 2009 to 2011, while To Be aspirations dropped 16%, then came back a little (for an 11% decrease from 2009 to 2011), but the Gap changes were not significant over any time interval.

For Information Foundation, the changes over time were less pronounced, and the changes from 2010 to 2011 not significant. In particular, the As Is maturity dropped 16%, then came back up a little, while To Be aspirations dropped 13% and came back up a little (for an overall decrease of 12% from 2009 to 2011), with the Gap decreasing 11% from 2009 to 2011 (but the single-year Gap decreases were not significant).

Define and Govern generally remained stable over the three year time frame. The only significant change was an increase of 11% in the Gap from 2009 to 2011 (As Is maturity went down a little, then came back up a little, while To Be aspirations increased a little each year).

Industry Differences

Table 3: 12 Capability Measure Comparisons by Industry Group

| Industry Grouping		DGAsIs **	AOAsIs	TIAsIs	IFAsIs **	DG2B	AO2B	TI2B	IF2B	DGGap **	AOGap	TIGap	IFGap *
Telecom	Mean	2.9688	2.5005	2.2804	2.4413	6.0375	6.0545	5.4625	5.8783	3.0688	3.5541	3.1821	3.4370
	N	24	22	24	23	24	22	24	23	24	22	24	23
	Std. Dev.	1.90148	1.47151	1.63119	1.70018	2.22140	2.47304	2.80881	2.54147	1.29697	1.49392	1.56524	1.47819
Energy & Utility/Media & Entertain	Mean	2.2063	1.8812	1.6563	2.3063	6.3750	5.6250	5.0125	5.5000	4.0906	3.8094	3.2906	3.2781
	N	16	16	16	16	16	16	16	16	16	16	16	16
	Std. Dev.	.82823	.92680	1.05449	1.75821	1.82227	1.54121	1.89803	2.08455	1.60522	.96957	1.30438	1.19540
Banking/ Financial	Mean	2.7542	2.3627	2.0645	2.3101	6.7407	5.9988	5.3457	5.5671	3.9870	3.6103	3.3241	3.2707
	N	84	82	83	84	81	80	81	82	81	80	81	82
	Std. Dev.	1.45485	1.38473	1.19747	1.17604	1.95287	1.89399	1.68018	1.64812	1.80620	1.69998	1.34808	1.26603
Industrial (incl Life Sci/ Pharma)	Mean	3.1417	2.1861	2.2458	2.6000	6.9104	6.4683	5.7098	6.2509	3.7687	4.2970	3.4640	3.6472
	N	53	54	53	53	53	54	53	53	53	54	53	53
	Std. Dev.	1.47126	1.25670	1.37178	1.65767	1.19153	1.72771	1.82911	1.72088	1.65768	1.83820	1.68425	1.70565
Government	Mean	2.4591	2.0341	1.8894	1.9152	6.5891	6.2078	5.7094	5.6906	4.1269	4.1715	3.8554	3.7815
	N	66	66	66	66	64	64	64	64	65	65	65	65
	Std. Dev.	1.63803	1.20055	1.33141	1.15894	1.55789	1.71772	1.71813	1.81648	1.48432	1.61269	1.31696	1.48943
Travel & Transport.	Mean	2.7000	2.5263	2.1421	2.7632	6.8368	6.4684	5.5368	5.8526	4.1368	3.9421	3.3947	3.0895
	N	19	19	19	19	19	19	19	19	19	19	19	19
	Std. Dev.	1.11654	1.26660	1.10369	.91846	1.39611	1.50483	1.45801	1.55326	1.65268	1.68599	1.35338	1.55274
Retail	Mean	2.2105	2.0326	1.7407	1.9988	6.4579	6.1605	4.9211	5.3211	4.2921	4.3474	3.3579	3.3289
	N	43	43	43	43	38	38	38	38	38	38	38	38
	Std. Dev.	1.11278	1.18155	1.13096	1.12834	1.95180	1.75738	1.86492	1.90705	1.47032	1.65672	1.33024	1.51442
Consumer Products	Mean	2.2696	2.3288	1.7783	2.1352	6.9084	6.7400	6.0967	6.3172	4.6228	4.4112	4.3183	4.1820
	N	25	24	24	25	25	24	24	25	25	24	24	25
	Std. Dev.	1.20678	1.28816	1.09500	1.01412	1.15536	1.87113	2.06012	1.91653	1.19289	1.46489	1.57061	1.79422
Insurance	Mean	2.9438	2.5889	2.1500	2.6693	7.4088	6.0575	5.7950	6.1050	4.4481	3.6313	3.6600	3.3763
	N	44	44	44	44	40	40	40	40	40	40	40	40
	Std. Dev.	1.23685	1.55721	1.07520	1.28063	1.27198	1.56466	1.67607	1.42234	1.65899	1.54541	1.80609	1.53573
Healthcare	Mean	2.8938	2.2925	2.0100	2.3731	6.3947	5.8320	5.1320	5.1920	3.4413	3.5867	3.1213	2.7940
	N	16	16	16	16	15	15	15	15	15	15	15	15
	Std. Dev.	1.24390	1.13682	.82430	1.09360	1.54776	1.63382	1.92293	2.01632	1.33563	2.11149	2.24925	1.83800
Total	Mean	2.6811	2.2617	2.0137	2.3099	6.7230	6.1780	5.5070	5.7830	4.0342	3.9576	3.5238	3.4721
	N	390	386	388	389	375	372	374	375	376	373	375	376
	Std. Dev.	1.42737	1.30628	1.22966	1.31061	1.66779	1.78639	1.85599	1.81594	1.60686	1.66581	1.52774	1.52544

*Column variable means were significantly different at the 0.10 level.
**Column variable means were significantly different at the 0.05 level.
***Column variable means were significantly different at the 0.01 level.

Table 3 shows the mean values of the 12 Capability measure values in each of the 10 Industry groups. The columns marked with asterisks indicate Capability measure categories where the differences in the means are significant at the 0.01, 0.05, and 0.10 levels. This occurred in only 4 of the 12 categories (DGAsIs, IFAsIs, DGGap, and AOGap).

Figure 2: As Is Maturity by Industry Grouping
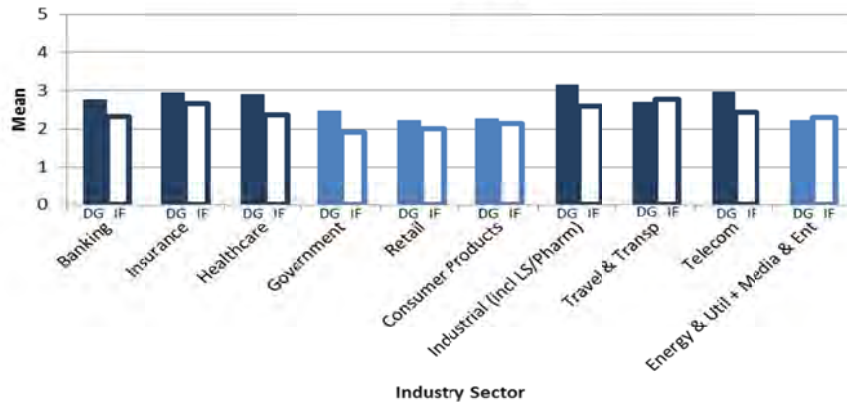
In the two As Is categories with significant differences (Define and Govern and Information Foundation), no individual industry group stood out as high or low, but they clustered into two groups, as shown in Figure 2. The mean of the high group was 23% higher than the mean of the low group for Define and Govern, and 24% higher for Information Foundation.

Figure 3: Maturity Gaps by Industry
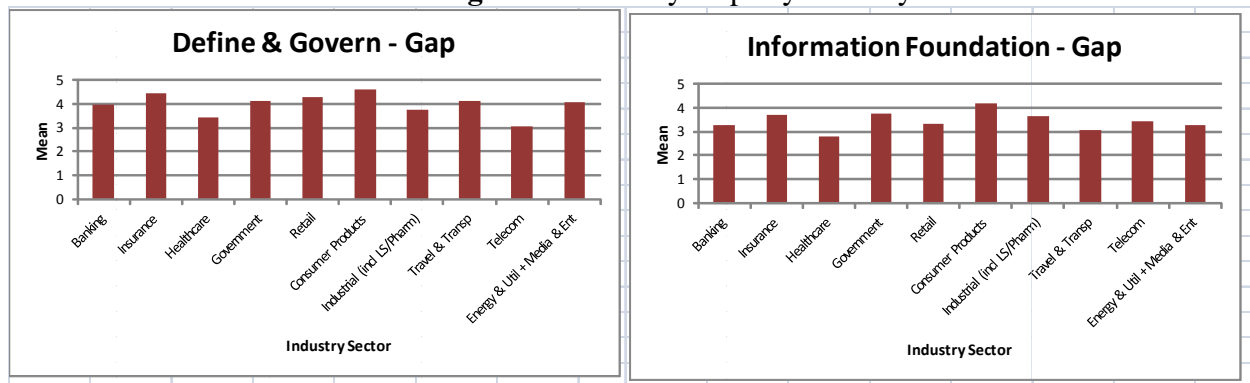
In the two Gap categories with significant differences (Define and Govern and Information Foundation), as shown in Figure 3, the Consumer Products mean was highest, and was significantly higher than the mean of all the other industries together (16% higher for Define and Govern, and 22% higher for Information Foundation). For the Define and Govern Gap, the Telecommunications mean was lowest, and significantly lower than the mean of all the others (by 25%). For the Information Foundation Gap, Healthcare was lowest, and significantly lower than all of the others (by 20%).

Geographical Differences

Table 4: 12 Capability Measure Comparisons by Geographic Cluster

| Geographic Area		DGAsIs ***	AOAsIs *	TIAsIs ***	IFAsIs **	DG2B ***	AO2B ***	TI2B ***	IF2B ***	DGGap ***	AOGap ***	TIGap ***	IFGap ***
CEE/ MEA	Mean	2.3614	1.8607	1.5171	2.1759	5.9000	5.0407	4.3393	4.8724	3.5386	3.1800	2.8221	2.6966
	N	29	27	28	29	29	27	28	29	29	27	28	29
	Std. Dev.	1.19678	.98051	.79569	1.47470	1.35620	1.56310	1.42396	1.76330	1.40240	1.49145	1.33053	1.18698
Latin America	Mean	3.2240	2.2680	1.9333	2.5760	7.8333	6.9375	6.4000	6.9250	4.5396	4.8104	4.4870	4.3188
	N	25	25	24	25	24	24	23	24	24	24	23	24
	Std. Dev.	1.62821	1.42762	1.07892	.90013	1.27507	1.68415	1.66187	1.63581	1.68452	1.74293	1.66687	1.22002
Asia Pacific	Mean	2.4217	2.1973	1.8928	2.1128	6.2762	5.9821	5.3976	5.5857	3.8512	3.8686	3.5244	3.4952
	N	90	90	90	90	84	84	84	84	84	84	84	84
	Std. Dev.	1.48009	1.24892	1.25623	1.37886	1.94085	1.86729	2.11899	1.96623	1.57799	1.36145	1.47680	1.33698
North America	Mean	2.5631	2.2431	2.0649	2.2474	6.9972	6.4450	5.7284	5.9814	4.4276	4.2352	3.7134	3.7389
	N	171	170	171	171	166	165	166	166	166	165	166	166
	Std. Dev.	1.42122	1.32464	1.29928	1.25865	1.56617	1.64606	1.74370	1.69730	1.66025	1.74849	1.58385	1.68103
West. Europe	Mean	2.9824	2.2949	1.9700	2.5327	6.6021	5.4340	4.9833	5.3830	3.6449	3.1365	3.0571	2.8312
	N	51	49	50	49	48	47	48	47	49	48	49	48
	Std. Dev.	1.11709	1.32226	1.08256	1.39693	1.43978	1.85546	1.89920	1.96251	1.33464	1.63921	1.38022	1.45356
Japan	Mean	3.7478	3.0167	2.8667	2.9583	6.5826	7.0542	5.9333	5.8750	2.8348	4.0708	3.0667	2.9167
	N	23	24	24	24	23	24	24	24	23	24	24	24
	Std. Dev.	1.31490	1.40238	1.14119	1.22116	1.56660	1.52458	1.35186	1.28275	.89423	1.35116	.95082	.70320
Total	Mean	2.6828	2.2620	2.0145	2.3120	6.7276	6.1812	5.5084	5.7851	4.0369	3.9605	3.5243	3.4720
	N	389	385	387	388	374	371	373	374	375	372	374	375
	Std. Dev.	1.42879	1.30796	1.23113	1.31166	1.66764	1.78775	1.85830	1.81792	1.60812	1.66706	1.52975	1.52748

*Column variable means were significantly different at the 0.10 level.
**Column variable means were significantly different at the 0.05 level.
***Column variable means were significantly different at the 0.01 level.

In the results of a 1-Way ANOVA, the means in *all* 12 Capability measure value categories were found to be significantly different at the 0.10 level (shown with asterisks in Table 4). Based on independent-sample t-tests, the more detailed results that follow were also significant at the 0.10 level. Figure 4 shows the means graphically.

Figure 4: Capability Measure Means by Geographical Area
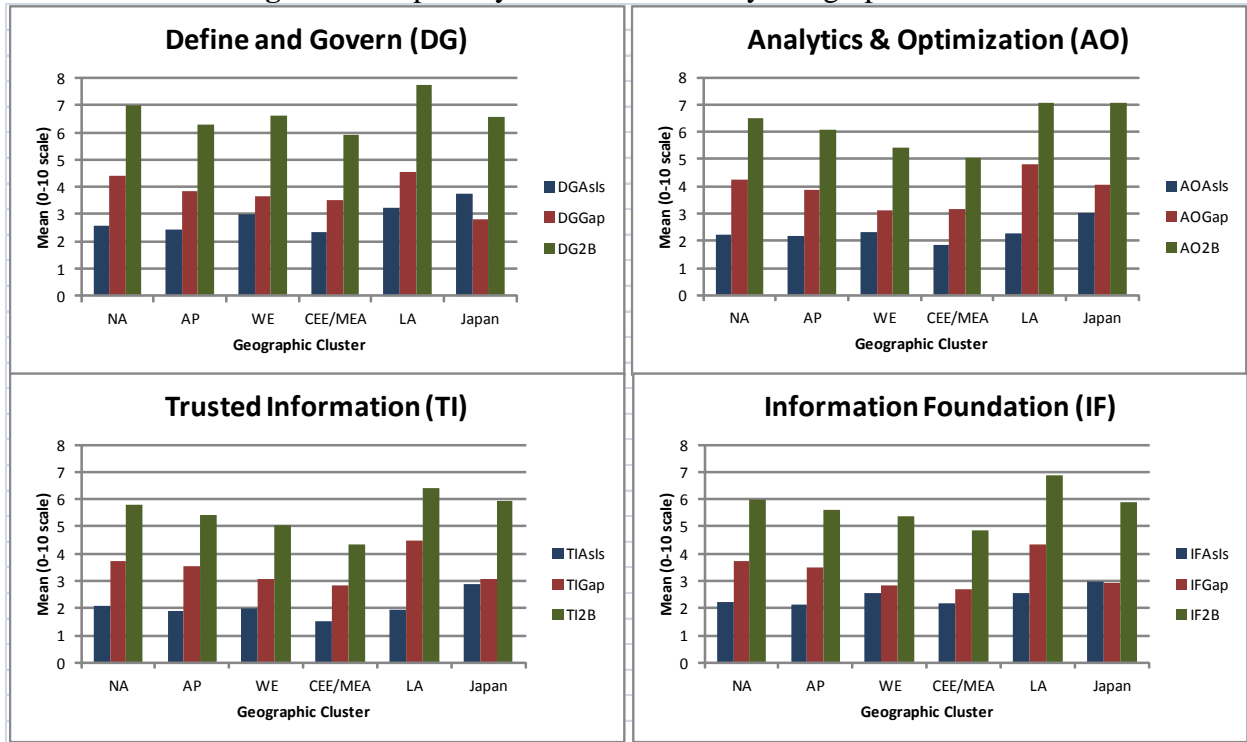
Central and Eastern Europe, the Middle East, and Africa (CEE/MEA) was *below* all other geographical areas by 13-26% in 10 of the 12 Capability Measure areas (all except As Is maturity in Define & Govern and Information Foundation).

Japan was 23-32% higher than all other areas in As Is maturity in all four areas, 13% above the rest in Analytics & Optimization To Be aspirations, 46% below the rest in its Analytics & Optimization Gap, and 20% below the others in its Information Foundation Gap. Latin America was 13-22% above the rest in its To Be aspirations in all four areas, 22% above the rest in Define & Govern As Is maturity, and 23-30% above the others in 3 of the 4 (all but Define & Govern) Gap areas. Japan and Latin America *together* were 19-35% above the rest in As Is maturity in all four areas, 9-16% higher in all four To Be aspiration areas, and 14% above the others in their Analytics & Optimization Gap.

PREDICTIVE MODELS

As shown above, levels of analytics maturity vary widely from organization to organization. Realistically, the analytics maturity of an organization has many determinants, and it reflects the combined effects of all of them.

Here, we explore the variations in analytics maturity by first formulating models that link measurements of analytics maturity to their determinants. We then apply regression analysis to estimate such models.

In the present context, we first assume that organizations develop analytics capabilities when such capabilities are expected to be worthwhile. We assume that the environment in which an organization functions has influenced its perception of the value of analytics capabilities and its decision to acquire such capabilities. In this analysis, we use industrial classification, geographical location, and year of assessment to capture the general characteristics of an organization's environment.[1] These are the same characteristics that we explored in the previous section on univariate analysis.

The assessment of an organization's analytics capability may well vary across its employees as areas of knowledge and interest vary by employee. To accommodate the possibility that the process of sampling employees differed systematically by type of workshop used to collect data, we include an indicator for workshop type in our model explaining the reported measures of an organization's analytics capability.

In the data at hand as described above, organizations have assessed analytics capability in four distinct areas: information foundation (IF), data governance (DG), trusted information (TI), and analytics and optimization (AO). To the extent that there is a natural developmental sequencing of these areas in the process of attaining analytics capability, a good model of analytics capability should reflect such sequencing. Here, the words of Davenport et al. (2010; 19) guide us: "good data is a prerequisite for everything analytical."[2] Our interpretation of these words is that acquiring data (IF) is necessarily first, while refining the data and setting up rules concerning its use (DG and TI), in order to make it "good", come next. Using the data for analytics and optimization (AO) is the destination of the path.

With this view, we propose that maturity in data governance and maturity in trusted information each require maturity in information foundation, while maturity in analytics and optimization requires maturity in all of the other three areas (information foundation, data governance and trusted information).

Taken in combination, these ideas imply the following equations:

$$IFAsIs = f(industry, geography, year, type\ of\ workshop)$$
$$DGAsIs = f(industry, geography, year, type\ of\ workshop, IFAsIs)$$
$$TIAsIs = f(industry, geography, year, type\ of\ workshop, IFAsIs)$$
$$AOAsIs = f(industry, geography, year, type\ of\ workshop, IFAsIs, DGAsIs, TIAsIs)$$

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[1] These general characteristics broadly reflect differences in production technology, market structure, economic development in the homeland, and cyclical circumstances. More detailed characteristics of organizations are unfortunately not available in the data set.

[2] Thomas H. Davenport, Jeanne G. Harris, and Robert Morison. (2010). *Analytics at Work: Smarter Decision, Better Results.* Boston, Mass.: Harvard Business Press.

In addition to assessing existing analytics capabilities, organizations in our data set express medium-term aspirations for future analytics capabilities. Here, in our model for an aspirational ("To Be") analytics capability, we assume that the aspiration for analytics capability in an area is influenced by the existing capability in that area, along with existing capabilities in any developmentally-prerequisite area(s). For reasons similar to those expressed above, we believe that industrial classification, geographical location, year of assessment and workshop type may also be factors in influencing aspirations for analytics capabilities.   Altogether, these ideas imply the following equations:

$$IF2B = f(industry, geography, year, type\ of\ workshop, IFAsIs)$$

$$DG2B = f(industry, geography, year, type\ of\ workshop, IFAsIs, DGAsIs)$$
$$TI2B = f(industry, geography, year, type\ of\ workshop, IFAsIs, TIAsIs)$$
$$AO2B = f(industry, geography, year, type\ of\ workshop, IFAsIs, DGAsIs, TIAsIs, AOAsIs)$$

For simplicity, we assume that the functional form of the relationship between the dependent (left-hand side) and independent (right-hand side) variables is linear, with a stochastic error term that is identically and independently distributed. We apply an ordinary least squares regression technique to estimate the coefficients of each linear relationship. Tables 5 and 6 present the estimation results for current ("As Is") and aspirational ("To Be") analytics capabilities, respectively.

The estimation results largely support our hypothesized path for the development of analytics capabilities. According to Table 5, organizations have significantly higher current capability in DG and TI, the higher their capability in IF: all other things being the same, the assessments of capability in DG and TI are .65 and .68 points higher, on average, for every point higher the assessment of capability in IF. As might be expected, variation in current capability in AO, the ultimate goal of the process, is more significantly linked to variation in current capabilities in the intermediate stages (DG and TI) of development, rather than variation in current capability in the initial stage (IF) of development. All other things being equal, for every additional point of capability in TI (DG), the assessment of capability in AO is on average .55 (.17) points higher. The differential in impact between capabilities in TI and DG is statistically significant (p=.000).

The results presented in Table 6 show somewhat similar tendencies concerning aspirations for analytics capabilities. Organizations have significantly higher aspirations for capability in DG, the higher their current capability in IF, all other things being equal. However, the same cannot be said about aspirations for capability in TI. The results do suggest that organizations have significantly higher aspirations for capability in AO, the higher their current capability in TI, all other things being the same. However, the current capability in DG appears to have no significant effect on the aspiration for capability in AO.

Indicators of industrial classification, geographical location, year of assessment and workshop type serve primarily as control variables. However, some of the significant findings are worth mention.

Findings of significant differences by geographical location are rather numerous in Tables 5 and 6. In the case of geography, we have used dummy variables to highlight differences between North America and five other locations: Japan; Asia Pacific; Western Europe; Latin America; and Central/Eastern Europe, the Middle East and Africa (CEEMEA). From Table 5, we see that all other things being equal, organizations in Japan tend to assess current analytics capability in all areas except AO as significantly higher than organizations in North America. All other things being equal, organizations in Latin America tend to assess current capability in DG as significantly higher, but current capability in TI as significantly lower, compared to otherwise-similar organizations in North America. Organizations in Western Europe and CEEMEA also tend to assess current capability in TI as significantly lower in comparison to otherwise-similar North American organizations.

From Table 6, we see that aspirations for analytics capabilities are significantly lower in all four areas for organizations in both Western Europe and CEEMEA, compared to similar North American organizations. Aspirations for capabilities in select areas are also significantly lower in Japan (IF and DG) and Asia Pacific (DG), but significantly higher in Latin America (IF, TI and AO). While one might speculate that these findings are linked to global differences in cultural perspective, political stability, and/or economic history and development, definitively naming the source of the difference is beyond the scope of this analysis.

In the case of industry, we have used dummy variables to highlight differences between retail and nine other industries: industrial products; insurance; banking and financial markets; telecommunication; energy, utilities, media and entertainment (EUME); government; healthcare; consumer products; and travel and transportation. All other things being equal, organizations in industrial products, insurance, telecommunications, and travel and transportation industries report significantly higher capability in IF, while organizations in industrial products, government and consumer products have significantly higher aspirations for capability in IF, in comparison to otherwise-similar organizations in other industries. Organizations in industrial products, banking and financial markets, telecommunications, government and healthcare industries report significantly higher capability in DG, while organizations in the insurance industry have significantly higher aspirations for capability in DG, compared to otherwise-similar organizations in other industries.

Fewer significant differences exist across industries in the other two areas of analytics capabilities. Organizations in telecommunications report significantly greater capability in TI, while organizations in government and consumer products industries have significantly higher aspirations for capability in TI, in comparison to otherwise similar organizations in other industries. In the area of AO, no significant differences exist across industries between

otherwise-similar organizations, in either current capabilities or aspirations for capability. Where findings of significant differences do exist across industries in IF, DG and TI, they may well stem from industry differences in regulation, production technology, competitiveness of market, sensitivity to business cycle fluctuations, et cetera. Again, definitively naming the exact sources of differences is beyond the scope of this analysis.

With respect to year of assessment, we have used dummy variables to highlight differences between 2010 and each of the years immediately preceding and following 2010. Surprisingly, perceptions of existing capabilities in IF, TI and AO are significantly higher in organizations assessed in 2009, compared to otherwise-similar organizations assessed in later years. However, organizations assessed in 2011 have significantly higher aspirations for capability in AO, compared to otherwise-similar organizations assessed in earlier years. These significant differences could stem from organizations' growing awareness of the potential value and challenges of handling "big data".

No statistically significant differences exist between organizations participating in the two different types of workshops (Enterprise Roadmap or Functional Area Assessment) used in the collection of these data.

Table 5: Regression Estimation Results for "As Is" Capability Measures[a]				
	IFAsIs	**DGAsIs**	**TIAsIs**	**AOAsIs**
Constant	1.936*** (.000)	.923*** (.001)	.372* (.063)	.661*** (.007)
Industrial Plus	.573** (.034)	.594*** (.010)	.144 (.400)	-.306 (.137)
Insurance	.719*** (.010)	.339 (.158)	-.009 (.960)	.144 (.496)
Bank & Financial	.381 (.125)	.368* (.084)	.219 (.163)	.084 (.655)
Telecom	.599* (.086)	.660** (.027)	.430* (.052)	-.123 (.647)
Energy/Media	.444 (.246)	-.123 (.706)	-.132 (.584)	-.002 (.994)
Government	-.097 (.706)	.365* (.097)	.242 (.136)	-.125 (.521)
Healthcare	.388 (.313)	.601* (.068)	-.031 (.898)	-.071 (.806)
Consumer Products	.136 (.678)	.051 (.856)	-.048 (.817)	.238 (.338)
Travel & Transportation	.721** (.045)	-.051 (.868)	-.071 (.754)	.220 (.415)
Japan	.544* (.064)	.712*** (.006)	.316* (.090)	.271 (.233)
Asia Pacific	-.237 (.192)	-.051 (.742)	-.144 (.210)	.007 (.960)
Western Europe	.247 (.247)	.176 (.335)	-.275** (.041)	.091 (.576)
Latin America	.332 (.243)	.516** (.034)	-.326* (.075)	-.037 (.866)
CEEMEA	-.214 (.431)	-.255 (.274)	-.532*** (.002)	.007 (.974)
d09	.452** (.046)	-.200 (.301)	.358** (.013)	.682*** (.000)
d11	.138 (.422)	-.059 (.684)	.048 (.655)	-.062 (.630)
Roadmap	-.152 (.440)	-.081 (.629)	-.014 (.911)	.016 (.916)
IFAsIs	---	.650*** (.000)	.680*** (.000)	-.016 (.791)
DGAsIs	---	---	---	.165*** (.001)
TIAsIs	---	---	---	.551*** (.000)
AOAsIs	---	---	---	---
Adjusted R-square	.042	.414	.568	.463
F-statistic	1.994**	16.177***	29.042***	17.409***
N	388	387	385	382
[a] P-values are in parentheses below estimated coefficients. *** indicates significance at a 1% level, ** indicates significance at a 5% level, and * indicates significance at a 10% level.				

	IF2B	DG2B	TI2B	AO2B
Table 6: Regression Estimation Results for "To Be" Capability Measures[a]				
Constant	3.533*** (.000)	5.005*** (.000)	3.609*** (.000)	4.624*** (.000)
Industrial Plus	.704** (.025)	.158 (.608)	.512 (.113)	.327 (.338)
Insurance	.200 (.544)	.574* (.076)	.458 (.176)	-.305 (.390)
Bank & Financial	.166 (.562)	.203 (.472)	.130 (.661)	-.336 (.283)
Telecom	.549 (.166)	-.238 (.541)	.358 (.383)	-.249 (.569)
Energy/Media	.205 (.635)	.071 (.865)	.172 (.697)	-.232 (.616)
Government	.557* (.064)	.041 (.889)	.589* (.057)	.065 (.841)
Healthcare	-.528 (.237)	-.622 (.156)	-.088 (.847)	-.536 (.266)
Consumer Products	.927** (.014)	.438 (.231)	1.025*** (.008)	.483 (.235)
Travel & Transportation	.194 (.633)	.259 (.514)	.324 (.436)	.122 (.780)
Japan	-.629* (.055)	-1.250*** (.000)	-.395 (.242)	-.061 (.866)
Asia Pacific	-.335 (.106)	-.701*** (.001)	-.120 (.570)	-.302 (.175)
Western Europe	-.903*** (.000)	-.643*** (.007)	-.693*** (.006)	-1.084*** (.000)
Latin America	.691** (.032)	.293 (.354)	.910*** (.007)	.701** (.050)
CEEMEA	-1.101*** (.000)	-1.063*** (.000)	-.846*** (.008)	-1.039*** (.002)
d09	.214 (.446)	-.341 (.216)	.201 (.488)	-.050 (.873)
d11	.057 (.766)	.264 (.158)	.115 (.557)	.427** (.039)
Roadmap	.359 (.101)	.272 (.204)	-.105 (.639)	.175 (.460)
IFAsIs	.784*** (.000)	.162** (.024)	.012 (.892)	-.129 (.178)
DGAsIs	---	.460*** (.000)	---	.014 (.866)
TIAsIs	---	---	.832*** (.000)	.243** (.046)
AOAsIs	---	---	---	.542*** (.000)
Adjusted R-square	.388	.300	.373	.276
F-statistic	14.110***	9.398***	12.564***	7.674***
N	374	373	371	368

[a] P-values are in parentheses below estimated coefficients. *** indicates significance at a 1% level, ** indicates significance at a 5% level, and * indicates significance at a 10% level.

SUMMARY AND CONCLUSIONS

The results show significant differences in analytics maturity and aspirations across time, industries, and geographies. Over time, AO maturity dropped and then rebounded, while TI dropped and then partially recovered. The banking, insurance, health care, industrial, travel and transportation, and telecom industries had higher average maturity for DG and IF as compared to all industries. Consumer products had high gaps in DG and IF, while telecom had a low DG gap and health care had a low IF gap. Concerning geography, CEE/MEA was lower than all other regions in nearly all capability areas. Japan had the highest maturity and had high aspirations in AO, while Latin America had high aspirations in all four areas.

Regression models were developed to determine if maturity and aspirations in each of the four areas (DG, AO, TI, and IF) follows an evolutionary path, in that acquiring data (IF) is necessarily first, while refining the data and setting up rules concerning its use (DG and TI) comes next, with AO the final destination. The estimation results largely support our hypothesized path for the development of analytics capabilities.

The findings from this paper provide an assessment of the current level of development in analytics within organizations and their future aspirations. They highlight the areas requiring analytics investment if organizations wish to improve their capabilities to remain competitive.

ACKNOWLEDGEMENT

RISKS AND BENEFITS OF BUSINESS INTELLIGENCE IN THE CLOUD

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ABSTRACT

The new phenomenon of business intelligence (BI) is transforming the way businesses handle data. BI environments require a large capital layout to implement and support the large volumes of data as well as massive processing power, which inflicts tremendous pressure on corporate resources. In recent years, cloud computing has made BI tools more accessible, but BI in the cloud comes with a number of risks and vulnerabilities; most notably threat to security. This paper presents the benefits and risks of using BI in the cloud and discusses the necessary precautions that should be taken prior to transitioning to cloud computing.

Keywords: business intelligence, cloud computing, risks and benefits, big data, saas.

INTRODUCTION

Traditional decision support systems have evolved to more complex solutions that support structured and unstructured data at all managerial levels and business processes [1]. *Business intelligence* (BI) refers to the organizational ability that captures internal and external information and converts them into knowledge. The assimilated knowledge is then used to develop new opportunities towards achieving competitive advantage. BI is indeed revolutionizing decision making and information technology across all industries. This phenomenon is largely due to the ever-increasing availability of data. The explosive volumes of data are available in both structured and unstructured formats, and are analyzed and processed to become information within context hence providing relevance, and purpose to the decision making process [2]. BI provides both information and knowledge that leverage a variety of data sources. Knowledge is derived from information but is more robust as it offers "justified beliefs about relationships relevant to the decision," [2, p. 5]. BI enables decision makers to optimize business resources, increase efficiency, reach goals, and identify areas for growth. Reaping the core benefits of BI requires technical and conceptual integration, which, in turn, increases the complexity of data management and storage [3],[4]. The financial and organizational burden of BI solutions may easily override the benefits they offer. "In many cases, the integrated infrastructures that are subject to BI have become complex, costly, and inflexible." [4]

Traditionally, Decision support systems tools reside on-premises. However, due to the increasingly digital presence of data [2 p. 262] many BI vendors are offering tools on the cloud. BI solutions based on Cloud Computing, called "Cloud BI" or "BI services on demand" are becoming increasingly popular and considered as one possible remedy to the restrains caused by BI solutions [4], [5], [2]. Cloud computing presents a model that provides

on demand access to software and hardware resources with minimal management efforts. The main features of cloud computing are: [6], [7], [8]

-Virtual, dynamic, scalable and massive infrastructure;
- Shared, configurable, flexible, dynamic resources;
- Accessible via internet from any device;
- Platform with minimal management or self-management;

The Cloud computing environment enables BI tools to be distributed as a service, more commonly known as Software as a Service (SaaS). SaaS is often called software "on demand" and has become a popular delivery model for business applications. Such models are data-centric and hosted in the cloud, making them accessible via a web browser. Most enterprise software companies now have several SaaS offerings on the cloud. SaaS is more robust and inclusive than Infrastructure as a Service (IaaS) or Platform as a Service (PaaS). Given the increasing popularity of cloud computing and the importance of choosing the appropriate BI tool, it is crucial to better understand the nature of cloud computing and examine the benefits and risks of using BI tools on the cloud.

Cloud computing is a virtual environment which gives users the facility to access computing power to which they might not otherwise have access due to financial or organizational limitations. Cloud computing, sometimes called "a field within service computing," is a cross-discipline that bridges the gap between business and IT services. This discipline aims to enable IT services and computing technology to perform business services more efficiently and effectively [9]. In technical terms cloud computing includes service oriented architecture (SOA) and virtual applications of both hardware and software. Cloud computing shares its resources among a cloud of service consumers, partners, and vendors. By sharing resources at various levels, this platform offers various services, such as an infrastructure cloud, a software cloud, an application cloud and a business cloud [10]. For those of less technical backgrounds, the cloud is similar to a "computer co-op." It enables entities to pool their resources to improve the business process at reduced capital costs. It also allows entities to outsource the information technology responsibilities, thus allowing the organization to focus on its core competencies. In essence, cloud computing provides large data centers at a low cost due to their expertise in organizing and provisioning computer resources.

While utilizing cloud computing delivers a number of benefits, enterprises that consider the use of the cloud in their environment should ponder upon the potential risks as well. Business must work with legal, security, and assurance professionals to ensure that the appropriate levels of security and privacy are achieved [6]. As pointed out by Gartner, "Organizations potentially can gain a competitive or cost advantage through selective adoption of cloud computing, but not without first taking a comprehensive look at the associated risks, ensuring that they are consistent with business goals, along with the expectations of regulators, auditors, shareholders and partners. It is especially challenging to understand the risks associated with cloud computing …." [9, page 2].

One of the biggest issues facing cloud computing is data security. For many mission-critical computations, cloud computing may be ill-advised because shared resource environment of cloud computing introduces unexpected side channels (passively observing information) and covert channels [11]. Other issues such as reputation fate sharing, which allows cloud users to take advantage of security best practices delivered by expertise at major cloud providers while at the same time a single disrupt can affect many users [12]. There is little doubt that

Cloud computing is viewed as a "target rich" environment for those wishing to do harm. Cloud users face security threats both from outside and inside the cloud. Many of the security issues involved in protecting clouds from outside threats are similar to those already facing large data centers. In the cloud, however, this responsibility is divided among potentially many parties, including the cloud users, the cloud vendor, and any third-party vendors that users rely on it for security-sensitive software or configurations.

In this paper we address benefits and risks of BI on the cloud and suggest some precautionary undertakings for organizations that would like to invest in cloud computing to achieve the ultimate goal of any modern business; gain economic advantage, but are weary of security risks.

The following sections discuss how cloud computing can improve BI, followed by what the main risks are. The discussion concludes with final considerations for managers when choosing a BI vendor and an overview of the implications for vendors themselves.

BENEFITS OF BUSINESS INTELLIGENCE ON THE CLOUD

When looking into practicalities of moving BI into the cloud we should first consider potential benefits and then examine the risks involved. In what follows we discuss the benefits.

Increased Elastic Computing Power

Computing power refers to how fast a machine or software can perform an operation. Hosting BI on the cloud means that the computing power, or processing power, depends on where the software itself is hosted, rather than the on-premises hardware. Cloud computing has become very popular over the last few years and is "hailed as revolutionizing IT, freeing corporations from large IT capital investments, and enabling them to plug into extremely powerful computing resources over the network," [12]. As the volume of data increases to unprecedented levels and the growing trend of "Big Data," becomes a norm rather than an exception more and more businesses are looking for BI solutions that can handle gigabytes (and eventually terabytes) of data [13].

The cloud lets users avoid the necessity to upgrade the computing power of their on-premise systems in order to use BI. Instead, it allows BI users to call on increased computing power as needed. The cloud's flexibility allows BI users to instantly scale computing activities up or down depending on the project at hand [14]. This benefit of elastic computing power is advantageous in "the face of changing conditions," [12]. Project sizes vary greatly and the flexibility in computing power is appealing for companies with fluctuating and growing data sources.

Potential Cost Savings

Pay-as-you-go computing power for BI tools has the potential to reduce costs. A user on the cloud only has to pay for whatever computing power is needed. Computing needs could vary considerably due to seasonal changes in demand or during high-growth phases [12]. This makes IT expenditure much more efficient.

The reduction of costs is particularly attractive for startups looking to use BI. Research by Gartner indicates that cost models can be cheaper over the first five years, as a direct

consequence of adopting the cloud. Long-term cost reductions are more difficult to quantify, but include the potential for reduced personnel costs and reduced IT support costs [15].

Regardless, any potential cost savings can be significantly beneficial to both BI vendors and users. For some vendors, cost is the "No. 1 reason that broader deployments [of BI are] blocked," [16]. On the other hand, new and independent BI cloud vendors like LogiXML and Jaspersoft enjoyed good sales in recent years, with cost being the primary reason for customer adoption [17].

Easy Deployment
The cloud makes it easier for a company to adopt a BI solution and quickly experience the value. Managers will see results quickly and increased confidence surrounding the success of the implementation. Deployment requires less complicated upgrades for existing processes and IT infrastructure [18]. The development cycle is much shorter, meaning that the adoption of BI does not have to be a drawn out process, thanks to the elimination of "complicated upgrade processes and IT infrastructures demanded by on-premises BI solutions,"[15].

Supportive of Nomadic Computing
Nomadic computing is "the information systems support that provides computing and communication capabilities and services to users, as they move from place to place," [19]. As globalization continues to dominate all industries, nomadic computing services and solutions will grow in demand. It also allows employees and BI users to travel without losing access to the tools.

The increasing number of global businesses, international offices, and remote teams, means that on-premises software can often be irrelevant or difficult to maintain. It is important for companies to use the same solutions internally, and it may be impossible to deploy the same on-premises solution across countries depending on the vendor. Globalized businesses will increasingly require BI solutions that are "more Web 2.0 and collaborative than Excel," [13] in order to work effectively and uniformly across offices. The cloud makes it possible for a company to deploy a uniform solution around the world.

RISKS OF BUSINESS INTELLIGENCE ON THE CLOUD

Despite the numerous benefits of adopting cloud-based business intelligence, there are many risks. The following is a discussion of the risks cloud-based BI presents, with a particular emphasis on security.

Security Risks
Today, security and privacy may represent the biggest risks to moving services to external clouds [20]. According to a survey of Chief Information Officers and IT specialists, 75% of respondents consider security as the number one risk of cloud computing integration with BI [5]. Using BI on the cloud poses significant security risks. "Since BI and analytics are data-intensive, there [is] a lot of nervousness about relying on outside cloud providers handling massive amounts of corporate data," [21]. With cloud computing, data is stored and delivered across the Internet. Since the location of data is unknown and not controlled by the owner of the data, there is a good chance that several competitors' data and applications reside on the same resources environment. In this multi-tenant environment, it may be very difficult to

have the level of isolation and associated guarantees that are possible with an environment dedicated to a single customer [9].

As a result, there are many risks surrounding the loss or compromise of data. Data hosting may be untrusted or unsecure, with the potential for data leakage [22]. There is significant potential for a data breach or data loss, potentially compromising customer or otherwise confidential data. If there is potential for a data breach, an organization using cloud BI runs the risk of damaging the bottom line and its reputation [12].

As noted before, when putting data onto an external server and outside of the user's direct control, there's no way avoiding confidentiality risks" [23]. Encryption is a viable option, but it is the responsibility of the user to ensure that data is appropriately encrypted on the cloud. Any cloud technology require the process of virtualization: housing several different data sets and sources on a single piece of hardware. The practice of virtualization actually presents opportunities for highly technical security breaches, as data is stored forever, even when its index is deleted [22].

Slow Data Breach Recovery
When data is hosted outside a company's direct control, the likelihood of a data breach remains high, but the recovery is more difficult due to the dependence on a third party. Timely and appropriate response to a data breach is crucial for customer retention. However, if the BI user does not know where the data is actually stored and processed (possibly outside the country), it is difficult to respond quickly, remedy the problem, and provide customers, clients, and employees with the answers they need in regards to privacy or accessibility.

Cloud BI Availability Is Determined By External Factors
Using BI on the cloud relies on the third party's server availability, rather than on-premises availability. A user is "gambling that your data will be available when you need it when you put it in the cloud, betting that the availability won't be eroded by network outages, data center outages and other single points of failure," [23]. If there is a failure, the BI user could lose access, visibility or control of its data [22].

Potential Compromise of Core BI Capabilities
Traditional, on-premises BI solutions offer full control and high-touch data integration. Data integration capability, one of the four core BI capabilities, is crucial to defining a successful and robust BI solution. The cloud presents the potential for compromised data, metadata, and application integration, according to Boris Evelson of Information Management [13]. BI tools must offer the "capability to import/export metadata so that business and technical metadata can be integrated and reused with other enterprise applications," [13]. Further, the import mechanism should be conducive to unstructured and structured data types that already exist within the organization. Since cloud BI solutions are often separate from the rest of the organization's IT, there is risk for incompatibility with other enterprise applications.

Costs Are Difficult To Quantify
Cost benefit analyses for business intelligence are difficult, even more so with cloud solutions. Despite the presumed short-term cost savings and increased efficiency, "long-term savings from SAAS lie in reduced IT support costs and other factors," [15] and are much more difficult to quantify without a control study. Gartner analyst James Richardson laments that returns on investment in cloud-based BI solutions have not been fully proven nor yet measured [21].

Changing and Controversial Regulatory Environment
Using the cloud to store and compute data complicates regulation, as there is increased likelihood of cross-border data storage and access. Brad Smith, General Counsel and Senior Vice President, Legal and Corporate Affairs at Microsoft, explained the implications of the Cloud Computing Advancement Act, legislation proposed to Congress by Microsoft to "build confidence for consumers and enterprises in the cloud," [14]. The proposal asks Congress to modernize laws regarding the cloud to promote privacy and security. Other legal frameworks, like Stop Online Piracy Act (SOPA) and the Protect IP Act (PIPA, are highly controversial and also have the potential to affect cloud computing, security, and data regulation. Both BI vendors and users need to understand how government legislation affects them and act accordingly.

The industry is young, and the regulatory environment is changing. Currently, there is a lack of standards across independent vendors. As the industry matures, standards will rise and vendors and managers alike will learn important lessons. As a result, appropriate regulation will follow. Anyone involved in cloud-based BI should actively monitor and participate where possible in the legislative process surrounding the topic.

PRECAUTIONARY REMARKS FOR CLOUD BI

Prior to embarking on a cloud transition, the organization should utilize the concept of the "trusted computing platform." This notion is similar to the value chain concept; the organization must establish long term relationships based on trust with the entities of the cloud. More specifically, all parties should be confident and assured that the cloud user is responsible for application-level security. It is imperative to the integrity of the organization that users within their cloud come from the trusted computing platform. In addition it must be mandated that all participants of the trusted computing platform implement a security mechanism on this platform to achieve the privacy and security individually. As a benefit to the organization, the cloud provider implements the physical security, in addition to enforcing external firewall policies. However the security for intermediate layers of the software stack is shared between the user and the operator.

As described, clouds are comprised of and configured with multiple entities. Among them are a great number of users with their own goals and behaviors. As with any pre-employment hire, or business partnership, due diligence should be conducted with all entities involved with the cloud relationship. In addition, different users have different security needs, so good design would offer a choice of security levels and security mechanisms. It is also recommended that those who use/access the organization's information (data) should be classified into several classes or groups and access control criteria for each should be implemented. That being said, despite the classified access and no matter how robust the security system, the cloud is only as secure as its weakest link. It is the ethos of a cybercriminal to identify the vulnerabilities of an entity's security system and to exploit it.

The lack of security associated with just one single entity within the cloud threatens the entire cloud in which it resides. If all participants of the cloud do not practice adequate security measures, it is almost certain the cloud will become a high-priority target for cybercriminals. More disturbing, and as determined by the inherent nature of the cloud's architecture, clouds offer the opportunity for simultaneous attacks to numerous sites. As a result without proper security, hundreds of sites could be comprised through a single malicious activity.

In addition to operating on a trusted computing platform, Gartner Research [9] has identified seven cloud-computing security risks, which should be analyzed by an organization in an attempt to mitigate risks when embarking on the cloud. First and foremost, it is recommended that organizations get as much information as possible about the people who manage the organization's data. It is also recommended that providers supply specific information on the hiring and oversight of privileged administrators, and the controls over their access. Organizations must be aware of cloud computing providers who refuse to undergo traditional external audits and security certifications, learn from providers if they will commit to storing and processing data in specific jurisdictions, and whether they will make a contractual commitment to obey local privacy requirements on behalf of their customers. Another important consideration is the attention to lost data and service in case of a disaster, as any offering that does not replicate the data and application infrastructure across multiple sites is vulnerable to a total failure.

Intel [7], [20] embarks on a high level cloud computing strategy taking advantage of SaaS for applications where there are clear benefits. However, they are very cautious about the type of applications suitable for external cloud. In fact, they use internal cloud for applications that:

- deliver competitive advantage
- are mission-critical
- are core business applications
- contain sensitive data
- are affected by network latency or bandwidth

CONCLUSION

Cloud computing promises significant benefits, but today there are security and several other barriers that prevent widespread enterprise adoption of an external cloud. In addition, the cost benefits for large enterprises have not yet been clearly demonstrated. A recent study [24] shows that 71% of the organizations consider Cloud Computing a realistic technological option, 70% believe that it would lead to increased business flexibility, 62% consider that it would speed up response to market conditions, and 65% consider that it would lead to increased focus on the main aspects of business.

Although the concept of the cloud is alluring to many organizations, the venture poses risks and vulnerabilities relating to organization's data, personnel, reputation and existence. Some experts believe that threats to an organization's viability increase exponentially with exposure in the cloud computing environment.

If after weighing the risks and rewards of embarking on the cloud, an organization deems it a worthy endeavor, it is imperative that the organization be diligent in mitigating the risks. As outlined in this paper this can be accomplished by operating on a trusted computing platform, conducting due diligence on the entities with whom the organization will be engaged, preparing for a disaster with an investigative protocol, and ensuring that data will be recoverable in the event the cloud "vaporizes."

It would be further suggested that if an organization embark on cloud computing, that it initially be selective concerning the types of data it relinquishes to the cloud. That data which is deemed proprietary and relevant to the organization's core competencies should remain in house. Just as an organization would not "outsource" its core competencies, nor should the organization "outsource" the information relative to its core competencies.

The impact of cloud computing to an organization's bottom line could be extremely beneficial or detrimental, all of which is incumbent upon the preparation, planning and implementation of the process. It is hoped this paper provided some insight into the magnitude of the undertaking such an organizational decision will carry.

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BENCHMARKING MANAGED HEALTH CARE ORGANIZATIONS USING DATA ENVELOPMENT ANALYSIS

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ABSTRACT

The objective of this paper is to benchmark the performance of twelve publicly owned managed care organizations against one another for the period 2009 to 2011. In this paper, we use data envelopment analysis, an operations research technique, to benchmark the performance of twelve publicly managed care organizations. Data envelopment analysis clearly brings out the organizations that are operating more efficiently in comparison to other firms in the industry. Data envelopment analysis also points out the areas in which poorly performing firms need to improve.

Keywords: Health Care, Data Envelopment Analysis

INTRODUCTION

Healthcare represents the largest sector of the US economy. According to the Centers for Medicare & Medicaid Services (CMS), a division of the US Department of Health and Human Services, total healthcare spending reached $2.59 trillion in 2010—$8,402.00 per capita—and 17.9% of the gross domestic product (GDP). The US government estimated that figure rose by 4.4% to $2.71 trillion, or 17.7% of GDP, in 2011.

Until late 2007, a confluence of trends helped the managed care industry thrive: a strong economy, pricing discipline, moderating medical cost trends, enrollment gains (including an influx of Medicare and Medicaid beneficiaries into private managed care programs), geographic expansion, and ongoing consolidation. Disciplined control of administrative functions—including above-average cost cuts and information system upgrades—was another positive driver. With the onset of economic crisis that began in December 2007, unemployment rates rose until October 2009 before trending down, albeit slowly. This rise in unemployment created obstacles to growth for managed care organizations, as commercial membership rolls dropped meaningfully. The rise in the number of uninsured people (16.3% of the US population for the year ended 2010, according to the US Census Bureau) has been an increasing burden on US society. Medicare funding for physicians and hospitals was poised to run out by 2017 (healthcare reform has extended its solvency to 2029), and national health expenditures continue to account for a growing share of US gross domestic product (GDP).

The objective of this paper is to benchmark the performance of twelve publicly owned managed care organizations against one another for the period 2009 to 2011. In this paper, we use data envelopment analysis, an operations research technique, to benchmark the performance of twelve publicly managed

care organizations. Data envelopment analysis clearly brings out the organizations that are operating more efficiently in comparison to other firms in the industry. Data envelopment analysis also points out the areas in which poorly performing firms need to improve.

This study is important for several reasons. Firstly, due to new health care reform legislation being introduced in the economy, the economic and operating environment for the large managed care organizations (MCOs) is less favorable than in recent years. Secondly, due to new legislation several drivers of cost and revenue in the health care industry will change and will impact the profitability of managed care organizations. Healthcare cost expansion in aggregate appears to have ceased moderating, the unemployment rate is up significantly (though it has recently started a gradual uneven decline), and government funding has been rising at a slower pace. With healthcare reform, the government radically changes the way MCOs operate. Although it provides funding to help subsidize the purchase of insurance by those in need (a positive for health insurers), it also imposes prohibitions on certain long-standing insurance industry practices designed to improve profitability and will exact fees from the insurers to help pay for the reforms. Furthermore, the growth in commercial market (i.e., employer-sponsored health insurance) has been stagnant. Therefore, it is important to benchmark the performance of these large managed care organizations to evaluate their performance against one another during the post-recession period.

The rest of the paper is organized along the following lines. In section II, we provide a review of previous studies. Section III discusses the model that we use in this study. Section IV discusses the data and methodology used in this study. In section V, we provide an empirical analysis of our results. Section VI summarizes and concludes our study.

LITERATURE REVIEW

Use of data envelopment analysis to analyze financial statements has been illustrated in some previous academic studies. Feroz, Kim, and Raad (2003) illustrate the use of data envelopment analysis to evaluate the financial performance of oil and gas industry. Edirisinghe and Zhang (2007) develop a data envelopment analysis model to evaluate a firm's financial statements over time in order to determine a relative financial strength indicator that can predict firm's stock price returns. Zhu (2000) uses data envelopment analysis to develop a multi-factor financial performance model that recognizes tradeoffs among various financial measures. Kao and Liu (2004) compute efficiency scores based on the data contained in the financial statements of Taiwanese banks. They use this data to make advanced predictions of the performances of 24 commercial banks in Taiwan. Pille and Paradi (2002) analyze the financial performance of Ontario credit unions. They develop models to detect weaknesses in Credit Unions in Ontario, Canada. Yasar and McCure (1996) use data envelopment analysis for measuring and assessing the financial performance for hospitals. They compute a financial performance index (FPI) as a measure of aggregate financial performance. They show that financial performance index across many financial ratios eases the comparison of an individual hospital with its peers. Halkos and Salamouis (2004) explore the efficiency of Greek banks with the use of a number of suggested financial efficiency ratios for the time period 1997-1999. They show that data envelopment analysis can be used as either an alternative or complement to ratio analysis for the evaluation of an organization's performance. The study finds that the higher the size of total assets the higher the efficiency. Neal (2004) investigates X-efficiency and productivity change in Australian banking between 1995 and 1999 using data envelopment analysis and Malmquist productivity indexes. It differs from earlier studies by examining

efficiency by bank type, and finds that regional banks are less efficient than other bank types. The study concludes that diseconomies of scale set in very early, and hence are not a sufficient basis on which to allow mergers between large banks to proceed. Paradi and Schaffnit (2004) evaluate the performance of the commercial branches of a large Canadian bank using data envelopment analysis. Chen, Sun, and Peng (2005) study the efficiency and productivity growth of commercial banks in Taiwan before and after financial holding corporations' establishment. They employ a data envelopment analysis approach to generate efficiency indices as well as Malmquist productivity growth indices for each bank. Howland and Rowse (2006) assess the efficiency of branches of a major Canadian bank by benchmarking them against the DEA model of American bank branch efficiency. Sufian (2007) uses DEA approach to evaluate trends in the efficiency of the Singapore banking sector. The paper uses DEA approach to distinguish between technical, pure technical and scale efficiencies.

Sanjeev (2007) evaluates the efficiency of the public sector banks operating in India for a period of five years (1997-2001) using DEA. The study also investigates if there is any relationship between the efficiency and size of the banks. The results of the study suggest that no conclusive relationship can be established between the efficiency and size of the banks. Lin, Shu, and Hsiao (2007) study the relative efficiency of management in the Taiwanese banking system through DEA. The goal is to estimate the competitiveness of each bank and managerial efficiency is to show the efficiency variation of each bank through Malmquist index. Bergendahl and Lindblom (2008) develop principles for an evaluation of the efficiency of a savings bank using data envelopment analysis as a method to consider the service orientation of savings banks. They determine the number of Swedish savings banks being "service efficient" as well as the average degree of service efficiency in this industry.

As illustrated above, there is no study that specifically deals with the managed health care industry. This study extends previous literature by analyzing the performance of the managed health industry at a point in time when the industry is the focus in the United States.

MODEL

The Data Envelopment Analysis Model:
The Data Envelopment Analysis (DEA) (Charnes et al., 1978) is a widely used optimization-based technique that measures the relative performance of decision making units that are characterized by a multiple objectives and/or multiple inputs structure. Data envelopment analysis is a technique used to assess the comparative efficiency of homogenous operating units such as schools, hospitals, utility companies, sales outlets, prisons, and military operations. More recently, it has been applied to banks (Haslem, Scheraga, & Bedingfield, 1999) and mutual funds (Haslem & Scheraga, 2003; Galagedera & Silvapulle, 2002; McMullen & Strong, 1998; Murthi, Choi, & Desai, 1997). It is a powerful technique for measuring performance because of its objectivity and ability to handle multiple inputs and outputs that can be measured in different units. The DEA approach does not require specification of any functional relationship between inputs and outputs, or a priori specification of weights of inputs and outputs. DEA provides gross efficiency scores based on the effect of controllable and uncontrollable factors.

The DEA methodology measures the performance efficiency of organization units called Decision-Making Units (DMUs). This technique aims to measure how efficiently a DMU uses the resources available to generate a set of outputs. The performance of DMUs is assessed in DEA using the concept

of efficiency or productivity defined as a ratio of total outputs to total inputs. Efficiencies estimated using DEA are relative, that is, relative to the best performing DMU or DMUs (if multiple DMUs are the most efficient). The most efficient DMU is assigned an efficiency score of unity or 100 percent, and the performance of other DMUs vary between 0 and 100 percent relative to the best performance.

DATA AND METHODOLOGY

We used the data available from Standard & Poor's Netadvantage for this study. We used hree operational efficiency variables (years 2009-11) to evaluate twelve managed care organizations. Twelve organizations that we include in our study are: Aetna, AGP, Centene, Cigna, Coventry, Health Net, Humana, Magellan, Molina, United Health Care, Well Care, and Well Point. We benchmark the operational performance of these organizations on the basis of the following functional variables:

Return on equity - Return on Equity equals the LTM Net Income from Total Operations divided by Common Stock Equity from the most recent balance sheet. It measures the return on each dollar invested by the common shareholders in a company; Return on assets - Return on Assets equals the LTM Net Income from Total Operations divided by the Total Assets from the most recent balance sheet. A measure of profitability, ROA measures the amount earned on each dollar invested in assets; Total Debt to Equity Ratio: A measure of a firm's leverage and is computed by dividing total liabilities by shareholders' equity. A high ratio makes the firm highly risky; Total Assets Turnover Ratio: measures the efficiency of a firm to use its assets to generate its sales; Medical Benefit Ratio: It is medical cost as a percentage of premium revenue. The lower this ratio, the better it is for the operational efficiency of a managed care organization.

DATA ENVELOPMENT MODEL SPECIFICATIONS FOR MANAGED CARE ORGANIZATIONS

Besides the mathematical and computational requirements of the DEA model, there are many other factors that affect the specifications of the DEA model. These factors relate to the choice of the DMUs for a given DEA application, selection of inputs and outputs, choice of a particular DEA model (e.g. CRS, VRS, etc.) for a given application, and choice of an appropriate sensitivity analysis procedure (Ramanathan, 2003). Due to DEA's non parametric nature, there is no clear specification search strategy. However, the results of the analysis depend on the inputs/outputs included in the DEA model. There are two main factors that influence the selection of DMUs – homogeneity and the number of DMUs. To successfully apply the DEA methodology, we should consider homogenous units that perform similar tasks, and accomplish similar objectives. In our study, the organizations are homogenous as they are identified by NetAdvantage to be competitors. Furthermore, the number of DMUs is also an important consideration. In addition, the number of DMUs should be reasonable so as to capture high performance units, and sharply identify the relation between inputs and outputs. The selection of input and output variables is the most important aspect of performance analysis using DEA. In general, the inputs should reflect the level of resources used or a factor that should be minimized. The outputs reflect the level of the economic variable factor, and the degree to which an economic variable contributes to the overall strength (efficiency) of a company.

To study the performance of the managed care organizations, we consider five factors to develop the DEA model: return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio. Out of these five factors, we specify total debt to equity ratio and medical benefits ratio as input, because for a given company the lower these variables are the better the performance of the company is. Similarly, higher total asset turnover ratio, return on equity, and return on assets imply a better-performing company. Thus, we consider these variables as output variables. Finally, the choice of the DEA model is also an important consideration. We should select the appropriate DEA model with options such as input maximizing or output minimizing, multiplier or envelopment, and constant or variable returns to scale. DEA applications that involve inflexible inputs or not fully under control inputs should use output-based formulations. On the contrary, an application with outputs that are an outcome of managerial goals, input-based DEA formulations are more appropriate. In addition, for an application that emphasizes inputs and outputs, we should use multiplier version. Similarly, for an application that considers relations among DMUs, envelopment models are more suitable. Furthermore, the characteristics of the application dictate the use of constant or variable returns to scale. If the performance of DMUs depends heavily on the scale of operation, constant returns to scale (CRS) is more applicable, otherwise variable returns to scale is a more appropriate assumption.

In our study, the comparative evaluation among the organizations is an important consideration. Therefore, we select the envelopment models for our analysis. In addition, the outputs are an outcome of managerial goals. Therefore, output-based formulation is recommended for our study. The objective of the analysis is to suggest a benchmark for the MCOs, to investigate the effect of scale of operations, if any, among the 12 organizations. Therefore, we consider variable returns to scale DEA model. Also, the structure of the DEA model (in envelopment form) uses an equation and separate calculation for every input and output. Therefore, all the input and output variables can be used simultaneously and measured in their own units. In this study, we use the Output-Oriented Variables Return to Scale (VRS) to evaluate the efficiency of 12 MCUs from 2009-2011.

EMPIRICAL ANALYSIS

Each of the MCU is a homogenous unit, and we can apply the DEA methodology to assess the comparative performance of these organizations. This study evaluates the status of the managed care organizations by benchmarking the relative performance of 12 organizations against each other in the industry. Using the DEA methodology, we can calculate an efficiency score for the 12 organizations on a scale of 1 to 100. We analyze and compute the efficiency of these organizations using the financial statements for the years 2009-11. Table 2 illustrates the efficiency scores for the 12 organizations. Further, we also study the peers (model organizations) for inefficient organizations.

Table 2 shows the relative performance of the MCOs benchmarked against each other. Table 2 also shows that five out of twelve organizations were consistently 100% efficient between the years 2009-11. Cigna, Health Net, Magellan, Molina, and Well Care are 100% efficient. On the other hand Aetna, AGP, Centene, Coventry, Humana, United Health Care, and Well Point are inefficient. Figure 1 shows the efficiency frontier graph of the pooled company data. The 100% efficient organizations (blue dots) are on the efficiency frontier, whereas the inefficient organizations (red dots) are inside the efficiency frontier. The DEA Analyzer calculates the level of inefficiency by measuring the distance between the efficiency frontier and the inefficient organizations. Therefore, a manager can use this efficiency

frontier to assess the relative efficiency of the firm in the industry. The DEA model compares the return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio.

We present the 12 MCOs ranked by efficiency for the year 2011 in table 3. We find that the output efficiency of Cigna, Health Net, Magellan, Molina, and Well Care is 100% with rank 1. On the other hand, the output efficiency of the remaining organizations are: AGP (91%), Centene(90%), Humana (83%), Aetna (74%), United Health Care (70%),   Coventry (56%), and Well Point (46%) in incrementing rank orders from 2 to 7. This means that the observed levels of return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio for AGP can be achieved with 91% of the current levels of return on equity, return on assets, total debt to equity ratio, medical benefits ratio, and total asset turnover ratio. The same rationale applies to Centene, Humana, Aetna, United Health, Coventry, and Well Point. Table 3 illustrates the efficiency scores and the corresponding ranking of the pooled organizations in the year 2011. The average score is 84%, with five organizations having efficiency levels above average while the remaining five are below the average level. The five 100% efficient organizations turned out to be the best practices organizations within the pooled dataset.

The best practices organizations: Cigna, Health Net, Magellan, Molina, and Well Care are 100% efficient. As AGP, Centene, Humana, Aetna, United Health, Coventry, and Well Point are inefficient; the next step is to identify the efficient peer group or organizations whose operating practices can serve as a benchmark to improve the performance of these organizations.
Table 4 illustrates the peer group for the inefficient organizations.

As shown in the Table 5, Well care and Cigna serve as peer for Aetna. In addition, Aetna is more comparable to Well Care (weight 96%) and less comparable to its more distant peer Cigna (4%).Thus, Aetna should scale up its return on equity, return on assets, and total asset turnover ratio. Similarly, AGP has Well Care (71%) as the closest peer that it should emulate and Health Net (29%) as the distant peer company that can also be investigated. Similarly, Coventry is closest in terms of its input-output mix to Well Care with 100% weight. Thus, Coventry should closely follow the policies and management structure of Well Care to improve its efficiency. Finally, Well Care is the most efficient company among the given pool of the organizations as not only is Well Care 100 % efficient, it also serves as a peer for all inefficient countries. Similarly, Healthnet is the next most efficient company among the group of organizations. Helathnet serves as the immediate peer AGP, Centene, and Humana. Finally, Aetna serves as ditant peer for AGP. The efficient peer organizations have a similar mix of input-output levels to that of the corresponding inefficient company, but at more absolute levels. The efficient organizations generally have higher output levels relative to the company in question. The features of efficient peer organizations make them very useful as role models that inefficient organizations can emulate to improve their performance. Furthermore, Well Care serves as the immediate efficient peer for all inefficient organizations, so its frequency of use as an efficient-peer, expressed as a percentage of the number of pareto-inefficient organizations, is 100%. Thus, we have enhanced confidence that Well Care is a genuinely well performing organization as it outperforms all the other organizations. Furthermore, these organizations are more likely to be a better role model for less efficient organizations to emulate as their operating practices and environment match the majority of the other organizations quite closely.

After calculating the efficiency of a company using DEA, and identifying the efficient peers, the next step in DEA analysis is feasible expansion of the output or contraction of the input levels of the company within the possible set of input-output levels. The DEA efficiency measure tells us whether or

not a given company can improve its performance relative to the set of organizations to which it is being compared. Therefore, after maximizing the output efficiency, the next stage involves calculating the optimal set of slack values with an assurance that output efficiency will not increase at the expense of slack values of the input and output factors. Once efficiency has been maximized, the model does seek the maximum sum of the input and output slacks. If any of these values is positive at the optimal solution to the DEA model that implies that the corresponding output of the company (DMU) can improve further after its output levels have been raised by the efficiency factor, without the need for additional input. If the efficiency is 100% and the slack variables are zero, then the output levels of a company cannot be expanded jointly or individually without raising its input level. Further, its input level cannot be lowered given its output levels. Thus, the organizations are pareto-efficient with technical output efficiency of 1. If the company is 100% efficient but one slack value is positive at the optimal solution then the DEA model has identified a point on the efficiency frontier that offers the same level on one of the outputs as company A in question, but it offers in excess of the company A on the output corresponding to the positive slack. Thus, company A is not Pareto-efficient, but with radial efficiency of 1 as its output cannot be expanded jointly. Finally, if the company A is not efficient (<100%) or the efficiency factor is greater than 1, then the company in question is not Pareto-efficient and efficiency factor is the maximum factor by which both its observed output levels can be increased without the changing its input. If at the optimal solution, we have not only output efficiency > 1, but also some positive slack, then the output of company A corresponding to the positive slack can be raised by more than the factor output efficiency, without the need for additional input. The potential additional output at company A is not reflected in its efficiency measure because the additional output does not apply across all output dimensions. Table 5 illustrates the slack values identified in the next stage of the DEA analysis. The slack variables for 100% efficient organizations are zero. Therefore, Cigna, Health Net, Magellan, Molina, and Well Care are Pareto-efficient as the DEA model has been unable to identify some feasible production point which can improve on some other input or output level. On the other hand, for Aetna, there is further scope for increasing return on assets by .24 units, return on equity by 3.0 units and decrease total debt to equity ratio by .24 units. Aetna can follow Well Care and Cigna as its role model and emulate their policies. Similarly, AGP can increase its return on equity by 3.0 units and decrease total debt to equity ratio by .31 units and medical benefits ratio by 1.92 units. Table 5 illustrates the slack values of the relevant factors for inefficient organizations.

SUMMARY AND CONCLUSIONS

Traditional financial statement analysis techniques use ratio analysis to compare a firm's performance against its peers in the industry as well as against the company's historical performance. On the basis of this comparison, analyst will recommend whether the company is doing well or underperforming relative to its peers or relative to its own past performance. DEA employs relative efficiency, a concept enabling comparison of organizations with a pool of known efficient organizations. The DEA model compares a firm with the pool of efficient organizations by creating an efficiency frontier of good firms—a tolerance boundary created by establishing the efficiency of firms in terms of several sets of financial ratios. Organizations lying beyond this boundary can improve one of the input values without worsening the others. We found that Cigna, Health Net, Magellan, Molina, and Well Care 100% efficient and serve as best practices organizations. On the other hand AGP, Centene, Humana, Aetna, United Health, Coventry, and Well Point are inefficient. We also illustrate the areas in which inefficient organizations are lacking behind efficient firms.

We also provide an insight into the benefits of DEA methodology in analyzing managed care industry. The managers can use a decision support system that stores the company's historical data, competitive firm's data, and other industry specific data, and uses the DEA methodology to analyze their organization's performance. Moreover, DEA modeling does not require prescription of the functional forms between inputs and outputs. DEA uses techniques such as mathematical programming that can handle a large number of variables and constraints. As DEA does not impose a limit on the number of input and output variables to be used in calculating the desired evaluation measures, it's easier for managers to deal with complex problems and other considerations they are likely to confront.

TABLES, FIGURES, & REFERENCES

Tables, figures, references, and full paper available upon request from the authors.

SAS JOINT DATA MINING CERTIFICATION AT BRYANT UNIVERSITY

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ABSTRACT

Bryant University is currently one of only 18 schools worldwide that offers a SAS Joint Data Mining Certificate. With the availability of very large data sets, Data Mining has become an important quantitative skill to have in business and other fields. Bryant's program was successfully completed by 22 undergraduate students last year. This paper provides a description of Bryant's program along with the history of how the program was started and how it has grown. We discuss the curriculum, teaching materials, the SAS collaboration and some of the challenges which have been encountered.

INTRODUCTION

The ability to analyze large data sets has become critical with all of the data currently available to organizations for analysis. Data mining allows the searching of these datasets for important patterns and is used extensively in predictive modeling. Using SAS as a teaching resource in a higher education environment has proven to be a valuable asset for the Mathematics Department at Bryant University. Students who complete a four course sequence of classes in statistics receive a joint certificate from Bryant and SAS. Certification is valuable to both undergraduate and graduate students. We know that many of our students have been able to obtain internships and full time positions because of their completion of our certification program at the undergraduate level. At the graduate level, professionals from diverse fields may enhance their quantitative credentials by obtaining a SAS certificate in data mining. Bryant has found that offering a SAS certification program to students gives them a competitive differentiator as they compete in an exploding analytical job market.

HISTORY

The SAS Joint Data Mining Certificate program is offered by the Mathematics Department in the College of Arts and Sciences at Bryant. The Mathematics Department was originally a department in the College of Business initially offering required mathematics courses in quantitative methods and statistics for business majors, and several electives including a second applied statistics course and graduate level quantitative business courses. In the seventies, the department offerings were increased to include other electives and also to offer a minor in both Mathematics and Statistics. In the early 80s a major in Actuarial Mathematics was established. This major has been very successful and has grown from its first graduating class in 1986 of 5 students to its current 172 students. Subsequent to the establishment of this major, in 2001, Bryant College became Bryant University and the mathematics department became part of the newly established College of Arts and Sciences. In 2007, an Applied Math/Stat major was introduced in response to demand from current and potential student inquiries. As the programs grew, the demand for electives grew as well. At the same time, Professor Alan Olinsky attended a summer SAS training program in Data Mining and introduced a course in Data Mining using SAS. This course was followed shortly by a course in SAS programming (these courses are required by SAS for joint certification). The courses became very popular and eventually led to the establishment of the current SAS Joint Data Mining Certificate program. The program is offered at the undergraduate level and is completed by Actuarial Mathematics (AM) majors, Applied Mathematics and Statistics (AMS) majors as well as Accounting, Finance, Marketing, Management, Psychology, and other liberal arts and business majors. This past year, 22 undergraduate students earned SAS certification in Data Mining.

We are in the final stages of offering a similar certificate at the graduate level. We know that this program will appeal to students since it has already been a huge success at the undergraduate level. This history is important to indicate the range of students that are currently enrolled in our program and also to differentiate our program from many of the programs that are geared to strictly business majors.

THE CURRICULUM

The curriculum for this program has been designed in partnership with SAS, a leading provider of data mining and business intelligence software and services. Currently, Bryant's undergraduate certification program is one of only 18 universities worldwide authorized to grant a joint certificate in data mining with SAS. These programs are both graduate and undergraduate programs.

Certification is awarded upon completion of four of the following 400 level courses.

Three required courses:

M455 SAS Programming and Applied Statistics
This course provides an introduction to SAS programming and covers the material required for the SAS Base Programming Exam. The first part of this course focuses on the following key areas: reading raw data files and SAS data sets; investigating and summarizing data by

generating frequency tables and descriptive statistics; creating SAS variables and recoding data values; sub setting data; combining multiple SAS files; creating listing, summary, HTML, and graph reports. The second part of this course focuses on how to manage SAS data set input and output, work with different data types, and manipulate data. Specifically, this part of the course discusses using the DATA step to control SAS data set input and output, combine SAS data sets, summarize data, process data iteratively with DO loops and arrays, and perform data manipulations and transformations. This course is required for our joint certificate with SAS in data mining. A major programming project will be required.

M460 Applied Data Mining
Employing SAS Enterprise Miner software with real-world case studies, this course introduces students to the current theories, practices, statistical tools and techniques in "data mining," which embodies cutting-edge methods to reveal competitive insight, market advantage, and strategic opportunities. This course will cover the most useful statistical tools in data mining such as cluster analysis, logistic regression, classification trees, and neural networks. In addition, a comprehensive real-world data project will be required along with a presentation to the class and other interested parties of key aspects of the project with an analysis of the results.

M461 Applied Multivariate Statistics
After a brief review of multiple regression and analysis of variance, students are introduced to multivariate statistical techniques including principal components analysis, factor analysis, cluster analysis, discriminant analysis, logistic regression and multivariate analysis of variance. Although this course will not be theoretical, it will provide an intuitive yet comprehensive discussion of each of these statistical methods. The computer package SAS will be used for analysis.

and one of the following two electives:

M470 Statistical Design and Analysis of Experiments
This course is an introduction to the design and analysis of statistical experiments. It will cover the main elements of statistical thinking in the context of experimental design and ANOVA. Students will learn to choose sound and suitable design structures and also how to explore real data sets using a variety of graphs and numerical methods and analyze these data sets from designed experiments and reach justifiable conclusions based on the analyses. This will be an applied course and will utilize SAS software for statistical analysis.

M475 Applied Analytics using SAS
This course will include an in depth review of applied analytical approaches, challenges, and solutions. A hands-on approach will be emphasized throughout the semester. A brief review of analytical techniques through material covered in MATH350 or AM332 will be included, as well as an introduction to further analytical tools such as multivariate analysis, predictive modeling, time series analysis and survey analysis. SAS Enterprise Guide Software will be introduced and utilized for applying hands on analysis to real world data problems.

The proposal for the graduate program is that initially these courses would run as dual level undergraduate/graduate courses with appropriate additional requirements for graduate students. These additional requirements are outlined below.

Each graduate student will complete a research project during the semester. The research project will be divided into four sections: proposal, milestone assessment, research paper (that will be peer reviewed by the other graduate students), and a presentation. All documents during the course of the research project will be required to follow the ACM Knowledge Discovery and Data Mining (KDD) Conference paper format. The research project that will constitute 30% of the final grade should have an applied focus. The research project can be developed one of two ways.

1. Consult/collaborate with a statistician/business analyst that is working in a company and using data mining to solve a real-world problem. The real-world problem will be the focus of the research project.

2. Choose a data mining or other appropriate research paper and make that the focus of the research project. The student will apply the methods discussed in the paper to a real-world data set that can be obtained from the many data mining competition websites such as kaggle.com or the KDD Cup website. The focus of the research project will be applying the methods of the chosen paper to a real-world data set.

The following will be the required components of the research project.

Proposal/Milestone: The student will present a 2 page proposal of what they expect to accomplish with the research project. The proposal will contain milestone dates to help the student ensure benchmarks and pace themselves as the semester progresses. Projects may require slight revisions in the goals based on the milestone dates. This will be due in the middle of the second month of class.

Research Paper: The research paper will be a minimum of a 10 page paper that will be due one month before the end of the semester (to allow time for a peer review and revisions).

Peer Review/Revisions: The research papers will go through a single-peer double-blind review process by the students. Each student is required to address each reviewer's comment and either make suggestions based on the comments or develop a scientific reason why they should not make changes based on the reviewer's comments.

Presentation: A one-half day will be set aside for all graduate students (undergraduates will be invited but it will not be required for them to attend) to make their presentations in a workshop-type environment.

TEACHING MATERIALS

SAS CEO Jim Goodnight believes that education is the engine of economic growth. SAS has an education philanthropy. This philanthropy provides teaching materials to help professors incorporate SAS into their teaching, including presentation slides, data sets and printable/editable files of the student manual. These materials are provided free of charge, with copyright permission for professors to use any of the content in their own class notes.

SAS also provides the software used in the classroom for no cost to students or professors. SAS OnDemand for Academics provides an online delivery model for teaching and learning data management and analytics. By connecting to a SAS-hosted server over the Web, users access the analytical power of SAS software through a user-friendly, point-and-click interface.

Since we are in a higher education environment it is vital that we have an appropriate academic textbook to accompany the SAS software. With the advancement of software it is very easy for a student to produce output from a very complex statistical analysis. Without the appropriate academic training a student will not know the statistical methodology behind the output, what the output means, how to interpret the output, and the common pitfalls that need to be avoided based on the type of statistical analysis being performed. For example, some pitfalls that often occur with a non-academically trained analyst is not knowing and assaying the data properly. That is, not having an intimate knowledge of the data. At a very basic level, a student must know how to deal with missing values and outliers and how each of these types of issues can affect the model. For instance, a decision tree can naturally handle missing values whereas a logistic regression cannot. Logistic regression requires action to be taken on the missing values or the analyst can produce an unexpected model. As educators in statistical higher education we are constantly seeking how to find an appropriate balance of giving students a solid statistical background with an appropriate academic textbook while ensuring the students have appropriate access to state-of-the-art software and technology in order to stay competitive.

In past classes of the Experimental Design course, Math 470, JMP software has been used with the use of an academic textbook and SAS teaching materials. JMP is statistical software created by SAS. Pronounced as "Jump", JMP is a tool for exploring data and interacting with it. JMP offers capabilities for design and analysis in a form a student can easily use. JMP allows the student to dynamically link data and graphics allowing the students to actively manipulate factors according to a specified design. JMP is the preferred statistical software package for the Math 470 class. The textbook book chosen was changed because the instructor wanted to have JMP output and results in the text to help students with running advanced topics in JMP. Currently, the Math 470 class is using SAS Enterprise Guide for the software piece of the class. The reason for choosing this software package is the availability of a pedagogical textbook that has Enterprise Guide output.

STUDENT SUCCESSES

Many of our graduates have reported that having SAS certification has greatly helped them not only in obtaining a job but also in advancing in their field. We want to highlight two success stories from among our first certification recipients. One of the first students to complete SAS certification was an AM major who first used SAS for a large accounting firm working on consulting projects for the federal government. He went on to several other positions, all requiring the use of SAS and each with a significant salary increase. Most recently, he moved to a position with the federal government utilizing SAS in a UNIX environment. He also is currently teaching an introductory SAS programming class at a large university.

Another of our first certification recipients recently contacted us to inform us that she had returned to graduate school and she feels that her SAS training is extremely helpful. She will be taking a course titled "Using Large Databases" next semester. She also felt that having knowledge of SAS was extremely helpful in getting her first job out of college. In her professional work, she dealt with national survey, assessment and administrative data and she expressed that the data mining background helped her to, in her words, "explore data to answer tough research questions". This led her to her current graduate work which requires the analysis of data in relationship to educational policy. To further quote this alumna, "The Data Mining certificate was a vital factor getting my foot through the door and exploring exciting career and education paths I did not even know existed."

CHALLENGES

There are a number of challenges that we have encountered as the SAS certification program has increased in popularity. The popularity among non-math majors to obtain the SAS certification has been steadily increasing. Two of the four classes are at full capacity for the Fall 2012 semester. It can be difficult to explain to students with non-quantitative backgrounds the intricacies and statistical details of data mining algorithms and designed experiments. Bryant is currently considering making the requirements to enter the four courses required for the certification more rigorous.

While SAS OnDemand is a wonderful piece of technology it does frequently crash and freeze up when many students are using it at the same time in class. Also, students may be working on their local computer and not realize that they have been disconnected from the server at SAS and so they are not able to save their latest work.

The data mining class has started to move away from using SAS OnDemand and is currently in a pilot program sponsored by the Bryant IT department that allows students to access SAS software on virtual machines. In addition, SAS does provide a classroom license that includes SAS, Enterprise Miner, and Enterprise Guide at a very reasonable cost. SAS is also now beta testing a web based interface for their SAS language. It would be expected that this would also be provided through the OnDemand program and be free of charge for students and instructors.

CONCLUSION

SAS Joint Data Mining Certificate program has been extremely successful at Bryant University. While there are a few challenges as outlined above, they are greatly outweighed by the rewards. Due to the success of the undergraduate program, the Math department is currently developing a graduate SAS certification program. This will allow working professionals to obtain a graduate level SAS Joint Data Mining Certification. Developing and teaching the courses for the SAS Joint Data Mining Certificate program not only offers the students a competitive advantage but also allows the faculty who teach the courses the ability to stay up-to-date on current statistical technology and teach with materials other than a textbook and chalkboard. By using SAS software and technology in the classroom we are able to bring new life to the world of statistics. We are able to teach tried and true statistical methods such as logistic regression and factorial designs with a 'twist' by being able to produce graphs and output that would not be possible in a traditional classroom setting. Not only does the software bring life to the data and make it easier to tell a story and make decisions with data, it allows the students to have a substantive credential on their resume that will allow them to compete in an analytical job marketplace that shows no signs of slowing down.

INFORMATION TECHNOLOGY AND CRISIS COMPLIANCE: IMPLICATIONS FOR STUDYING HURRICANE SANDY

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ABSTRACT

This paper develops a comprehensive framework for the role of IT in Crisis Compliance—the use of IT to predict crises, prevent them from occurring, prevailing over the ones that do occur, and aiding in Post-Crisis Renewal. Theoretical perspectives from Crisis Management, Normal Accident Theory, High Reliability Organizations, and the Target and Shield Model will inform the analysis. Additional implications for characterizing whether IT is the cause, prevention, or cure of the crisis, applying the model to diverse urban areas, dealing with malevolent threats, distinguishing between precedented and unprecedented threats, and determining the scope of the crisis will extend the theoretical framework. Suggestions for studying Hurricane Sandy in the light of this framework will conclude the analysis.

Keywords: Crisis Compliance, Crisis Management, Normal Accident Theory, High Reliability Organizations, Target and Shield Model, Hurricane Sandy, Post-Crisis Renewal.

INTRODUCTION: THE ROLE OF IT IN CRISES

Information Technology **(IT)** has created both the potential for threats that can lead to major crises, and opportunities for creating systems to help prevent crises, prevail over crises if they do occur, and aid in Post Crisis Renewal. This paper develops a theoretically based framework for educating individuals, organizations, and government leaders about how to approach IT based threats and opportunities.

The paper focuses on the topic of IT and Crisis Compliance **(CC),** developed by Lally [9,10]**.** Crisis Compliance is defined as: 1) the development of methodologies and systems to prepare individuals, organizations and government leaders to predict, prevent and prevail over crises, 2) the development of an awareness of IT based best practices currently available for combating crises, 3) the development of an understanding of newly emerging technologies, their vulnerabilities that could make them crisis prone as well as their potential for combating crises, 4) the development of an understanding of the *obligation* of individuals, managers and government leaders to make use of these technologies in an appropriate manner, and 5) the development of an understanding of how IT based systems aid in Post-Crisis Renewal **(PRC)**—the restoration of well being and culture in the wake of a crisis.

Crisis Compliance argues that if the proper methodologies are used, then individuals, organizations and governments will have fulfilled their obligations to their stakeholders and be free from unfair criticisms and potential lawsuits. Crises are resulting in an increasing number of lawsuits resulting in large financial settlements and even manslaughter convictions [1]. Crisis Compliance cannot guarantee that no crisis will arise and that no negative impacts will occur, but rather that organization and government leaders have done everything humanly possible to *predict* the crisis, *prevent* its occurrence and mitigate negative impacts, to create a learning environment to help *prevail* over future crises, and to help restore well being and culture after the crisis has passed. Crisis Compliance draws on the theoretical perspectives of Perrow's Normal Accident Theory, the Theory of High Reliability Organizations and Lally's IT Target and Shield Model.

NORMAL ACCIDENT THEORY (NAT) AND THE THEORY OF HIGH RELIABILITY ORGANIZATIONS (HRO)

The first theoretical perspective, which addresses the potential threats involved in large scale systems is Charles Perrow's Normal Accident Theory. Normal Accident Theory **(NAT)** argues that characteristics of a system's design make it more or less prone to accidents. Accidents are defined as [14] "a failure in a subsystem, or the system as a whole, that damages more than one unit and in doing so disrupts the ongoing or future output of the system." Perrow distinguishes between disastrous "accidents," which are system wide and seriously impact the system's overall functioning and "incidents," which involve single failures that can be contained within a limited area and which do not compromise the system's overall functioning. Perrow argues that no system can be designed to completely avoid incidents, but that inherent qualities of the system determine how far and how fast the damage will spread. Systems that are not designed to contain the

negative impact of incidents will, therefore, *be subject to accidents in the course of their normal functioning.*

The first key characteristic of accident prone systems is their complexity. **NAT** argues that as systems become more complex, they become more accident prone. **NAT** distinguishes a second characteristic of systems that exacerbate potential problems brought about as a result of complexity -- tight coupling. Tight coupling means there is no slack time or buffering of resources between tasks, interactions happen immediately. **NAT** distinguishes one further characteristic of disaster prone systems, a lack of control.

Researchers in High Reliability Organizations **(HRO)** have examined organizations in which complex, tightly coupled, technologically based systems appeared to be coping successfully with the potential for disaster. High reliability theorists' studies of the Federal Aviation Administration's air traffic control system, the Pacific Gas and Electric's electric power system, including the Diablo Canyon nuclear power plant, and the peacetime flight operations of three United States Navy aircraft carriers indicate that organizations can achieve nearly error free operation [8].

HRO theorists identify four critical causal factors for achieving reliability:

* Political elites and organizational leaders put safety and reliability first as a goal.
* High levels of redundancy in personnel and technical safety measures.
* The development of a "high reliability culture" in decentralized and continually practiced operations, and
* Sophisticated forms of trial and error organizational learning.

The two theories have been contrasted as "pessimistic" -- **NAT**s contention that disaster is inevitable in badly designed systems, versus "optimistic" – **HRO**s pragmatic approach to achieving greater reliability. The theories, however, are in agreement as to which characteristics of systems make them more or less accident prone.

LALLY'S TARGET AND SHIELD MODEL

Lally [4] argued that Normal Accident Theory was a sound theoretical perspective for understanding the risks of Information Technology, because IT is complex, tightly coupled and often poorly controlled. She also argued [5] that IT based systems do not operate in isolation but in organizational settings where failures in IT can lead to more widespread secondary failures in organizations and to society as a whole. Additionally, she argued [6] that the frequent rapid change in both IT based systems and the work processes they support can further exacerbate the potential for disaster. These characteristics are what permitted a design flaw, such as Y2K, considered "trivial" by software designers to potentially propagate into a global disaster and why even the experts were unable to predict what the impact would be.

Figure 1 illustrates the Target and Shield Model

Lally [7] further extended her model and argued that IT based systems are not only a **target** used as a weapon of destruction to cause serious accidents, but that IT based systems can be a **shield** used to prevent damage from future incidents, whether they be IT based or physical.

The Target and Shield model incorporates Lally's extensions to Normal Accident Theory. The model also contains *three significant feedback loops*, which allow IT to play a positive role in preventing future incidents from materializing, having real world impacts, and mitigating their impacts when they do occur. In the Feedback Loop #1, **Prevent future incidents**, controls can be built into the system to prevent future incidents from materializing. In Feedback Loop #2, **Prevent Propagation of Incidents**, controls can be built into the system to prevent future incidents that have materialized from turning into accidents. In the Feedback Loop #3, **Mitigate Impact of Disasters**, IT based systems can be developed to prevent accidents resulting from IT based or physical attacks from propagating even further, and to provide more rapid recovery and renewal of culture and quality of life.

TECHNOLOGY—SOURCE OF THE CRISIS, PREVENTION, CURE?

An important characteristic of a crisis when examining the role of IT is whether the crisis is technology based. Y2K clearly had its foundation in poor software design and the rapid expansion and proliferation of technology. Hurricane Katrina, however, was a natural disaster in which IT could have played a much more successful role in combating the crisis than it did. When organizations use white hat hackers or war gaming experts to simulate cyberattacks with the goal of preventing future attacks [2], IT is used as both a target and shield.

EXTENDING THE MODEL TO CRISES IN DIVERSE AREAS

An additional factor that emerged in the Post 9/11 environment was that disasters can occur in large scale social environments such as cities and nations, rather than in organizations. **NAT** and **HRO**, which were developed to prevent innocent mistakes from propagating into system-wide disasters in organizational settings had to be extended. Lally [8] addressed challenges of extending the models to *large diverse environments,* rather than organizational settings. Large areas add additional layers of complexity and tight coupling when compared to organizational settings.

UNPRECEDENTED CRISES POSE GREATER CHALLENGES

Another characteristic of crises that add to the potential for damage is whether or not they are unprecedented. Both Y2K and 9/11 had no precedent on the scale at which they occurred. Despite 130 years of technological advances, civil reform, and building code updates, Japan's 2011 earthquake and tsunami resulted in 20,000 deaths [3]. In these cases there was no collection of best practices to draw on.

THE CHALLENGE OF MALEVOLENT THREATS

A final characteristic of crises is whether or not they are the result of malevolent actions. Y2K was caused by an inadvertent error by program designers. The result of extensive Y2K testing has lead to better software design. 9/11, however, was malevolent and preventing the reoccurrence of another major terrorist attack involves investigating groups of individuals who may or may not be guilty with serious implications for privacy and civil rights.

CRISIS AND SCOPE

Another characteristic of crises is their scope. Can the crises be controlled by quarantining the area or will the effects of the crisis spread quickly? Sites like Chernobyl were remote and able to be quarantined, resulting in limited impact outside the effected area. The March, 2011 tsunami and nuclear disaster in Japan posed serious threats to the people of Tokyo, and resulted in nuclear radiation increases in California.

CRISIS COMPLIANCE AND THE SEARCH FOR FEASIBLE SOLUTIONS

When implementing IT based systems in a crisis situation the issue of feasibility must be addressed. Four essential types of feasibility emerge:

Technical feasibility—Is there an IT based solution to the problem? Solutions that required cell phones, the Internet and digital cameras would be feasible now but not forty years ago. For organizations to be Crisis Compliant, their disaster plans need to include the most recent technology.

Operational Feasibility—Will the solution work in the given environment? Technically sophisticated users will more readily adopt new technologies. Technologies are more likely to be adopted in High Reliability Organizations with strong organizational cultures that support its use.

Economic feasibility—Can we afford the solution (or afford not to use it)? The high risk exposure to hurricanes in New Orleans was well known but budgetary constraints prevented the development of stronger levees. Flood protection in the Netherlands far surpasses what was and is currently available on the Gulf Coast because the government placed a high priority of protecting its citizens.

Schedule feasibility—Do we have time to implement the solution? In unprecedented crises, such as 9/11, leaders did not have adequate lead time to envision the full extent of the problem and respond with optimal solutions. Government leaders could argue that schedule feasibility did not permit full compliance. In the case of Katrina, however, there had been years of warnings and a simulation model the year before indicated results very similar to those which actually happened, yet the problem was not responded to.

HURRICANE SANDY AND THE NEW YORK METROPOLITAN AREA

Electricity and information are the twin life bloods of modern societies. If electricity and information are disrupted, then everything from the production of food to the supply of potable water, to ATM service service—literally everything in modern society—grinds to a halt—We are truly coupled and interdependent as never before. [12, p. 13].

Hurricane Sandy was a natural disaster on a scale that was unprecedented in recent history. The storm was predicted several days in advance allowing for mass evacuations and a relatively low loss of life, compared to hurricanes like Katrina. Major property damage did occur in many waterfront communities including Breezy Point Queens, the New Jersey Shore, and Coney Island. Many historical landmarks on the waterfront were destroyed by the nine foot storm surge. Flooding caused extensive power blackouts that included lost heat and water, including Manhattan below 34th Street for a week, and areas of Long Island, Staten Island and New Jersey for up to two weeks, leaving individuals unable to obtain information through television or the Internet. The storm caused major disruptions in transportation--the Midtown and Brooklyn Battery Tunnel were closed for over a week, and gas shortages prevented the use of automobiles.

A number of questions emerge in the light of the theoretical analysis.

1. Was Sandy truly unprecedented, especially in the light of Hurricane Irene the year before?
2. What technically feasible solutions, such as those used by the Netherlands, London, and Hong Kong, could have mitigated the damage?
3. What were the responsibilities of governments, utilities, and individuals living in red zones? How well were these responsibilities fulfilled?
4. How did the initial damage of the storm (high winds and storm surge) propagate into secondary damages (gas shortages, long term power outages, business losses, unemployment)? How could this propagation have been minimized?
5. How can the culture of the neighborhoods affected, and the New York Metropolitan Area aid in Post-Crisis renewal?

The focus of upcoming case study will be to highlight in depth the nature of the disaster in the context of Crises Compliance, and to suggest IT and non-IT solutions and methodologies to predict, prevent, and prevail over future hurricanes.
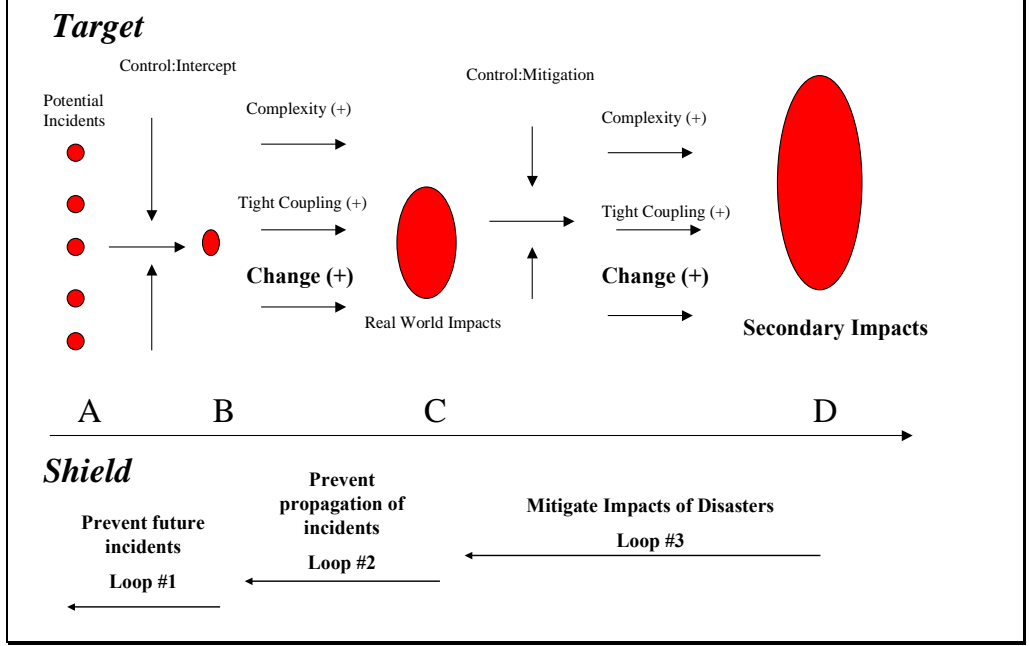
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Figure 1: The Target and Shield Model

Target

Control:Intercept

Potential Incidents

Control:Mitigation

Complexity (+)

Complexity (+)

Tight Coupling (+)

Tight Coupling (+)

Change (+)

Real World Impacts

Change (+)

Secondary Impacts

A   B   C   D

Shield

Prevent future incidents

Loop #1

Prevent propagation of incidents

Loop #2

Mitigate Impacts of Disasters

Loop #3

Preference Trade Programs: Lessons Learned

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The U.S. government has enacted different preference trade programs with developing countries in order to expand their economic outlook and also to deal with other issues, such as illegal trade. Among these programs, the African Growth and Opportunity Act (AGOA) and the Andean Trade Preference Act (ATPA) are considered highly successful programs. This research examines the features of AGOGA and ATPA preference programs and highlights its main goals and objectives. In addition, the paper discusses major obstacles. Furthermore, this study assesses the extent of the success of these programs. The final part of this research explores the future potentials of AGOA and ATPA.

China's Operating Environment: The causes of Trade Disputes

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This research studies the operating environment of china along several dimensions, financial services, local content requirement, market access and human resources. The study examines several trade disputes due to China's discriminatory treatment of non-Chinese companies belonging to the countries that are a member of the World Trade Organization (WTO). In addition, the paper discusses the needed reforms to China's market structure that have the potential of alleviating some of the problems and disputes in trading with China.

Green Field FDIs in Indo-Pacific

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Numerous emerging and developing countries are providing green field investment opportunities for foreign corporations where foreign direct investments (FDIs) are given tax breaks and subsidies for setting up full operations and creating jobs in these countries. The underlying assumption of green field FDIs is that the transfer of knowledge and technology and creation of jobs in a country offset the tax breaks and subsidies provided to these FDIs.

This study explores the green field FDIs in Indo-Pacific by concentrating on Chinese green field FDIs in Australia and India. The research investigates the impact of Chinese green field FDIs on technology transfer and creation of jobs in these countries. In addition, the paper examines the challenges that the countries with green field investment policies may face and proposes several remedies to deal with them.

MANAGERIAL SENTIMENT, INVESTMENT OPPORTUNITY SET AND FIRM PERFORMANCE

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ABSTRACT

This study examines the relationship among managerial sentiment, investment opportunity set and firm performance. We first perform a test to gauge the managerial sentiment, then to investigate the relationship between managerial sentiment and firm performance. Managerial optimism would overestimate investment opportunities so as to destroy corporate performance. Our evidence shows a negative relation between corporate performance and managerial optimism. Secondly, we find that there is a positive association between the investment opportunity set and firm performance. However, the interaction of managerial optimism and high investment opportunity set would eliminate the significantly positive effect. Our findings imply that managerial sentiment would bias the selection of investment opportunities and adversely affect firm performance.

Keywords: Managerial sentiment, Firm performance, Investment opportunity set

1. INTRODUCTION

This paper investigates how managerial sentiment and investment opportunities relate to corporate performance. Specifically, we focus on the manager optimism which could overestimate value of investment opportunities to influence the corporate performance. Heaton (2002) suggests that optimistic managers depending on external finance sometimes reject positive net present value projects, believing the cost of external finance simply too high.

Anderson (1993) shows the investment opportunities are firm specific defined relative to such things as managerial skill. When managers consider the need for corporate growth and take the positive net present value (NPV) project, the different managerial sentiment would carry out different investment policies. This study thus displays the interaction effect on investment opportunities and managerial sentiment. Besides, we are wondering whether managerial sentiment will influence firm performance or not. Few empirical studies can be found on this topic.

This paper has two objectives: to examine the relationship between investment opportunities and firm performance, and to examine the relationship between managerial sentiment and investment opportunities. Managerial sentiment reflects a manager's optimism or pessimism. The term "optimism" in this paper is synonymous with the term "overconfidence" used by Malmendier and Tate (2005). The empirical results in this study show that manger plays a role on firms' investment behavior and performance. The investment opportunities have significantly positive relationship with firm performance. The managerial optimism has a negative relationship with firm performance. On the other hand, the positive relationship between investment opportunities and firm performance is eliminated by managerial sentiment.

This paper contributes to the literature in two ways. First, this paper shows that managerial sentiment would disturb firm performance. Second, we posit that managerial sentiment would affect the relationship between the investment opportunity set and firm performance.   An implication of our results is that firms with growth opportunities should consider managerial sentiment to maintain firm performance.

In the remainder of this paper, Section 2 describes model. Section 3 describes model variable measure. Section 4 describes the data set and results, and the last section presents conclusions.

2. THE MODEL

We use Panel data and quantile regression to examine whether managerial sentiment has any impact on the firm performance with investment opportunity set, as follows:

$$\text{ROE}_{it} = \alpha + \beta_1 ISO_{it} + \beta_2 O_{it} + \beta_3 NO_{i,t} + \beta_4 \text{IOS}_{it} \times O_i + \beta_5 IOS_{i,t} \times NO_{i,t} + \beta_6 \text{SIZE}_{it} + \varepsilon_i \quad (1)$$

where ROE_{it} represents the firm performance; ISO_{it} represents the investment opportunities set; O_{it} is a dummy variable which is equal to 1 if the CEO is classified as optimistic, otherwise 0; $NO_{i,t}$ is a dummy variable which is equal to 1 if the CEO is classified as being pessimistic, otherwise 0;; $SIZEit$ represents the firm size.

3. MEDEL VARIABLE MEASURE

3.1 The managerial optimism measure

Following Lin (2005) to construct a managerial optimism measure on a personal basic, we weight each forecast equally. Given that CEO's optimism in assessing future outcome is likely to result in upwardly-biased forecasts, we classify whether a CEO is optimistic if he/she has first and last forecasts which overestimate earnings of a fiscal year and define a CEO as optimistic. A forecast is defined as upward-biased if its error is positive, where the definition of forecast error:

$$FE \equiv Manager's\ forecast\ for\ earnings\ before\ tax - Actual\ earnings\ before\ tax. \quad (2)$$

Yet previous literature confirms that managers may have other incentives to bias their forecasts. To address concerns that the measure may reflect managers' incentives other than optimism, we exclude from measure construction any forecasts that may be contaminated by incentive effects. We detect three potential incentives and then remove forecasts from the sample if they meet any one of the following criteria: First, intending to make stock offerings at a favorable price, some firms may temporarily boost their stock price by releasing upwardly-biased forecasts (e.g., Lang and Lundholm, 2000). Second, for employment concerns, managers of firms financially distressed may release upwardly-biased forecasts to mislead investors; even "cheating" only pertains for a short while. Frost (1997) finds that managers of distressed firms clearly released over-predictions for a current year's financial results when compared to actual outcomes. Koch (2003) finds that management earnings

forecasts issued by distressed firms exhibit greater upward bias and are viewed as less credible by analysts than similar forecasts by non-distressed firms. Third, managers may act in self-interest to profit from trade, publish upwardly-/downwardly-biased forecasts, then sell (buy) shares.

The managerial sentiment dummy variable is defined as:

$$O_{i,t} = \begin{cases} 1 & \text{if the manager is classified as optimistic, } FE > 0 \\ 0 & \text{if the manager is classified as non-optimistic} \end{cases} \qquad (7)$$

$$NO_{i,t} = \begin{cases} 1 & \text{if the manager is classified as pessimistic, } FE < 0 \\ 0 & \text{if the manager is classified as non-pessimistic} \end{cases} \qquad (8)$$

3.2 The investment opportunities measure

The investment opportunities is unobservable as it is related to discretionary expenditures and firm-specific factors such as physical and human capital in place and industry-specific and macroeconomic factors (Kallapur and Trombley, 1999). Then, this study follow Hutchinson and Gul (2004) consider the three variables which used as proxy measures of growth are: the market value of assets to book value of assets ratio(MBVA)[1], the market-to-book value of equity ratio(MBVE)[2] and ratio of gross plant, property and equipment to market value(PPEMVA)[3] of the firm. This implies the following model for investment opportunities set (IOS):

IOS= Factor score (equally weighted average) of MBVA, MBVE, PPEMVA for the investment opportunity set

4. EMPIRICAL EVIDENCE

4.1 Data Sources

Following MacKie-Mason (1990) and Hovakimian et al. (2001), security issues are identified using annual firm level data from the non-financial quoted companies in Taiwan for our empirical study, with the primary source of information being the Taiwan Economic Journal (TEJ) database. Our panel was constructed to cover the

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[1] The market value of assets to book value of assets ratio(MBVA)= [(total assets-total common equity)+shares of outstanding*share closing price]/total assets
[2] The market-to-book value of equity ratio and ratio of gross(MBVE)=(shares outstanding*share closing price)/total common equity.
[3] The ratio of gross plant, property and equipment to market value(PPEMVA)=gross property, plant and equipment/(market value of the firm + non-current liabilities)

1996-2005 period in order to avoid endogeneity and unobservable heterogeneity; i.e., an unbalanced panel comprising of 434 companies on which information was available for at least eight consecutive years during that period, resulting in 4,143 observations. The structure of the panel, by annual number of observations per company, is provided in Table 1.

Table 1

Structure of the sample: Panel of Taiwan non-financial quoted companies (period 1996-2005)

Number of annual observations per company	Number of companies	Number of observations
10	314	3,140
9	43	387
8	77	616
Total	434	4,143

4.2   Results

We first summarize the descriptive statistics in Table 2. As you can see, this is a basic test to clarify if the managerial sentiment would influence firm performance. We only employ few control variable in this study.

Table 2 Descriptive Statistics

	Mean	Std.Err.	Min	Max.
ROE	3.2816	25.5413	-365.68	999.33
IOS	1.5155	3.6667	-0.2226	123.739
O	0.0924	0.2896	0	1
NO	0.0385	0.1924	0	1
SIZE	15.6035	1.1813	12.3997	20.04509

The results of our examination of the relationship between firm performance and investment opportunity set with controlling for managerial sentiment (optimism or pessimism), are presented in Table 3. We also included the dummy variables d_t to measure the time effect, so as to control the effect of macroeconomic variables on firm performance. Consequently, we split the error term into three components: the individual effect, η_i; the time effect, d_t, and , finally, the random disturbance, $v_{i,t}$. As a result, the final specification of the models to estimate is as follows:

$$\mathrm{ROE}_{it} = \alpha + \beta_1 ISO_{it} + \beta_2 O_{it} + \beta_3 NO_{i,t} + \beta_4 \mathrm{IOS}_{it} \times O_i + \beta_5 IOS_{i,t} \times NO_{i,t} + \beta_6 \mathrm{SIZE}_{it} + \eta_i + d_t + v_{i,t}$$

(9)

Table 3 Estimation of the firm performance model using panel data methodology to avoid endogeneity and heterogeneity.

	α	β_1	β_2	β_3	β_4	β_5	β_6
Coefficient	-42.0798	0.8461	-3.7951	9.7549	-0.0581	0.7931	2.7830
	(8.5183)***	(0.1201)***	(1.3216)***	(2.6560)***	(0.2807)	(1.1504)	(0.5432)***

Note: standard errors in ( ). *:10%, **:5%, ***:1% significance level

In Table 3, the coefficients of β_1 was 0.8461 that significantly different from zero. There is a positive association between firm performance and the investment opportunity set. The coefficients of optimism β_2 and pessimism β_3 were -3.7951 and 9.7549, both significantly different from zero. The coefficients of β_4 was -0.0581and β_5 was 0.7931, both insignificant different from zero.

Our finding implies that basically investment opportunity is positively related to firm performance, and managerial sentiment also significantly affects firm performance. However, when we simultaneously consider their interaction effect, the evidence shows that the higher investment opportunity given high managerial optimism does not benefit its corporate performance apparently.

5. CONCLUSIONS

We examine the relation between managerial sentiment and firm performance in this study. This paper makes two fundamental contributions to the analysis of firm performance. First, using a sample of Taiwanese firms, we first judge managers are optimistic or pessimistic. The empirical results show a significant relation between firm performance and managerial sentiment. Optimism manager may decrease firm performance but the pessimism manager would increase firm performance. Second, we posit that there is an adverse influence between firm performance and the investment opportunity set when managerial sentiment interacted with investment opportunity set.

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THE RELATIONSHIP AMONG ADVERTISEMENT, ELECTRONIC WORD OF MOUTH, AND PURCHASE INTENTION OF VIRTUAL COMMUNITY MEMBERS

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Abstract

With the spread of the Internet, virtual communities (VCs) have important applications for business. Moreover, advertisements (ads) and electronic word of mouth (eWOM) are central to the key strategies that firms adopt to manage VCs. However, in a virtual context the commercial benefits of ads and eWOM is questionable. An increasing number of scholars suggest that firms should adopt activities that are appropriate for specific types of VCs. This study tries to examine the influences of ads and eWOM on purchase intentions according to different types of VCs. After surveying 290 valid responses, ads were found to have no significant influence on purchase intentions, whereas eWOM was found to play a very important role. In addition, types of VCs were found to moderate the relationship between ads and purchase intentions. Low-involvement ads are negatively related to the purchase intentions of non-transactional community members. This result indicates that ads do not generally have positive effects and have negative effects in non-transactional communities. With regard to eWOM, it has a significant effect on purchase intentions regardless of the type of VC. Furthermore, this study found that positive eWOM is positively related to purchase intentions and has a greater effect on purchase intentions than ads. The findings suggest that firms should encourage members to share their knowledge or experience rather than just posting ads, especially in non-transaction VCs. In addition, low-involvement ads have negative

effects in virtual communities, so firms should design high-involvement ads, such as virtual props, blogs, and rich media, to attract the attention of potential customers.

Key words：Advertisement, Electronic word of mouth, Virtual communities, Purchase intention

1. Introduction

As an increasing number of consumers are interacting online and using the Internet to share their knowledge, experiences, and opinions, virtual communities (VCs) play an important role in marketing [1].   Many online vendors currently consider VCs to be potential channels to advertise brands and promotions, improve store image, develop and gauge demand, and increase barriers to entry for competitors [2].   Online vendors also consider VCs to potentially provide a source of customers, improve their reach, and increase online sales, as well as develop deeper and broader relationships with their customers [3].   Consequently, VCs have become an important business tool.

The business world assumes that VCs can be leveraged to provide access to consumers and consumer data.   However, these benefits have not always been realized.   Many online vendors have sponsored VCs in the hope of reaping commercial benefits, but few have been successful in this effort [4].   Success in VCs depends on the attitude of contribution, dedication of resources, building of critical mass, and alignment of community and business needs [5].   In addition, advertisements (ads) and electronic word-of-mouth (eWOM) have been the key strategies that firms adopt to reap benefits from VCs [6-8].   eWOM has also become a significant market force that influences consumer decisions [9].   Nevertheless, according to previous studies, ads and eWOM may not always positively affect purchase intentions of VC members.   It is critical for firms to adopt activities that are appropriate for the various types of VCs.   However, there is a lack of empirical studies on this issue.

With regard to the development of VCs in Taiwan, an increasing number of firms have invested in VCs but are reaping limited benefits from this investment.   This study therefore seeks to explore the effects of ads and eWOM in a virtual context. According to previous studies, different types of VCs may play an important role in moderating the influence on purchase intentions.   This study will examine the effects of ads and eWOM on purchase intentions in relation to various types of VCs. Finally, this study provides suggestions to firms that intend to reap commercial benefit from their involvement with VCs.

2. Literature Review and Hypotheses

2.1 Virtual communities

Many new business practices have emerged with the development of the Internet and Web 2.0. Among these, the ones related to VCs could be the most important for businesses to reach potential customers. VCs have become forums where Web users express themselves, get information, interact with each other, and establish their social networks. They provide effective platforms for the development of e-commerce based on social networks [10].

There are several definitions of VC. First, Rheingold [11] focused on the technological aspect of VCs and defined them as "social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace." Fernback and Thompson [12] recognized the importance of "social relationships" and defined VCs as "social relationships forged in cyberspace through repeated contact within a specified boundary of place (e.g., a conference or chat line) that is symbolically delineated by topic of interest." VCs can generally be defined as aggregations of Internet users who form webs of personal relationships [5, 11, 13].

Researchers have developed different classification schemes for VCs. Armstrong and Hagel III [14] identified four kinds of VCs: (1) *transaction communities* focus on transactional needs and provide a platform where people can obtain relevant trading information; (2) *fantasy communities* usually refer to online games and allow people to come together to have virtual fantasy experiences; (3) *interest communities* provide a platform for people with common interests or expertise on a specific topic to gather and interact with each other; and (4) *relationship communities* allow people with similar experiences to come together and form meaningful personal relationships. Similarly, Kannan, Chang [13] divided the virtual community space into four categories: (1) the main function of *transaction-oriented communities* is to bring sellers and buyers together; (2) *interest-oriented communities* gather users around a common theme such as Macintosh computers (www.macrumors.com), or product support (support.dell.com); (3) *relationship-oriented communities* generally focus on real-life relationships, such as family (MyFamily.org) or business relationships (LinkedIn.com); and (4) users of *fantasy-oriented communities,* such as Second Life, expect to participate in an interesting environment in exchange for their time [5].

Drawing from these relevant studies, the definition of Kannan, Chang [13] was

adopted in this study, which defines a VC as a group of members who use a platform or website to share information.   We selected the four most representative VCs in Taiwan and summarized their characteristics in relation to ads and eWOM in Table 1.

Table 1. Most popular ads and eWOM in four types of VCs

Type of VC	Case	Ad	eWOM
Transaction	Books.com.tw	Banner, Flash, Click-through, Rich media	Consumer review, "Like" button
Interest	Mobile01	Banner, Flash, Click-through, Rich media	Unboxing [a], Testing [b]
Relationship	Facebook	Click-through, Virtual props [c], Rich media, Blogs, Fan page	Platform for sharing information, "Like" button
Fantasy	Maplestory	Virtual props [d], Rich media	Recommendation of virtual props

[a] Unboxing is when members share firsthand experience about getting a product in VCs.   The text of an unboxing usually includes the entire process from opening the product package to using the product.   Members are usually customers.

[b] Writers usually receive products from sponsors.   These writers are members of the VC and usually are also sales representatives, reporters, or opinion leaders.   They announce not only their firsthand experiences about getting a product but also the test results of the product's features, quality, and functions.   This kind of article is much more objective and professional than unboxing.

[c] For example, Melege Olive provided its products as seeds for the Happy Farm, which is the most popular game on Facebook.   Game players got free seeds of Melege products and planted them.   Melege Olive also provided free houses and scenery with its product images.   In doing so, Melege Olive is promoting its product image.

[d] For example, Cheetos integrates their product ads into Maplestory, which is the most popular gaming website in Taiwan.   Game players bought a Cheetos' product and got virtual props that they can use in Maplestory.   In doing so, Cheetos is promoting the image of its products and influencing sales volumes.

2.2 Advertisements and purchase intentions

Since the first banner ads appeared in 1994, the Internet advertising industry has experienced exceptional growth.   Existing academic research encompasses a broad spectrum of studies on Internet advertising effectiveness as measured by direct response and branding metrics.   There are few studies that include click-through rates (CTR) as a measure of online advertising effectiveness.   Robinson, Wysocka [15] investigated the impact of seven creative characteristics of banner ads on the effectiveness of online advertising.   After surveying 209 banner ads, they suggested that the creative characteristics of effective banner ads in the online gaming arena include: larger size, absence of promotional incentives, and presence of information about casino games.   In contrast, banner features such as animation, action phrases, and the presence of company brands or logos were ineffective in generating click-throughs.   Jiang, Chan [16] conducted a laboratory experiment and explored

how website interactivity can impact purchase intentions through website involvement. They found that websites with a high level of active control generate cognitive involvement and websites with reciprocal communication generate affective involvement. The responses of the participants also revealed that increases in website involvement lead to higher purchase intentions.

The impact of traditional advertising has been reduced by new technological alternatives and changes in consumer purchasing behaviors. Clemons, Barnett [17] mentioned that Lord Leverhulme had complained that "half of money I spend on advertising is wasted; I just don't know which half!" However, Clemons et al. (2007) believe that Lord Leverhulme would feel somewhat differently today because of information technology changes. They found that some websites produce sufficient resonance to create strong VCs and these strong VCs may have significant monetary value. They also believe that *resonance marketing* allows every consumer to decide what he wants based on true *informedness* rather than compromising for a product that has been hyped through advertising.

As in previous studies, this study found that Internet advertising also influences the purchase intentions of VC members. This study concluded that ads with several characteristics, such as the absence of promotional incentives, the presence of information, high involvement, or resonance, enhance purchase intentions (Clemons et al., 2007; Jiang et al., 2010; Robinson et al., 2007). However, ads with low involvement, animations, action phrases, and the presence of company brands or logos are ineffective in generating purchase intentions (Robinson et al., 2007). Therefore, this study states that the more involving the ads, the more effective they are in a virtual context. Therefore, H1 was derived as follows:

H1: Relative to low-involvement ads, high-involvement ads have a greater positive influence on the purchase intentions of VC members.

2.3 eWOM and purchase intentions

WOM is defined as independent information and opinions about marketplace offerings [18]. There are many forms of WOM, such as chat room, newsgroup, bulletin boards, listservs, and electronic consumer forum [18, 19]. These electronically based forms provide consumers with the ability to share their experiences, opinions, and knowledge with others on specific topics. To differ with the traditional (offline) WOM, the scholars called these forms as electronic word-of-mouth (eWOM) [20]. Besides, consumer judgements can be positive or

negative. This research followed most scholars' classification and explored the influence of positive and negative eWOM separately [21-25].

Consumers always search for information before making a purchase in order to reduce their perceived risk [26, 27]. One such source of information is word of mouth (WOM). In addition, online consumer reviews, such as consumer-created product information, can be viewed as a special type of WOM [28]. Consumer reviews are important for unsophisticated consumers, who may hesitate to make a purchase if only seller-created product information is available. Recent evidence suggests that consumer reviews have become very important for consumer purchase decisions and product sales [29]. Regardless of whether they are positive or negative, traditional WOM communications have been shown to directly influence consumer attitudes and behaviors [23]. Therefore, H2a and H2b were developed as follows:

H2a: Positive eWOM will enhance the purchase intentions of VC members.
H2b: Negative eWOM will reduce the purchase intentions of VC members.

The Internet and information technology represent a new opportunity for consumers to share their product evaluations online [30]. Indeed, traditional forms of communication, such as advertising, appear to be losing their effectiveness, possibly because consumers doubt their reliability and trustworthiness [31]. The credibility of WOM combined with the fact that consumers are more involved suggests that WOM has stronger effects than advertising [32]. Thus, H3 was proposed as follows:

H3: Relative to ads, eWOM has a greater influence on the purchase intentions of VC members.

2.4 The moderating effects of VC types

VCs are used for both advertising and building brand loyalty. There has been some success in this area; however, marketing in VCs is still very experimental in nature. Each type of community requires a different approach to marketing [5]. Spaulding (2010) indicated that the definition of a successful venture into a VC is the acceptance of the firm or its activities by the community. He suggested that it is difficult to reap the benefits of advertising in interest and fantasy communities. As interest communities are very sensitive to the improper use of their resources, trust is easily broken and reputations are easily damaged. Similarly, fantasy communities are not likely to view direct advertising positively, if they notice the advertisements at all [17, 33]. Interest communities may discuss favorite brands, product quality, and other

commercially beneficial topics. On the other hand, it is effective to advertise in transaction communities because participants are looking to spend money. In this context, word ads or featured ads can produce results as long as the participants do not mentally or technically block them (Spaulding, 2010). The main obstacle of advertising in transaction communities is that when participants are ready to make a purchase, they are often focused only on exactly what they want (Clemons et al., 2007). Thus, H4 was developed as follows:

H4: The effectiveness of ads on purchase intentions is higher in transaction VCs than in non-transaction VCs.

Gupta, Kim [4] proposed that the committed participation of members in VCs is the springboard for online vendors to convert VC members into online buyers. Spaulding (2010) suggested that products will become popular through WOM and require little marketing in relationship communities. In addition, some scholars considered trust to be a moderator or intervening variable to explain the influence of eWOM on purchase intentions. Trust is "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" [34]. In e-commerce, trust has long been recognized as a critical success factor, and has been the focus of many studies [35-37]. In non-transaction VCs, members exchange information and share common interests. Therefore, these VCs are more likely to cultivate trust among members. Furthermore, in comparison with transaction communities, participation and trust play a more important role in non-transactional communities. Subsequently, this study suggested that the influence of eWOM on purchase intentions may differ in accordance with the type of VC. In other words, the type of VC will moderate the relationship between eWOM and purchase intentions. Thus, H5 was derived as follows:

H5: The effectiveness of eWOM on purchase intentions is higher in non-transaction VCs than in transaction VCs.

3. Method
3.1 Data collection

This study aimed to explore the relationships among online ads, eWOM, and the

purchase intentions of VC members. To further clarify the characteristics of four types of VCs, we adopted qualitative research firstly. The study surveyed the most representative websites as case study objects: Books.com, Mobile01, Maplestory, and Facebook represent transaction, interest, fantasy, and relationship communities, respectively (Table 1). Then, we adopted quantitative research. Online consumers in Taiwan were selected for the research sample. Online questionnaires were created using mySurvey (http://www.mysurvey.tw). To gather data, the URL was posted on the following websites, which are the most popular VCs in Taiwan: Facebook.com, AHHA.com, U-CAR.com, Gamer.com, and Gamebase.com. Any single computer was restricted from submitting more than one questionnaire in order to avoid duplicate responses. A total of 482 responses were received, 192 of which were excluded for being invalid. Invalid responses include those containing more than five missing values, those with the same answer to all questions, and those that answered reverse and general questions in the same way. There were 290 valid responses, resulting in a validity rate of 60%. A description of the sample is presented in Table 2. Table 3 shows the sample distribution of VCs.

Table 2. Sample description (*N*=290)

Demographics	Frequency	Percent
Gender		
Female	151	52
Male	139	48
Age		
Under 15	6	2
16 - 20	39	13
21 - 25	133	46
26 - 30	58	20
31 - 35	23	8
36 - 40	14	5
Above 41	17	6
Education		
Below Junior High School	10	3
High School	43	15
College / University	173	60
Graduate School	64	22
Income [a]		
Under 15,000	136	47
15,001 – 20.000	21	7
20,001 – 25,000	29	10
25,001 – 30,000	30	10
30,001 – 35,000	23	8
35,001 – 40,000	14	5
Above 40,001	37	13

[a] The average monthly income of NT dollars

Table 3. Sample distribution of virtual communities (*N*=290)

Types of Virtual Communities	Frequency	Percent
Transaction (n=141)		
Books.com.tw (www.books.com.tw)	28	9.7
Yahoo! (tw.bid.yahoo.com)	94	32.4
Yahoo! (buy.yahoo.com.tw)	1	0.3
PC home (shopping.pchone.com.tw)	15	5.2
ICHIBA (www.rakuten.com.tw)	1	0.3
ETMall (www.etmall.com.tw)	1	0.3
8591 Treasure Transaction Network (www.8591.com.tw)	1	0.3
Interest (n=46)		
Mobile01 (www.mobile01.com)	16	5.5
Bahamut (www.gamer.com.tw)	24	8.3
Gamebase (www.gamebase.com.tw)	2	0.7
Garena--connecting world gamers (www.garena.tw)	1	0.3
U-CAR (www.u-car.com.tw)	1	0.3
Yahoo!(tw.stock.yahoo.com)	1	0.3
PTT BBS (www.ptt.cc)	1	0.3
Fantasy (n=6)		
Maplestory (tw.beanfun.com/maplestory)	3	1.0
World of Warcraft (tw.battle.net)	1	.3
Lineage (www.i-gamer.net)	2	.7
Relationship (n=97)		
Facebook (www.facebook.com)	95	32.8
Plurk (www.plurk.com)	2	0.7
Total	290	100

3.2 Variables

Independent variables.   This research defined eWOM as independent information and opinions about marketplace offerings.   In addition, these are spread via Web-based platforms and will influence other's cognition about the offerings.   We classified eWOM into positive and negative ones.   Because this research tries to explore the influence of positive and negative eWOM on consumers' purchase intentions, the measurement of eWOM aimed at the level of consumer attention for users' evaluation.   According to Fang and Chang [38], Zeithaml et al. (1996), and Hennig-Thurau et al. (2002), this study measured respondent's cognition about the product evaluation and developed measurements in accordance with reliability, priority, and reference.   Table 4 shows the detailed items.   All items are measured on a seven-point Likert scale, ranging from "1" (Strongly Disagree) to "7" (Strongly Agree).

Table 4. Reliability and validity of variables (*N*=290)

Variables	Factor Loadings	Eigenvalue	Cumulative explained variance (%)
Positive Electronic WOM (α=0.763)		2.058	68.60
My friends in the A community leave a message and evaluation Product B positively, I think the product is reliable.	.873		
My friends in the A community leave a message and evaluation Product B positively, I think the product is not worthwhile to purchase with high priority. (reverse question)	.734		
My friends in the A community leave a message and evaluation Product B positively, I think the product deserves a reference.	.870		
Negative Electronic WOM (α=0.807)		2.172	72.40
My friends in the A community evaluate Product B negatively and blame it, I think the product is not worthwhile to refer.	.859		
My friends in the A community evaluate Product B negatively and blame it, I think the product is not worthwhile to purchase with high priority.	.846		
My friends in the A community evaluate Product B negatively and blame it, I think the product is not reliable.	.848		
Purchase Intentions (α=0.844)		2.294	76.46
I am highly willing to buy the B product that A community recommended.	.901		
I will probably not buy the B product that A community recommended. (reverse question)	.823		
I consider to buy the B product that A community recommended.	.897		

After reviewing the four most representative virtual community websites in Taiwan, this study measured ads according to the five most popular Internet ad types: banner, click-through, flash, rich media, and virtual props.   Following the recall idea of [39], respondents were asked to select ads that they were aware of.   The chosen ads were coded with "1" and the others were coded with "0".   According to the degree of interaction, the ads were further classified into two categories and the sum of each type was calculated.   Banner, click-through, and flash ads are considered to be the low-involvement ad due to their passive characteristics.   Rich media and virtual props require consumer interaction; these ads are therefore classified as the

high-involvement ad.

Dependent variables.   Many scholars define purchase intention similarly [29, 31, 40-42].   Following their work, this study defined purchase intention (PI) as the likelihood of purchasing the product.   Measurements include the degrees of willingness, probability, and consideration to buy the product that VCs recommended. Table 4 shows the detailed items.   All items are measured on a seven-point Likert scale, ranging from "1" (Strongly Disagree) to "7" (Strongly Agree).

Moderating variables.   After reviewing several studies, this research adopted the definition of Kannan et al. (2000) of a virtual community as a group of members who participate on a platform or website to share information.   In addition, researchers have developed different classification schemes for VCs.   The following widely adopted four categories were used in this study: transaction, interest, fantasy, and relationship (Armstrong and Hagel III, 1996; Lu et al., 2010; Spaulding, 2010).   As the transaction communities differ from the other VCs, VCs were further divided into transaction and non-transaction types, coded as "1" and "0", respectively.

Control variables. As previously noted, purchase intentions may be affected by consumer demographics.   Therefore, gender, age, education, and income were used as control variables.   Gender is a dummy variable for which "0" is assigned to females and "1" to males.   The three other control variables are quasi-interval scales.

3.3 Measurement development

Questionnaire design.   Items to measure the constructs came from existing scales that were developed and tested in previous research.   Three Chinese researchers in the e-marketing area were asked for feedback on the instrument.   After minor revisions to the instrument, 30 students were asked to complete the questionnaire.   In accordance with the pretest, the questionnaire was revised again.

To avoid potential sources of common method bias, the suggestion of Podsakoff, MacKenzie [43] was adopted.   First, this study cannot measure the predictor and criterion variables in different times or locations and it is therefore necessary to use all procedural remedies related to questionnaire design.   This study sought to reduce method bias by guaranteeing response anonymity and psychologically separating the predictor and criterion variables by mixing all questions.   As these two methods do not eliminate all of the different method biases associated with a common rater and

measurement context, this study needed to depend more on statistical remedies. The threat of common method variance was investigated via the Harman one-factor test. No single factor emerged from the analysis nor did a single general factor account for most of the variance in the variables. As a result, common method bias appears to be minimal.

Validity and Reliability. Factor Analysis was employed to verify construct validity. Table 4 shows that all variables have construct validity. Besides, the Cronbach's alpha values of positive eWOM, negative eWOM, and purchase intentions are .763, .807, and .844 respectively. Therefore, the measurement of these constructs is statistically reliable.

4. Result and discussion

Table 5 presents the descriptive statistics and Pearson correlation coefficients for the study variables. The correlation matrix indicates that education, income, and eWOM are significantly positively related to purchase intentions. The low-involvement ad is significantly negatively related to purchase intentions. This indicates that better educated and higher income consumers are more likely to purchase the products recommended in VCs. It is noteworthy that consumers exposed to negative eWOM still have positive purchase intentions. The VC type is positively related to the low-involvement ad, whereas it is significantly negatively related to the high-involvement ad. It seems that transaction VCs are more likely have low-involvement ads, whereas non-transaction VCs prefer high-involvement ads. This result conforms to previous case studies (Table 1).

Table 5.   Descriptive statistics and Pearson correlation coefficients   (*N*=290)

	1	2	3	4	5	6	7	8	9	10
1.Gender [a]	1									
2.Age	.118**	1								
3.Education	-.034	.135**	1							
4.Income	.169***	.663***	.062	1						
5.VC type [b]	-.174***	.220***	-.063	.167***	1					
6.LIAd	-.089	-.045	.018	-.004	.113*	1				
7.HIAd	.127**	-.036	-.127**	-.028	-.107*	.016	1			
8.PEWOM	-.003	-.151***	.132**	-.024	-.034	.073	-.026	1		
9.NEWOM	-.137**	.057	.121**	.056	-.096	.116**	-.037	.320***	1	
10.PI	-.012	.055	.205***	.132**	-.082	-.127**	-.067	.465***	.174***	1
Mean	.479	3.560	3.000	2.910	.486	.386	.231	5.146	4.931	4.495
SD	.500	1.341	.713	2.203	.501	.339	.294	.804	1.015	1.052

[a] Gender: 0 for female and 1 for male
[b] VC type: 0 for non-transaction virtual communities, 1 for transaction virtual communities
*p<.10; **p<.05; ***p<.01

With regard to the influence of eWOM, Table 6 shows that positive eWOM does have a positive influence, whereas negative eWOM does not have a significant influence. Therefore, **H2a is supported and H2b is not supported**. Furthermore, the standardized coefficient of positive eWOM is the largest in the regression model. This result indicates that eWOM has a stronger positive influence than ads. Therefore, **H3 is supported**.

Table 6. Regression result of purchase intentions (N=290)

Variables	β	VIF
Control Variables		
Gender [a]	-.021	1.121
Age	-.004	1.965
Education	.143***	1.084
Income	.122*	1.844
Moderator		
VC types [b]	.101*	1.142
Independent Variables		
Low Involvement Ad	-.177***	1.037
High Involvement Ad	-.017	1.045
Positive eWOM	.461***	1.188
Negative eWOM	.010	1.175
Model F	12.902***	
R^2	.293	

[a] Gender: 0 for female and 1 for male
[b] VC types: 0 for non-transaction virtual communities, 1 for transaction virtual communities
*p<.10; **p<.05; ***p<.01

Table 7. Regression result of purchase intention in accordance with types of VCs

Variables	Transaction VC (n=141)	Non-Transaction VC (n=149)
Control Variables		
Gender[#]	-.027	.016
Age	-.093	.119
Education	.063	.175**
Income	.070	.123
Independent Variables		
Low Involvement Ad	-.037	-.286***
High Involvement Ad	.087	-.063
Positive eWOM	.384***	.447***
Negative eWOM	.231***	-.098
Model F	7.077***	11.875***
R^2	.300	.404

[#] Gender: 0 for female and 1 for male
*p<.10; **p<.05; ***p<.01

Table 6 shows that VC type has a significant influence on purchase intentions. To further clarify the influence of VC types, this research divided samples into two

groups and the regression results were analyzed separately. Table 7 indicates that ads have no significantly positive effect on purchase intentions in both transaction and non-transaction VCs. Furthermore, the low-involvement ad has significantly negative influence on the purchase intentions of non-transaction VC members, whereas the high-involvement ad doesn't have a significant influence. This result indicates that ads generally do not positively affect consumer purchase intentions. Table 8 presents the interaction effects of VC types on purchase intentions. It seems that both high- and low-involvement ads have significantly negative effects on the purchase intentions of non-transaction VC members. Low-involvement ads, such as banner, click-through, and flash ads, are more likely to decrease consumer purchase intentions, especially in non-transaction VCs. This result confirms Prendergast, Ko [31], who stated that advertising appears to be losing its effectiveness because consumers doubt its reliability and trustworthiness. Furthermore, products become popular through WOM and require little marketing in relationship communities. Therefore, for non-transaction VCs, ads are less effective in influencing purchase intentions. However, there is no evidence that advertisements have a positive effect on the purchase intentions of transaction VC members. Therefore, **H4 is not supported.**

Regression analyses were used to test the hypotheses, and the results are shown in Tables 6 and 7. All of the Variance Inflation Factors (VIF) values in the regression models are below two, which indicates that there are no significant multicollinearity problems. According to Table 6, both high- and low-involvement ads have negative standardized coefficients. It seems that ads generally negatively influence the purchase intentions of VC members. In addition, the low-involvement ad has a significantly negative influence on purchase intentions. Whether the high-involvement ad has a greater positive influence on purchase intentions compared with the low-involvement ad cannot be verified. Thus, **H1 is not supported.**

With regard to the influence of eWOM, Table 7 shows that positive eWOM has a strong influence on the purchase intentions of both transaction and non-transaction VC members. In addition, for transaction VCs, regardless of whether the eWOM is positive or negative, consumers are still likely to purchase the product recommended by the community. This phenomenon could be attributed to the past experiences of members. Jones, Aiken [23] investigated the extent to which online consumers are influenced by eWOM communications. They integrated experience, advertising, and eWOM into a model and found that when past personal experience is favorable, an ad alone is sufficient to produce a favorable brand evaluation. When personal

experience is unfavorable, eWOM influences brand attitudes but neither advertising nor word of mouth has any impact on purchase intentions. Therefore, the study questions if the members/consumers of transaction VCs have already decided to make a purchase and are therefore only focused on what they want. In addition, members of transaction VCs may have favorable past experiences and ignore negative eWOM when they make a purchasing decision. Therefore, even negative eWOM has a significantly positive influence on purchase intentions.

Table 8. Interaction effects of VC types on purchase intentions (N=290)

Variables	β
Control Variables	
Gender [a]	-.012
Age	-.018
Education	.193[**]
Income	.057[*]
Moderator	
VC types (Non-transaction VCs)	1.465[**]
VC types (Transaction VCs)	.424
Independent Variables	
Low Involvement Ad	-.080
High Involvement Ad	.282
Positive eWOM	.476[***]
Negative eWOM	.203[**]
Interaction Items	
Non-transaction VCs * Low Involvement Ad	-.878[***]
Non-transaction VCs * High Involvement Ad	-.622[*]
Non-transaction VCs * Positive eWOM	.144
Non-transaction VCs * Negative eWOM	-.306[***]
Model F	557.491[***]
R^2	.966

[a] Gender: 0 for female and 1 for male
[*] $p<.10$; [**] $p<.05$; [***] $p<.01$

Comparing the effectiveness of eWOM between transaction and non-transaction VCs, positive eWOM was found to have the strongest influence on the purchase intentions of non-transaction VC members, according to the standard coefficients (Table 7). Table 8 presents the interaction of VCs and eWOM on purchase intentions. It seems that the influence of positive eWOM on purchase intentions does not differ between transaction and non-transaction VCs. However, in comparison with transaction VCs, negative eWOM does have greater negative impact on the purchase intentions of non-transaction VC members. Thus, the effectiveness of eWOM on purchase intention is higher for non-transaction VCs than for transaction VCs. Therefore, **H5 is supported**.

5. Conclusion and implications

Several theories have been used by previous researchers to explain how ads and WOM influence consumer behavior in daily life. This study has taken some of those theories and applied them to the online environment, thereby extending our understanding of factors that are influential in a new context. The research results show that ads in VCs do not have positive effects. Instead, eWOM has a stronger influence on the purchase intentions of VC members.

According to Spaulding's (2010) work, marketing activities in interest communities require respect for both the social contract and the topic of interest. There is a temptation to place ads in every possible location in interest or fantasy communities. However, advertising only costs a business the time it takes to post the ad. The consequence of this type of advertising is the negative impression created by polluting forums and environments with unwanted material. To further clarify the influence of VC type, this study divided the sample into transaction and non-transaction groups. The results indicate that ads have no effects on purchase intentions in transaction VCs, which differs somewhat from Spaulding's (2010) suggestion that advertising in transaction communities would be effective. In non-transaction VCs, low-involvement ads negatively influence purchase intentions and high-involvement ads do not have a significant influence. This result shows that ads generally do not affect the purchase intentions of VC members. Furthermore, low-involvement ads, such as banner, click-through, and flash ads, are more likely to decrease member purchase intentions. This study suggests that the effects of advertising in the virtual context may differ from the real world. It is worthwhile to further investigate how ads work and what kinds of ads are more effective in virtual communities.

With regard to the influence of eWOM, this study found that positive eWOM has a strong influence on the purchase intentions of non-transaction VC members, whereas both positive and negative eWOM positively influence the purchase intentions of transaction VC members. The results further demonstrate that eWOM plays a very important role in the marketing activities of VCs. In addition, members' past experiences may explain why negative eWOM still has a significantly positive influence on the purchase intentions of transaction VC members. It is worthwhile to further explore the influence of VC members' characteristics on their behaviors.

The research findings suggest that firms should not just post ads on VCs. It would

be better for firms to encourage members to share their knowledge or experience. By building eWOM, firms can enhance VC members' trust and reap benefits from VCs.

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HOW ELECTRONIC WOM AFFECTS BEHAVIORS OF VIRTUAL COMMUNITY MEMBERS?

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Abstract

Nowadays, virtual communities (VCs) have become the most important medium for people to interact and to share the knowledge with others.   Consumers tend to search for information prior to making a purchase in order to reduce perceived risk.   As a result, word of mouth (WOM) marketing plays more and more important role in marketing strategy.   However, negative WOM is the most concerned issue for firms, because it might arouse great impact on business operation.   Most studies relating to eWOM are to explore what leads to eWOM and the influence of eWOM on consumers' behavior intentions.   Previous studies focus on the impact of eWOM on a certain product; while there is a lack of research about the impact of on-line platform itself.   The research aims to explore factors that influence on non-transaction VC members' continuance intention.   This research adopted two studies.   The first one used qualitative research methods to explore reasons that internet users continued using Facebook.   Then, this research conducted quantitative research to further verify hypotheses.   After surveying 183 internet users, this research found that negative WOM will significantly decrease the continuance intention; while positive eWOM does not have as much influence as the negative one. This research also found that trust and web service quality has significant impact on continuance intention.   According to these findings, this research suggests that firms utilizing VCs should put effort in cultivating trust among members.   Besides, high quality of web service can alleviate the impact of negative word of mouth.

Keywords: Non-transaction Virtual Communities, Electronic Word of Mouth, Trust, Web Service Quality, Continuance Intention

INTRODUCTION

With the development of the internet, the population of internet users has increased rapidly.   More and more people choose the virtual community as a medium to

interact and have connections with others, and to share the knowledge they have. Product experiences posted by virtual communities (VCs) members are likely to be perceived as reliable because the information providers are fellow consumers, who presumably have no interest in marketing the product [1]. VCs serve both social and business functions [2]. For the social functions, they provide a communication platform to foster interaction among members. The members of these communities come together to develop friendships, share common interests, and exchange information. On the other hand, VCs comprise a viable trading and marketing platform that enables commercial interaction between sellers, buyers, and intermediaries [3]. Besides, electronic word-of-mouse (eWOM) has become a significant market force that influences consumer decision-making [4]. However, negative WOM is the most concerned issue for firms dedicating in e-commerce, because it might arouse great impact on business operation.

Most studies relating to eWOM are to explore what leads to eWOM and the influence of eWOM on consumers' behavior intentions [5]. For example, studies examine what leads to eWOM (e.g., [6], [7]) and how eWOM affects the business bottom line, including product sales (e.g., [8], [9]), customer value and loyalty [10], and the success of new product introductions (e.g., [11]). These studies focus on the impact of eWOM on a certain product; while there is a lack of research about the impact of on-line platform itself. Are VC members more sensitive to negative WOM? Once there are negative eWOM about the online platform appear; do members still continue using that platform?

There are four kinds of VCs: transaction, fantasy, interest and relationship communities [12, 13]. Among these VCs, the members of non-transaction VCs do not intent to promote products on the online platform; therefore the members' comments are more persuasive than transaction VCs'. After observing the development of Facebook in Taiwan, the researcher found that the population of Facebook users in Taiwan continues growing in spite of the negative comments, such as insecurity in privacy. Therefore, this research tries to explore factors influencing the continuance intention of non-transaction VC's members, especially when there are negative eWOMs appear.

Literature Review and Hypotheses

Virtual Communities

There are several definitions of VC. First, Rheingold [14] focused on the technological aspect of VCs and defined them as "social aggregations that emerge from the Net when enough people carry on those public discussions long enough, with sufficient human feeling, to form webs of personal relationships in cyberspace." Fernback and Thompson [15] recognized the importance of "social relationships" and defined VCs as "social relationships forged in cyberspace through repeated contact within a specified boundary of place (e.g., a conference or chat line) that is symbolically delineated by topic of interest." VCs can generally be defined as aggregations of Internet users who form webs of personal relationships [13, 14, 16].

Researchers have developed different classification schemes for VCs. Armstrong and Hagel III [17] identified four kinds of VCs: (1) transaction communities focus on transactional needs and provide a platform where people can obtain relevant trading information; (2) fantasy communities usually refer to online games and allow people to come together to have virtual fantasy experiences; (3) interest communities provide a platform for people with common interests or expertise on a specific topic to gather and interact with each other; and (4) relationship communities allow people with similar experiences to come together and form meaningful personal relationships. Similarly, Kannan, Chang [13] divided the virtual community space into four categories: transaction-oriented, interest-oriented, relationship-oriented, and fantasy-oriented communities [16]. Among these VCs, members of non-transaction VCs usually do not intent to promote products when they posed information on the online platform; therefore the members' comments are more persuasive.

eWOM and Continuance Intention

WOM is defined as independent information and opinions about marketplace offerings [18]. There are many forms of eWOM, such as chat room, newsgroup, bulletin boards, listservs, electronic consumer forum [18, 19], and online forum which is an online community where visitors may read and post topics [1]. These electronically based forms provide consumers with the ability to share their experiences, opinions, and knowledge with others on specific topics. To differ with the traditional (offline) WOM, the scholars called these forms as electronic word-of-mouth (eWOM) [6]. Besides, consumer judgements can be positive or negative. This research followed most scholars' classification and explored the influence of positive and negative eWOM separately [20-24].

The power of WOM to influence consumers' decision-making processes has long

been known to researchers and practitioners; the power of WOM has recently become even more important with the advent of the internet [6, 18, 25].   Consumers always search for information before making a purchase in order to reduce their perceived risk [26, 27].   In addition, online consumer reviews, such as consumer-created product information, can be viewed as a special type of WOM [28].   Consumer reviews are important for unsophisticated consumers, who may hesitate to make a purchase if only seller-created product information is available.   Recent evidence suggests that consumer reviews have become very important for consumer purchase decisions and product sales [29].   Regardless of whether they are positive or negative, traditional WOM communications have been shown to directly influence consumer attitudes and behaviors [22].   Therefore, H1a and H1b were developed as follows:

H1a: Positive eWOM will enhance the non-transaction VC members' continuance intention.

H1b: Negative eWOM will reduce the non-transaction VC members' continuance intention.

Although similar to the traditional form, eWOM has several unique characteristics. eWOM often occurs between people who have little or no prior relationship with one another and can be anonymous [25, 30, 31].   This anonymity allows consumers to more comfortably share their opinions without revealing their identities [30]. However, the anonymous nature of eWOM can make it difficult for consumers to determine the quality and credibility of the eWOM [32, 33].   There must be other factors will influence the continuance intention of VC members.

Previous studies have classified the motivations of continuance usage of web sites into system attributes and individual attributes [34].   System attributes include information quality, usefulness and ease of use [35-39]; while individual attributes contain trust, loyalty, and satisfaction [39-41].   Drawing from these studies, this research referred that web service quality and trust are the other influence factors and the moderators of the relationship between eWOM and continuance intention.

The Effects of Web Service Quality

Sine computer-aided services have grown in number and significance in proportion to the rapid growth of Internet adoption, the quality of enterprise web sites has become a key indicator of how well a company is likely to satisfy its customers [42, 43]. E-service quality is the overall customer perceptions, judgments and evaluations of

the quality of service obtained from a virtual marketplace [44]. Both practitioners and researchers use e-service quality and web service quality interchangeably [42]. Several authors have developed diverse instruments to measure e-service quality [44, 45] and there are discrepancies regarding service quality measurement. One of the first and most widely used instruments to measure service was developed by Parasuraman, Zeithaml [46] and was intended to provide managers with insights into information systems service perceptions, and subsequently to provide a benchmark across information systems business processes [47]. Parasuraman, Zeithaml [48] later adapted and extended the model to include dimensions reflecting e-service quality, defined as the extent to which a website facilitates efficient and effective shopping, purchasing and delivery, many of which are identical to the dimensions proposed as factors impacting service quality in physical service encounters. This research adopt Udo, Bagchi [42]'s definition and measurement, because their study focused on examining the dimensions of web service quality based on e-customer's, expectations and perceptions and have included relevant studies.

Some researchers have emphasized the importance of web service quality, because it is the antecedent of e-customer satisfaction [42, 49-51]. Web service quality is crucial because it shapes customers' initial impression of a web site's value. According to the impression, customers determine whether they will continue using the web site [52]. In the Information Systems Success Model [37], web service quality is the most important variable in affecting user satisfaction. Most authors conclude that both service quality and satisfaction have direct links to behavioral intentions [53, 54]. Cronin Jr, Brady [54] concluded that the direct link between service quality and behavioral intentions is significant. Therefore, this research inferred that high web service quality will enhance members' satisfaction and then they are more likely to continue using the online platform that VCs provided. Hypothesis 2 is developed as below:

H2: Web service quality will enhance the non-transaction VC members' continuance intention.

It is difficult for customers to determine the quality and credibility of the eWOM due to the anonymous nature of eWOM [32, 33]. According to the impression of website, customers will determine whether continue using the website or not [52]. Therefore, this research inferred that high web service quality will alleviate the impact of negative eWOM on continuance intention of VC members. Thus, H3 was developed as follows:

H3: Web service quality will moderate the influence of negative eWOM on the non-transaction VC members' continuance intention.

The Effects of Trust

In VCs, trust plays an important role in affecting members' behavior as people would act more proactively when they trust the environment and other people [55, 56]. Many researchers proposed that trust is a cornerstone in terms of constructing a long-term business relationship and partnership.   In e-commerce, trust has been long recognized as a critical success factor, and much research has been conducted on trust [57-59].

Trust refers to the depth and assurance of feelings based on inconclusive evidence [2, 60-62].   Mayer, Davis [63] defined trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party."

Lu, Zhao [64] proposed two kinds of trust, that are trust in the website and trust in members.   Trust in the website refers to the beliefs that the C2C website or the VC sponsor is capable of providing quality services and would do something good to its consumers or users.   This kind of institutional trust affects consumers' purchase behaviors [65, 66].   On the other hand, trust in members can be a major factor that affects the prosperity and success of VCs as, in a virtual environment where participants are usually anonymous and do not engage in direct face-to-face communication, trust can be a significant issue [64].   The research objectives of Lu, Zhao [64]' work are online venders; while the research tried to explore factors that influence continuance intention of using online platform that non-transaction VCs provided.   Because the purchase intention of a certain product is not the research issue, this study adopted trust in website [64] as a research variable.

Trust between members in VCs positively affects members' behaviors such as obtaining or contributing information [64].   Ridings, Gefen [67] found that trust in members significantly affects the desire to get and give information in VCs.   Thus, the research inferred that members trust others will enhance their desire to continue using the online platform that VCs provided.   Hypothesis 4 is developed as below:

H4: Trust in members will enhance the non-transaction VC members' continuance intention.

Because strong generalized trust implies a general belief in the good intent of others [68], Kankanhalli, Tan [55] stated that generalized trust positively affects knowledge contribution using electronic repositories. From the view of transaction cost theory, trust prompts knowledge sharing as trust can reduce the transaction cost in the interactions between buyers and sellers [69]. Therefore, the study refers that members trust others will alleviate the negative impact when someone posted unfavorable comments relating to the online platform that VC provided, because members believe their friends of the VC will not do something to hurt them, especially for non-transaction VCs which allow members share common interests. Thus, the research derived Hypothesis 5 as below.

H5: Trust in members will moderate the influence of negative eWOM on the non-transaction VC members' continuance intention.

Method

Data collection

This research adopted two studies. The first one used qualitative research methods to explore reasons that internet users continued using Facebook. This study selected Facebook as the research object due to it is the biggest virtual community not only in Taiwan but also in the whole world. Besides, there are many negative evaluations come out along with the growth of Facebook. The most concerned fault is the problem of members' privacy and security. In spite of the negative WOM, the population of Facebook users in Taiwan does not decrease at all. At first, the researcher randomly selected online guests and interviewed them through chat room on Facebook and MSN. It took one week to collect conversation data. This research conducted content analysis approach to conclude variables from chatting content and then compared these results with literature.

After qualitative research, this research conducted quantitative research to further verify hypotheses. The Internet users in Taiwan were selected for the research sample. Online questionnaires were created using mySurvey (http://www.mysurvey.tw). To gather data, the URL was posted on the following websites, which are the most popular VCs in Taiwan: Facebook.com, Gamer.com, and

Ptt.cc.　Any single computer was restricted from submitting more than one questionnaire in order to avoid duplicate responses.　A total of 205 responses were received, 22 of which were excluded for being invalid.　Invalid responses include those containing more than five missing values, those with the same answer to all questions, and those that answered reverse and general questions in the same way. There were 183 valid responses, resulting in a validity rate of 89%.　A description of the sample is presented in Table 1.　Table 2 shows the sample distribution of VCs.

Table 1. Sample Description (*N*=183)

Demographics	Frequency	Percent
Gender		
Female	101	55
Male	82	45
Education		
Below Junior High School	10	6
High School	29	16
College / University	112	61
Graduate School	32	17
***Income*[1]**		
Under 15,000	89	48
15,001 – 20.000	13	7
20,001 – 25,000	16	9
25,001 – 30,000	16	9
30,001 – 35,000	16	9
35,001 – 40,000	13	7
Above 40,001	20	11

Note 1. The average monthly income of NT dollars

Table 2. Sample Distribution of Virtual Communities

Virtual Communities	Frequency	Percent
Facebook	156	85
Plurk	5	3
Youtube	4	2
Bahamut	13	7
Gamebase	3	2
Mobile01	2	1
Total	183	100.0

Variables

Electronic WOM.　This research followed most scholars' classification and explored the influence of positive and negative eWOM separately [20-24].　Following Goyette, Ricard [70] and Holloway, Wang [71]'s measurement, this research developed 6 and 3 items to measure positive and negative eWOM respectively (Table 3).　All items are measured on a seven-point Likert scale, ranging from "1" (Strongly Disagree) to "7" (Strongly Agree).

Web Service Quality.   E-service quality is the overall customer perceptions, judgments and evaluations of the quality of service obtained from a virtual marketplace [44].   Both practitioners and researchers use e-service quality and web service quality interchangeably [42].   This research adopt Udo, Bagchi [42]'s definition and measurement.   Four items were used in the questionnaire with seven-point Likert scale.   After factor analysis and item to total analysis, this research removed one items because of the low factor loading and reliability.

Trust in Members.   This research defined trust as the depth and assurance of feelings based on inconclusive evidence [2, 60-62].   This research adopt Lu, Zhao [64]'s measurement.   They proposed two kinds of trust, those are trust in the website and trust in members.   The research objectives of Lu, Zhao [64]' work are online venders; while this research tried to explore factors that influence continuance intention of using online platform that non-transaction VCs provided.   Because the purchase intention of a certain product is not the research issue, this study adopted trust in website [64] as a research variable.   The measurement items are shown in Table 3.

Continuance Intention.   This research adopt the concept of information systems continuance and applied Bhattacherjee [40]'s measurement.   There are three items in the construct, but one of these items was deleted due to low factor loading and reliability.

Control variables. As previously noted, behavior intention may be affected by consumer demographics.   Therefore, gender, income, age, and education were used as control variables.   Gender is a dummy variable for which "0" is assigned to females and "1" to males.   Education is also a dummy variable for which "0" refers senior high school or less and "1" refers above university.   Income belongs to quasi-interval scale; while age belongs to ratio scale.

Measurement Development

Questionnaire design.   This research developed items measuring the constructs by adapting existing scales developed and tested in previous research.   As the original items were in English, the author used the following procedures to ensure the translation validity.   First, a researcher whose native language is Chinese forward translated the items into Chinese. Next, another researcher independently backward translated the items into English.   Subsequently, the two researchers compared and

discussed the two English versions to develop the first Chinese version of the items. After minor revisions to the instrument, 30 students were asked to fill questionnaire. According to the pretest, this research revised the questionnaire again.

To avoid potential sources of common method biases, this research adopted Podsakoff, MacKenzie [72]'s suggestion.   First of all, this study cannot measure the predictor and criterion variables in different times or locations, therefore it is necessary to use all procedural remedies related to questionnaire design.   This study tried to reduce method bias by guaranteeing response anonymity, and then separated the predictor and criterion variable psychologically by mixing all questions.   Because these two methods do not eliminate all of the different method biases associated with a common rater and measurement context, this research need to depend more on the statistical remedies.   The threat of common method variance was investigated via the Harman one-factor test.   No single factor emerged from the analysis nor did a single general factor account for most of the variance in the variables.   As a result, common method bias appears to be minimal.

Validity and Reliability.   Factor Analysis was employed to verify construct validity. Table 3 shows that all variables have construct validity.   Besides, the Cronbach's alpha values of positive eWOM, negative eWOM, web service quality, and trust in members are .804, .727, .677 and .812 respectively.   Because there are two items of continuance intention construct were left, this research used the Pearson Correlation Coefficients to show their relation.   The coefficient is .261, so these two items have high relation.   Therefore, the measurement of these constructs is statistically reliable.

Table 3：Reliability and Validity of Variables

Variables	Factor Loadings	Eigenvalue	Cumulative explained variance (%)
Electronic WOM			
Positive EWOM (α=.804)		3.205	35.609
My friends recommended the A community	.792		
My friends spoke of the A community's good sides	.665		
My friends are proud to say to others that they are the A community's members.	.686		
My friends strongly recommend people buy products online from the A community.	.656		
My friends mostly say positive things to others.	.701		
My friends have spoken favorably of the A community to others	.760		
Negative EWOM (α=.727)		1.846	56.114
My friends mostly say negative things to other about the A community.	.660		
My friends warn others not to purchase form the A community	.890		
My friends discouraged others to use the A community.	.841		
Web Service Quality (α=0.677)		1.835	61.160
The A community website gives prompt service to customers.	.837		
It was easy to find what you were looking for in A community.	.725		
The A community website provides high quality information.	.780		
Trust in Members (α=.812)		2.876	57.515
I feel very confident about the skills that the other members in the A community have in relation to the topics we discuss.	.685		
The other participants on the A community have much knowledge about the subject we discuss	.716		
The other participants on the A community have specialized capabilities that can add to the conversation in this community	.763		
The other participants on the A community are well qualified in the topics we discuss	.815		
The participants in the A community are concerned about what is important to others	.804		
Continuance Intention (r=.261***)		1.140	69.185
I intend to continue using the A community rather than discontinue its use	.674		
If I could, I would like to discontinue my use of the A community (reverse question)	.881		

***$p<.01$

Result

The first study conducted content analysis to conclude moderating variables from chatting content and then compared these results with literature. This research found that the trust among virtual community members and the abilities of users are the most important variables. Besides, the service quality of Facebook is also the key factor for users to continue using this platform. The findings is consistent with previous studies that stated the motivations of continuance usage of web sites can be

classified into system attributes and individual attributes [34]. In addition, this research found that there are several ways to cultivate trust among members, such as classify members based on their contribution to community, and set up a threshold of organizing fans club to maintain the specialty and professional of community. In order to improve the trust in members and the website, firms can reveal the rule of community and privacy policy on official website. To improve web service quality, firms should continually update interface for easy-using, because friendly interface makes users not only feel comfortable but also recognize the credibility of communities.

Drawing from the first study, this research treats web service quality and trust in members as moderating variables. This research tried to propose normative suggestion; while personal characteristics are these factors that website managers can't select. Therefore, this research treated user's ability, such as income, age, and education, as control variables.

Table 4 shows the descriptive statistics and Pearson correlation coefficients for the study variables. The correlation matrix indicates that gender, age, and education are significantly related to trust in members. The result indicates that male, older people, and students with senior high school or less are tend to trust others. Age is also positively related with eWOM and web service quality. Nevertheless, personal characteristics are nothing to do with continuance intention. Positive eWOM has significant positive relationship with web service quality, trust in members, and continuance intention. As to negative eWOM, it has significant negative relationship with continuance intention.

Table 4. Descriptive Statistics and Pearson Correlation Coefficients

	1	2	3	4	5	6	7	8	9
1. Gender	1								
2. Income	.249***	1							
3. Age	.169**	.463***	1						
4. Education	.040	.218***	.234***	1					
5.Positive EWOM	.115	-.078	.189**	-.187**	1				
6.Negative EWOM	.053	.028	.174**	-.081	.176**	1			
7.Web Service Quality	.022	-.024	.188**	-.009	.589***	.135*	1		
8.Trust in Members	.167**	-.006	.234***	-.125*	.669***	.066	.675***	1	
9. Continuance Intention	.064	.119	.107	.024	.300***	-.285***	.360***	.393***	1
Mean	.448	2.870	24.541	.787	3.353	4.940	3.674	3.377	3.216
SD	.499	2.202	5.664	.411	.854	1.098	1.036	.930	1.086

Note 1. N=183
　　　2. Gender: 0 for female and 1 for male
　　　3. Education: 0 for senior high school or less, 1 for university

This study used a series of hierarchical regression analyses to test hypotheses. Variance inflation factors (VIF) in regression models indicate no significant sign of a multicollinearity problem. VIF values range from 1.067 to 4.497 for Models 1, 2, 3, and 4. To test Hypotheses, control variables were first entered, after which eWOM and moderating variables were next entered as main effect predictors of continuance intention (see Models 1, 2, and 3 in Table 5). Next, moderator terms were created by multiplying each of the moderating variables by negative eWOM (see Model 4). To avoid the amplified effect of multiply, the study made centering treatment for each variable first. For example, the centered negative eWOM was computed as the value of original figures minus its mean.

When independent variables were entered into the equation, there was a significant increase in Model fit (ΔR^2 = .234, $p < .01$). The positive eWOM significantly enhance continuance intention; while the negative eWOM has significant negative effect. Thus, Hypotheses 1a and 1b is supported. When the moderator terms were entered into the equation, there was a significant increase in Model 3 (ΔR^2 = .072, $p < .1$). The Model 3 represents that web service quality and trust in members also significantly enhance continuance intention. However, when interaction terms were entered into model 4, it shows there's no significant interaction effect on continuance intention. Therefore, Hypotheses 2 and 4 are supported; while Hypotheses 3 and 5 are rejected.

Table 5. Standardized Regression Results for Continuance Intention [a]

Variables	Model 1	Model 2	Model 3	Model 4
Control Variables				
Gender [b]	.033	-.001	-.006	-.003
Income	.083	.139*	.148**	.131*
Age	.066	.028	-.014	-.012
Education [c]	-.011	.028	.017	.022
Independent Variables				
Positive eWOM (PeW)		.373***	.123	.124
Negative eWOM (NeW)		-.357***	-.347***	-.317***
Moderating Variables				
Web Service Quality (WSQ)			.203**	.206**
Trust in Members (Trust)			.204**	.195*
Interaction Terms [d]				
NeW * WSQ				.087
NeW * Trust				.007
Model F	.845	8.948***	9.561***	7.835***
R^2	.019	.234	.305	.313
ΔR^2	.019	.215***	.072***	.008

Note a. *N*=183

    b. Gender: 0 for female and 1 for male

c. Education: 0 for senior high school or less, 1 for university
*p<.10; **p<.05; ***p<.01

According to the standardized coefficients (see Models 2, 3, and 4 in Table 5), this research further found that negative eWOM plays the most important role to affect continuing intention in comparison with other variables. It indicates that firms should be aware of negative comments and should solve members' dissatisfaction as soon as possible.

Conclusion and Implication

After surveying 183 internet users, this research found that negative eWOM will decrease the continuance intention significantly; while positive eWOM, web service quality, and trust in members will enhance the continuance intention of VCs' members. However, web service quality and trust in members don't have moderating effects on the relationship of negative eWOM and continuance intention. Besides, this research found that negative eWOM is the most important factor to influence members' continuing usage in comparison with other variables. It indicates that firms should be aware of negative comments and should solve members' dissatisfaction as soon as possible, because those negative eWOM have determined detrimental effects. Nevertheless, higher level of trust in members and high quality of web service may alleviate the impact of negative word of mouth.

According to these findings, this research suggests that firms should be wary of negative comments from members and put effort in improving trust and web service quality, especially when negative eWOM appears. Drawing from the qualitative study, the research further suggest firms utilizing VCs should do something to cultivating trust among members, such as classify members based on their contribution to community, and set up a threshold of organizing fans club to maintain the specialty and professional of community. In order to improve the trust in members and the website, firms can reveal the rule of community and privacy policy on official website. Continually updating interface for easy-using is also an important task, because friendly interface makes users not only feel comfortable but also realize the credibility of communities.

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Pragmatic Financial Variations and Efficiency of Insurance Sector of Pakistan in the Era of 2001 to 2010

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Abstract:

The insurance industry does not like releasing numbers of policyholders and individuals covered by their group life insurance plans. But based on some data provided by firms, as well as conversations with experts inside the industry. This study provides an overview about financial changes in Insurance sector of Pakistan since 2001-2010. Secondary data is used for analysis from Karachi stock exchange (KSE). Mainly this study discussed changes in Sales and profitability of insurance sector of Pakistan and by using Paid-up-capital, numbers of Shares, equity, total assets, profit before tax and profit after tax as explanatory variables and check their impact of Sales of insurance sector of Pakistan over the decade. This study finds out consistency of over the decade. Changes and modifications in following variables also presented graphically in this paper.

Keywords: consumer credit, settlement, PUC, Total Assets and Equity

Introduction:

Insurance is designed to protect the financial well-being of an individual, company or other entity in the case of unexpected loss. Some forms of insurance are required by law, while others are optional. Agreeing to the terms of an insurance policy creates a contract between the insured and the insurer. In exchange for payments from the insured (called premiums), the insurer agrees to pay the policy holder a sum of money upon the occurrence of a specific

event. In most cases, the policy holder pays part of the loss (called the deductible), and the insurer pays the rest.

Types of Insurance:

- **Travel insurance:** To cover you in case you lose your luggage, miss your plane or train.
- **Vehicle insurance:** To cover your vehicle's accidental damages or if your vehicle is stolen.
- **Home buildings insurance:** To cover your home in case of fire and other defined events.
- **Contents Insurance**: To cover your property in case of burglary, fire and other defined events.
- **Health insurance:** To cover you for injury, or medical or dental treatment.
- **Life insurance:** To cover you if you can't work due to an accident or illness, or if you die.
- **Consumer credit insurance:** To cover you if you can't repay some of your loan because you are unable to work.

Some reasons to insure:

- Insurance can help you replace something you own and could not afford to replace. For example, if your home was destroyed in a fire, you would need a big lump sum to rebuild it.
- Insurance can protect you from something that might not happen, but which would be bad for you if it did. For example, if you were injured in an accident and couldn't work anymore, you would need money to live on.
- Insurance can help you pay off a debt if something you've bought with a loan is damaged or destroyed. For example, if you took out a loan to buy a car and the car was written off in an accident, you would need money to pay off the loan.

Insurance Sector in Pakistan

The business of insurance in Pakistan has been regulated under the Insurance Act, 1938. In order to implement and administer the provisions of the aforesaid Act, the Government established the Department of Insurance, in April 1948, as a department of the Ministry of Commerce, headed by a Controller of Insurance. Until eventual implementation of the new law of insurance, namely, Insurance Ordinance, 2000 which has only recently been enacted, the insurance industry has continued to be regulated by the Controller of Insurance.

MAIN FEATURES OF INSURANCE ORDINANCE, 2000

- The Ordinance provides for regulation of Insurance Industry by an autonomous body i.e. the Commission replacing the institution of Controller, Department of Insurance.
- The insurance business has been bifurcated into two main divisions,
  - Life Insurance Business; and
  - Non-Life Insurance Business. Each of these two divisions has further been divided into different classes.
- Capital requirements for life insurance and non-life insurance companies have been raised from Rs. 100 million to Rs. 150 million and from Rs. 40 million to Rs. 80 million respectively.
- The minimum solvency margin has not been fixed and is to be prescribed under the rules from time to time.
- Enforcement of the insurance law has been made more effective by giving to the Commission powers of investigation and issuance of directives.
- Detailed provisions have been made to prevent insurers from indulging in practices prejudicial to the interest of policyholders.
- Provision has been made for the institution of an Insurance Ombudsman who shall have the authority to investigate mal-administration of insurance companies and to redress grievances of the insurers.
- Provision has been made for the constitution of an Insurance Tribunal, which shall have, civil as well as criminal jurisdiction.
- Special provisions have been made for the establishment of a Small Disputes Resolution Committee for speedy settlement of minor claims.
- Penal provisions for contravention of the insurance law have been made stricter.
- Reinsurance arrangements have been strengthened and rules would be made for reinsurance arrangements even outside Pakistan.
- Life insurance business companies are required to maintain separate funds for separate classes of their business.
- Adequate disclosure requirements by insurance companies have been prescribed for purposes of reporting to the regulator.

Literature Review:

The Growth Rates of Private Health Insurance Premium were analyzed by Feldstein ET. AL (1995) for a selected sample of 95 insured groups over the period 1985 to 1992. The result of this study describes that during this time period, premiums increased by approximately 150%

in nominal terms and by 45% in real terms. The observed rate of growth was not constant over time, however. The most rapid growth occurred during the years 1986 to 1989; thereafter, the rate of increase in premiums declined. Further, this analysis suggests that the insurance underwriting cycle may play an important role in influencing insurance premium growth rates. These results support the belief that health maintenance organization induced competition has potential to control the rate of increase in health care costs.[1]

The study titled "A Review of Insurance Sector and HRM/HRD Aspects" by PROF. DR. KHAWAJA AMJAD SAEED in 2007 describes that Insurance Sector has registered a very slow growth in the history of Pakistan. Based on this research study, the following conclusions emerged:

1. Listed insurance sector on Karachi Stock Exchange in terms of companies is only 4.4%.
2. Share of listed insurance sector on total listed companies on Karachi Stock Exchange is only 1.41%.
3. Out of 637 listed companies, only 29 relate to insurance sector.
4. From the birth of Pakistan till now we have added only 29 listed companies- giving us a ratio of less than 0.5 per company per year.
5. Turnover for 10 months (January – October 2007) on the Karachi Stock market was only 1.55% of the total turnover.[2]

A research paper written by Robert Cull, Lemma W. Senbet, Marco Sorge in Feb, 2005, this paper has provided an empirical evidence on the impact of deposit insurance on banking sector development and stability. We use a unique dataset capturing a variety of deposit insurance features, such as coverage, entry hurdles, premium structure, etc. The empirical construct is guided by recent theories of banking regulation that employ an agency framework. Overall we find out the empirical evidence to be consistent with this theory. [3]

A research paper written by Krishna Gopal Menon and David D. Williams in April, 1994, that paper provides some empirical tests of the insurance hypothesis of auditing. The disclosure of L&H's bankruptcy are attributable to the absence of the expected insurance coverage, i, rather than to problems of monitoring introduced by the bankruptcy of the auditor. III. Conclusion This paper provides some empirical tests of the insurance hypothesis of auditing. The disclosure of L&H's bankruptcy was found to have a negative impact on L&H client stock prices. There was no corresponding increase in stock prices on announcement of a replacement auditor. The value of the expected insurance coverage, i, included in the price of the stock, was hypothesized to vary with the magnitude of losses

previously sustained by the security and with the security's classification either as an IPO or as a seasoned security. These hypotheses were supported empirically. Overall, the results of the paper suggest that auditors are viewed by investors as guarantors of financial statements, and in a sense, as guarantors of investments. Investors appear to be willing to pay a premium for the right to recover potential investment losses from auditors through litigation. These findings have important implications.[4]

A research study conducted by Jonathan Gruber in Dec, 2001, that provide a key question or understanding the determinants of health insurance coverage, as well as the broader impacts of tax reform, is the sensitivity of insurance decisions to tax subsidies. The findings in this paper suggest that this sensitivity is significant. In particular, we find that the firm's decision to offer insurance is sizeable affected by the tax price of insurance; the implied elasticity of firm offering with respect to taxes is -0.7. This confirms the conclusion from other recent work that employers are very sensitive to tax incentives in their decisions to offer insurance. we also find that taxes appear to exert little independent influence on worker take up decisions. This is consistent as well with other findings that worker take up of insurance is not price elastic.[5]

A research study conducted by Bradley Herring and Mark V. Pauly in 2001, the results of this study of a large sample of individual insurance purchasers the mid-to-late-90s are highly consistent with those exhibited in our earlier work using a smaller sample of purchasers the late-80s. Premiums are not very strongly related to risk, and the risk associated with differences in health status (other things equal) has no detectable relationship to premiums buyers actually paid-whatever it might do to the premiums some insurers quote. Somehow, high-risk individuals in the individual market who do end up buying insurance pay premiums not very different from those charged to average risks.[6]

A research paper is conducted by Jan J. Kerssens and Peter P. Groenewegen in 2005, this study examined preferences of per sons with social health insurance for 27 different hypothetical insurance schemes (scenarios) that differed across 12 characteristics. Respondents made discrete choices regarding four random pairs of scenarios. Response data are modeled within benefit (or satisfaction) functions that provide information on whether the given characteristics are important; the relative importance of characteristics and the rate at which individuals are willing to trade between characteristics.[7]

This study is written by Claus Steinle and Bernd Eggers in 1994, Numerous concepts and instruments of strategic plan- ning have been developed for the underlying interests of the industrial enter- prises, but not for insurance companies.[8]

A research is written by J. S. Dagpunar in 2000; the main advantages of the method described here are that it provides a continuous time solution with no necessity to discrete the state space. As a result, the method gives exact solutions, whereas previously implemented value iteration methods give approximate solutions, both from the discretisation of the state space, and the slow convergence for MDPs with large state spaces.[9]

A research paper is written by K. A. Smith, R. J. Willis, M. Brooks in 2000, this paper has discussed a case study from the insurance industry that demonstrates the benefits of data mining to the daily operation. The business problem is the optimal pricing of policies to find a balance between profitability and growth and retention. These often conflicting goals are achieved in this case study by considering the sub problems of customer retention classification and claim cost modeling.[10]

Methodology:

Two types of test are applied for observing the performance of Insurance sector over the years and other is apply for checking the consistency of the different variables in different years. In this study ANOVA is used for comparing the means of different variables from year 2001 to 2010. Applied the Least significance different test for checking the means of different years. We take profit after tax as depended variable and paid-up capital, no. of share, equity, profit before tax as independent variables. Another place we take dependent variable sales and paid-up capital, equity, no. of share, financial charges as a independent variable.

Empirical Results:

A histogram is one of the basic quality tools. It is used to graphically represent and summarize and show the distribution and variation of a process data set.
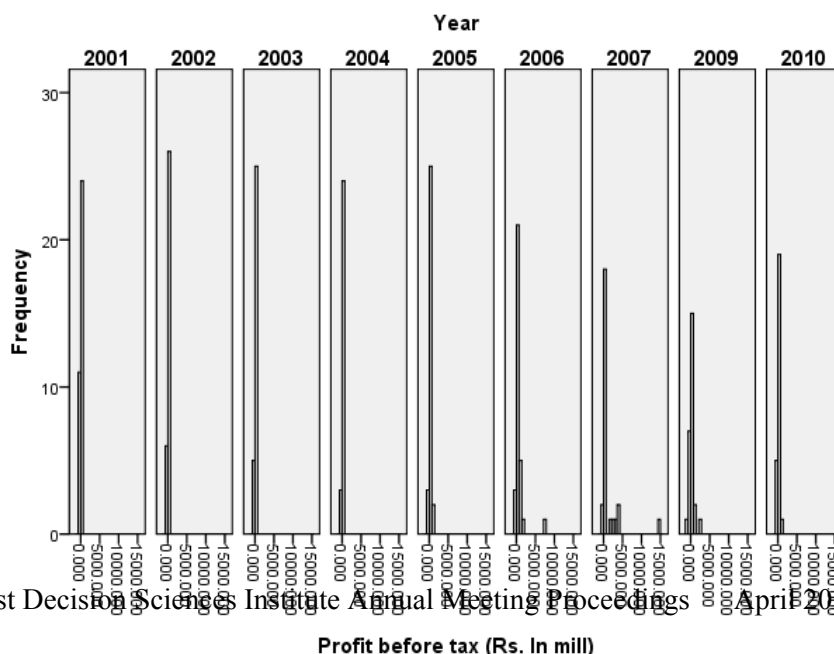
This graph shows that the insurance companies of Pakistan gain maximum profit before tax in year 2002 and year 2003 is on the second number. Unfortunately it started declining from 2005 to 2009 and in year 2009 it has the minimum mean value.
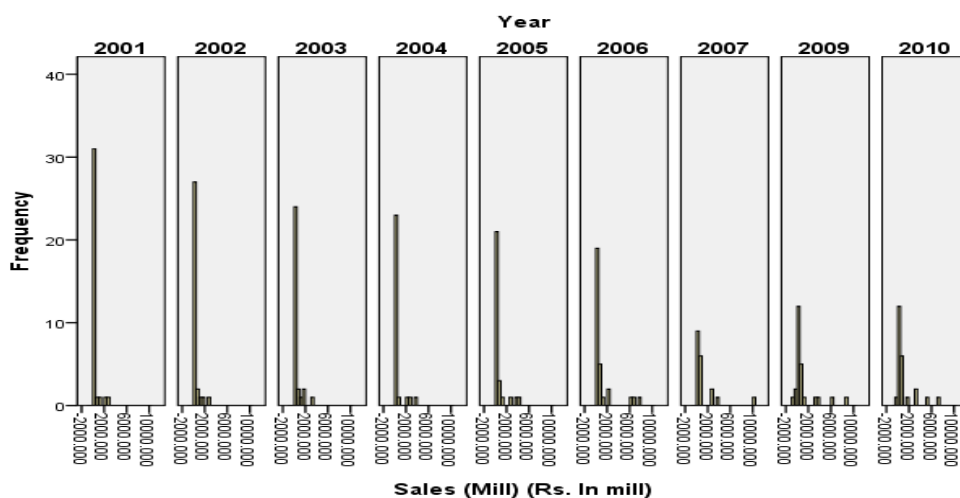

On the other hands, Sales graph is showing that, the companies Average Sales were maximum in year 2001 but after year 2001, it continuously start declining in every year till 2007 and then again sale increase gradually from 2009 to 2010. Sales graph is showing the minimum value in 2007.
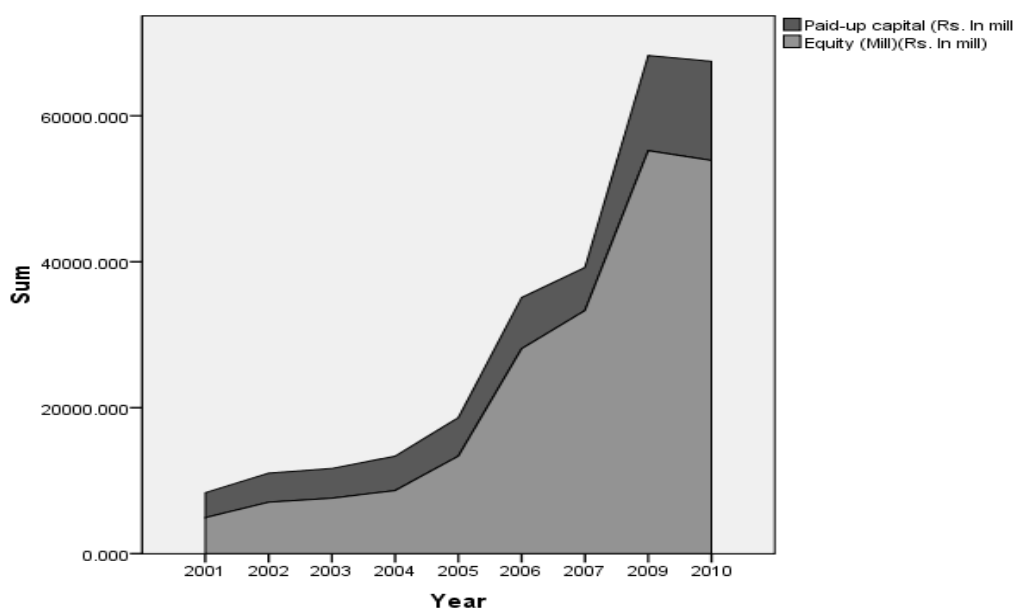
This line chart shows that the Paid-up capital is slightly increasing from year 2001 to year 2008 but year 2009 and year 2010 was declining period. And the line of equity is following the line of paid-up capital.

In 2001 the mean value of Total assets was nearly 5 million and year 2002 to year 2009 was rising period, suddenly in 2010 it rapidly decreased. As it is from year 2001 to year 2007 the Profit before tax and Profit after tax was increased but 2009-2010 was decreasing period.
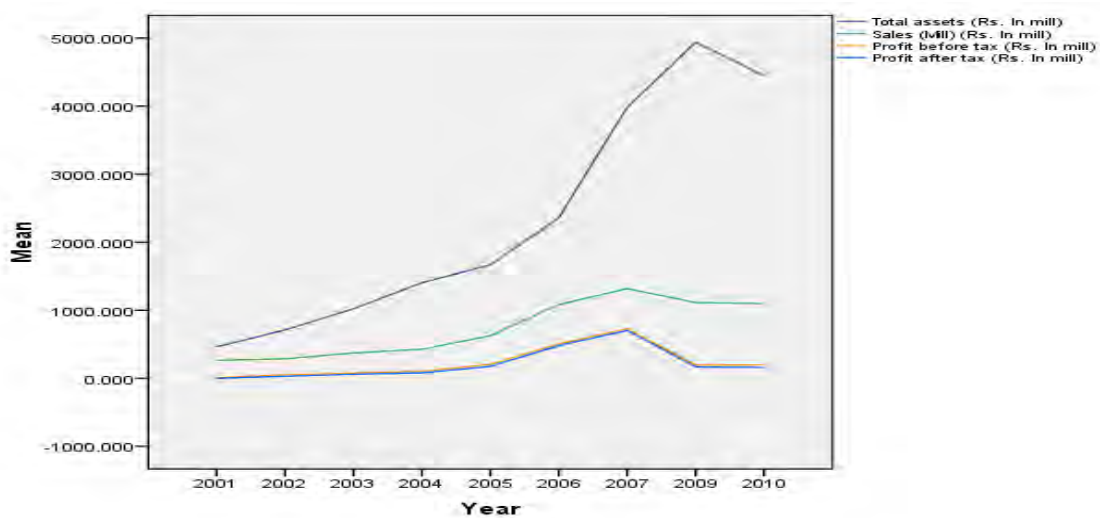
	Year	X bar	S.D	C.V
	2001	97.21	113.47	116.73
	2002	124.51	139.35	111.92
	2003	135.76	157.37	115.97
PAID-UP CAPITAL (Rs. In Mill)	**2004**	196.45	186.81	95.09
	2005	163.12	177.99	109.12
	2006	186.72	208.16	111.49
	2007	**307.93**	**250.9**	**81.48**
	2008	51.57	365.32	708.46
	2009	452.65	579.19	127.96
	2010	541.41	590.32	109.03
	Total	**2257.33**	**2768.88**	**1687.25**
	2001	10.71	12.75	119.08
	2002	13.79	15.25	110.6
	2003	15.21	17.38	114.29
	2004	21.99	20.51	93.24
NO. OF SHARE	**2005**	18.11	20.12	111.1

(Rs. In mill)	2006	20.82	23.73	113.98
	2007	**32.5**	**25.58**	**78.69**
	2008	5.16	18.01	349.35
	2009	4.48	57.15	1275.33
	2010	56.85	58.8	103.44
	Total	**199.62**	**269.28**	**2469.1**
EQUITY (Rs. In mill)	2001	141.11	175.59	124.44
	2002	220.32	303.09	137.57
	2003	253.49	377.61	148.96
	2004	360.43	376.09	104.35
	2005	361.39	614.67	170.09
	2006	739.14	1685.44	228.03
	2007	1148.79	2962.86	257.91
	2009	1904.13	3518.79	184.8
	2010	2177.2	3544.44	162.8
	Total	**7306**	**13558.58**	**1518.95**
TOTAL ASSETS (Rs. In Mill)	2001	460.04	798.6	173.59
	2002	710.35	1279.2	180.08
	2003	1021.92	1725.33	168.83
	2004	1579.88	2090.08	132.29
	2005	1261.83	2334.63	185.02
	2006	1861.71	3395.31	185.02
	2007	2608.75	5466.39	209.54
	2009	4259.41	6826.42	160.27
	2010	5559.12	8274.15	148.84
	Total	**19323.01**	**32190.11**	**1543.48**

As we know that Coefficient of Variation is used for checking the consistency; the table shows that **PAID-UP CAPITAL** was most consistent in 2007 because the C.V value is 18.48 which is minimum value as compare to other years. Same as **NO. OF SHARES** is also showing consistency in 2007 and **EQUITY** was consistent in 2004 as compared to other. **TOTAL ASSETS** also have similar results to **EQUITY**.

SALES (Rs. In mill)	2001	263.58	63.73	239.67
	2002	286.12	601.58	210.25
	2003	373.55	720.3	192.82
	2004	478.99	903.83	188.7
	2005	473.62	1129.35	238.45
	2006	854.89	2088.72	244.33
	2007	869.32	2364.32	273.56
	2009	959.34	2225.77	232.01
	2010	1012.34	1833.04	181.04
	Total	**5571.75**	**11930.64**	**2000.83**
PROFIT	2001	5.51	93.6	1697.5
	2002	50.88	98.75	194.08
	2003	75.38	116.14	154.08
	2004	117.27	141.27	121.04
	2005	153.41	293.6	191.38

BEFORE TAX	**2006**	399.01	1335.41	334.68
	2007	1136.55	2968.4	261.18
	2009	166.49	597.94	359.14
	2010	179.04	288.59	161.19
	Total	**2283.54**	**5933.7**	**3474.27**
PROFIT AFTER TAX	**2001**	-0.18	92.18	-52081.8
	2002	29.29	52.73	180.02
	2003	59.21	99.58	168.17
	2004	89.88	108.93	121.2
	2005	130.44	255.31	195.73
	2006	380.52	1329.4	349.37
	2007	1115.72	2975.19	266.66
	2009	143.37	568.16	396.3
	2010	144.75	258.25	178.41
	Total	**2093**	**5739.73**	**-50226**

SALES showing consistency in year 2010 and in 2010 the value of C.V is **181.04** which is minimum as compare to other. **PROFIT BEFORE TAX** was consistence in 2004. **PROFIT AFTER TAX** showing consistency in 2001.

ANOVA							
		Sum of Squares	df	Mean Square	F	Sig.	
Paid-up capital (Rs. In mill	Between Groups	6484528.190	9	720503.132	7.965	.000	
	Within Groups	24152085.227	267	90457.248			
	Total	30636613.417	276				
No. of Share (Rs. In mill)	Between Groups	73147.266	9	8127.474	9.156	.000	
	Within Groups	276059.421	311	887.651			
	Total	349206.687	320				
Equity (Mill)(Rs. In mill)	Between Groups	161000986.613	8	20125123.327	5.658	.000	
	Within Groups	857157124.965	241	3556668.568			
	Total	1018158111.577	249				
Total assets (Rs. In mill)	Between Groups	612213264.216	8	76526658.027	4.929	.000	
	Within Groups	3741780221.163	241	15526059.009			
	Total	4353993485.379	249				
Sales (Mill) (Rs. In mill)	Between Groups	37168130.701	8	4646016.338	2.158	.031	
	Within Groups	518864388.523	241	2152964.268			
	Total	556032519.224	249				
Profit before tax (Rs. In mill)	Between Groups	33786152.015	8	4223269.002	3.701	.000	
	Within Groups	288736585.525	253	1141251.326			
	Total	322522737.540	261				

Profit after tax (Rs. In mill)	Between Groups	33479554.586	8	4184944.323	3.691	.000
	Within Groups	286844889.336	253	1133774.266		
	Total	320324443.921	261			

Hypothesis:

Sales:

Ho: $\mu_{2001} = \mu_{2002} = \mu_{2003} = \mu_{2004} = \mu_{2005} = \mu_{2006} = \mu_{2007} = \mu_{2008} = \mu_{2009} = \mu_{2010}$

H1: At least one mean is significantly different

Profit after tax:

Ho: $\mu_{2001} = \mu_{2002} = \mu_{2003} = \mu_{2004} = \mu_{2005} = \mu_{2006} = \mu_{2007} = \mu_{2008} = \mu_{2009} = \mu_{2010}$

H1: At least one mean is significantly different

Well the p-value of Paid up capital is less than 0.05, so for this we will accept the alternative hypothesis and reject the null hypothesis. Sales, Equity, No. of share, Total assets, Profit before tax and Profit after tax have p-value which is less than 0.05 from 2001 to 2010 same as for Paid up capital.

We applied the (LSD) test for checking that which year's mean is significantly different from each other.

LSD

(I) Year	(J) Year	Mean Difference (I-J)	Std. Error	Sig.
2007	2001	210.728887[*]	75.522899	.006
	2002	183.424547[*]	77.110339	.018
	2003	172.234839[*]	78.322775	.029
	2009	-196.946366[*]	81.230169	.016
	2010	-255.135868[*]	82.082309	.002
2009	2002	380.370913[*]	79.409785	.000
	2003	369.181205[*]	80.587633	.000
	2004	330.263020[*]	82.640144	.000
	2005	341.761268[*]	76.966976	.000
	2006	276.003151[*]	79.981877	.001
	2007	196.946366[*]	81.230169	.016
2010	2001	465.864754[*]	78.757747	.000
	2002	438.560415[*]	80.281249	.000

	Year			
	2003	427.370707[*]	81.446495	.000
	2004	388.452521[*]	83.477891	.000
	2005	399.950770[*]	77.865785	.000
	2006	334.192653[*]	80.847175	.000
	2007	255.135868[*]	82.082309	.002

After applying LSD we observed that the mean value of from year 2001 to 2010 is significantly different.

Multiple regression analysis has applied; in ANOVA table the p-value tells us that the overall model is significant.

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	67603326.125	6	1.127E7	78.510	.000[a]
	Residual	34873673.381	243	143513.059		
	Total	102476999.507	249			
2	Regression	67482398.561	5	1.350E7	94.104	.000[b]
	Residual	34994600.946	244	143420.496		
	Total	102476999.507	249			

a. Predictors: (Constant), Sales (Mill) (Rs. In mill), Banks/Financial charges (Rs. In mill), No. of share (Rs. In mill), Total assets (Rs. In mill), Equity (Rs. In mill), Paid up capital (Rs. In mill).

b. Predictors: (Constant), Sales (Mill) (Rs. In mill), Banks/Financial charges (Rs. In mill), No. of Share (Rs. In mill), Total assets (Rs. In mill), Paid-up capital (Rs. In mill

c. Dependent Variable: Profit after tax (Rs. In mill).

Model		Non-standardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
	(Constant)	11.597	30.400		.381	.703
	Paid-up capital (Rs. In mill	-.771	.347	-.408	-2.218	.027
	No. of Share (Rs. In mill)	5.573	3.295	.303	1.691	.092
	Total assets (Rs. In mill)	-.045	.012	-.295	-3.760	.000
	Banks/Financial charges (Rs. In mill)	17.219	1.756	.400	9.806	.000

		.384	.028	.894	13.500	.000
Sales (Mill) (Rs. In mill)						
a. Dependent Variable: Profit after tax (Rs. In mill)						

Profit after tax is consider as depended variable and Paid up capital, Equity, Sales, Total Asset, No. of Share and (Bank) / Financial charges are explanatory variables and by the backward method we observed that Profit after tax is best described by Paid up capital, Sales, Total assets, No. of share and (Bank) / Financial charges.

Model can be written as:

PAT = β1 + β2 Paid up capital + β3 No. of share + β4 Total assets + β5 Bank/Financial charges + β6 Sales

PAT = 11.597 + -0.771 Paid up capital + 5.573 No. of share + -0.45 Total assets + 17.219 Financial charges + 0.384 Sales

Model		Non-standardized Coefficients		Standardized Coefficients		
		B	**Std. Error**	**Beta**	**t**	**Sig.**
	(Constant)	65.460	59.261		1.105	.270
	Equity (Mill)(Rs. In mill)	.219	.071	.296	3.088	.002
	Total assets (Rs. In mill)	.218	.029	.609	7.563	.000
	Banks/Financial charges (Rs. In mill)	-12.090	5.117	-.121	-2.363	.019

The depended variable is Sales while Paid up capital, Equity, No. of share, Total assets and Bank / Financial charges are consider as independent variables again backward method is applied and it indicates that Equity , Total assets and Bank / Financial charges is best describe in the total sales.

Model can be written as:

Sales = β1 + β2 Equity + β3 Total assets + β4 (Bank) / Financial charges

Sales = 65.460 + 0.219 Equity + 0.218 Total assets + (-12.090) Bank / Financial charges

It means that unit change in Bank/financial charges will decrease the Sales by 12 points. On the other hand unit change in Equity and Total Assets has positive effect on Sales by 0.129 and 0.218 points respectively.

Conclusion:

The purpose of this paper is to discuss Financial Changes and profitability of Insurance Sector of Pakistan (2001 to 2010). From results of this study we conclude that paid-up-capital and no. of shares both were consistent in 2007, equity and total assets both were consistent in 2004, sales showing consistency in year 2010, profit before tax was consistence in 2004

while profit after tax is showing consistency in 2001. Unit change in PUC and Total Assets will decrease the PAT by 0.771 and 0.45 points respectively. On the other hand number of shares, financial charges and sales has positive impact on PAT.

Overall, it can be seen that profit of insurance companies are getting higher and higher day by day in Pakistan only due to that the persons are now much aware of insurance and about its benefits which is largest factor of insurance companies profit because more insurance means more shareholders which is directly related to sales and Profit.

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Analysis and Impression of Energy Consumption on GDP: An Pragmatic Evidence From Five Continents of Two Decades

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Abstract

Consumption is generally the major GDP. Many persons review the economic performance of their state primarily in terms of ingesting level and dynamics. The focal point of this study is to determine effect between energy consumption and GDP. Previous studies show no conformity or no relationship of gross domestic product with personal consumption expenditure though this study shows strong relation of GDP with energy consumption. SPSS and Microsoft Excel, both have utilized to accomplish this research and generate results as per objectives. Furthermore, many tests and statistical techniques have applied to validate the results. Coefficient of variance has applied to corroborate most consistent consumption years. ANOVA has tested to compare the regions and identify the mean differences and to further authenticate the results LSD has concerned. Finally, regression model has instigated to verify positive or negative relation between GDP and energy consumption.

Keywords
GDP, ANOVA, LSD, OLS, Regions, Consumption

Introduction
First, consumption may have estranged according to the permanence of the purchased objects. In this element, a wide classification separates durable merchandise (as cars and T.V. sets) from non-durable commodities (as food) and from services (as restaurant expenses). These three classes often illustrate different paths of expansion.
Second, consumption has divided according to the requirements it satisfies. A frequently used cataloging identifies ten sections of expenditure:
1. Food
2. Heating and energy
3. Health
4. Housing

5.   Clothing and foot wear
6.   Communication
7.   House furniture and appliances
8.   Culture and schooling
9.   Transport
10.   Entertainment

People in diverse position in respect to income have thoroughly diverse structures of consumption. The wealthy spend more for each section in supreme terms, but they spend a lower proportion in income for food and other fundamental needs.

The rich have equally higher levels of consumption and savings. In distinguished product markets, the rich can typically buy better goods than poor ones. This occurs also because they lean to use diverse decision-making rules. In other terms, consumption depends on societal groups and their behaviors, over and above their proneness to marketing.

Third, one should differentiate "consumption" as utilization of goods and services from "consumption expenditure" as trade operations. For durable commodities, this difference may be applicable, since they have used for long periods.

In this lode, the rich have a much wider growing package of durable goods bought over time, so they take pleasure in a very extensively higher degree of need contentment, whereas the poor can experience deficiencies even in the most indispensable goods.

Fourth, only recently produced merchandise enter into the meaning of consumption, whereas the purchase of, say, an old home is not measured consumption in macroeconomics, given that it was already calculated in the GDP of the time in which it was assembled. For the user, both old and new goods offer some need fulfillment.

Energy consumption is apparently elevated in countries where below 5 percent of the population lives lower than the poverty line than it is in states where the majority of people live in scarcity four times greater. For instance, Americans make up below 5 percent of the world's population yet use 26 percent of the world's energy.

Simultaneously, the United States and Canada account for 50 percent of power consumed by the world's wealthiest mechanized countries; Europe, 33 percent. When there is a talk about energy consumption, then it is about the supply of energy that produces our power: coal, oil, natural gas and alternatives like wind, solar, hydropower and bio-fuels. (Brazil, for example, produces electricity by flaming sugarcane waste.) Presently, the world's population devours 15 terawatts of power from a blend of these energy sources.

Communally, developing countries utilize 30 percent of the earth's energy, but with anticipated population and fiscal growth in those marketplaces, energy demands have expected to climb 95 percent. In general, global consumption has expected to increase 50 percent from 2005 to 2030, mainly in the fossil-fuel zone.

At least part of the increase in worldwide consumption is the result of population enlargement. The U.N. projects that world population will boost 41 percent by 2050 to 8.9 billion people, by almost all of this expansion in developing countries.

This flow in human figures intimidates to offset any savings in resource use from improved competence, over and above any gains in falling per-capita consumption. Even though the standard American eats 20 percent fewer meat in 2050 than in 2000, entire U.S. meat captivating will be 5 million tons larger in 2050 due to population growth.

A rising share of the worldwide consumer group now subsists in developing countries. China and India unaided claim above 20 percent of the global sum—with a shared consumer group of 362

million, surplus in all of Western Europe. (Nevertheless, the average Chinese or Indian member consumes significantly below the standard European.)

Developing countries also have the maximum potential to enlarge the lines of consumers. China and India's large consumer class comprises only 16 percent of the region's inhabitants, while in Europe the number is 89 percent. Certainly, in most developing countries the consumer set accounts for below half of the population—signifying substantial room to grow.

While the consumer class flourishes, great disparities linger. The 12 percent of the world's population that survives in North America and Western Europe reports for 60 percent of classified consumption expenses, whilst the one-third existing in South Asia and sub-Saharan Africa reports for merely 3.2 percent.

The consumer civilization has strong magnetism and carries with it many financial benefits, and it would be unjust to argue that those who come later should not share the advantages gained by an earlier cohort of consumers. Undeniably, lack of concentration to the needs of the poorest can effect in greater uncertainty for the prosperous and in augmented spending on self-protective measures. The necessity to spend billions of dollars on wars, boundary security, and mediation debatably has linked to ignorance for the world's imperative social and environmental tribulations.

Regardless of increasing utilization in the developing world, manufacturing countries remain in charge for the immensity of the world's reserve consumption—over and above the associated global environmental squalor. Yet there is little proof that the consumption locomotive is braking, still in the United States, where the majority of people are adequately supplied with the goods and services required to lead a decorous life.

Individuals often face personal expenses related with serious altitudes of consumption: the monetary debt; the time and strain related with working to shore up high consumption; the time required to hygienic, advance, store, or otherwise keep possessions; and the ways in which consumption restores time with family and friends.

Belligerent pursuit of a throng consumption society also associates with a decline in health gauges in many countries, as corpulence, offense, and other social ills persist to surge.

Consumer advocates, economists, policymakers, and ecologist have developed inventive options for meeting people's requirements while dampening the ecological and social costs associated with bunch consumption. As well as serving individuals locate the balance between surplus and insufficient consumption, they stress placing more importance on publicly provided commodities and services, on services instead of goods, on goods with elevated levels of recycled content, and on authentic option for consumers.

Governments can redesign economic inducements and regulations to make sure that businesses offer reasonable options that congregate consumers' requirements. They also have a responsibility for limiting consumption glut, chiefly by eliminating incentives to consume—from subsidized energy to endorsement of low-density expansion.

Objectives

The objectives of this research are as follows:

1. To identify most highest GDP and energy consumption regionally
2. To corroborate most consistent consumption years
3. To test out if there are any mean differences regionally by taking all variables dependent one by one
4. To check positive or negative effect of consumption on GDP

Literature review

Fölster and Henrekson (1999) argued that there is no conformity concerning the direction of causality between economic growth and consumption expenditure. Kweka and Morrissey (1998) who worked on the impact of economic growth on consumption expenditure using Granger causality test with time series data of Tanzania, reported no verification of impact of GDP on consumption expenditure of Tanzania.

Chioma employed regression analysis to examine the casual relationship between gross domestic product and personal consumption expenditure of Nigeria using facts and figures from 1994 - 2007. A non insignificant value of 0.0514 was found as a slope coefficient demonstrating that an increase in gross domestic product has no significant effect on the personal consumption expenditure of Nigeria.

Goudie and Ladd (1999) described there are indications that here is perhaps a negative effect in the reverse direction, to lower growth from high inequality. Countries with extreme inequality of land and consumption, may then be less successful at decreasing poverty, because they change a given growth rate into slower poverty reduction. However, it is not easy to generalize the effect of a change in the pattern of distribution upon growth.

Taylor and Weiserbs (1972) originate a positive collision of advertising on consumption. Therefore, the informative function of advertising shows to be strong enough to motivate potential consumer to boost their consumption expenditure.

Heckman (1974) shows that if consumption and leisure are alternatives for each other, consumption also amplifies over the life cycle. This clarifies a positive association between consumption and current income in a life-cycle model. Browning, Deaton and Irish (1985) and Macurdy (1981, 1983, 1985) further detailed this theory and experienced its empirical validity.

Preferences exhibit relative consumption effects if a person's satisfaction with their own consumption appears to depend upon how much others are consuming. Samuelson examines a model of an evolutionary environment in which Nature optimally builds relative consumption effects into preferences in order to compensate for incomplete environmental information. (Samuelson, 2004)

Research on environmentally significant consumption, defined as consumption of materials or energy in such as way as they are less available for future use or have harmful effects biophysical and human systems (Stern, 1997)

Per capita energy consumption has been one of the most commonly used metrics of consumption for a number of reasons. It is easy to measure (relative to materials consumption), it has easily convertible units (joules, calories, watts, etc.), and each unit of energy consumption is environ

mentally meaningful (in terms of pollutants or greenhouse gas emissions). Yet understanding of national-level per capita consumption of any resource offers limited insight for policy action, since variations within populations can be great, and they are significantly influenced by household characteristics. (Curran and de Sherbinin, 2004)

Research in California found that energy consumption for a one person house hold was only half that of four and five person households (Lutzenhiser, 1997). Spangenberg and Lorek (2002) have identified three household consumption "clusters" that together account for nearly 70% of an economy's material extraction and energy consumption, and more than 90% of land use.
A closer look at the traded commodities show that India's export and import baskets are highly diversified compared to other members of the region. India's sale of production is higher and it has better capabilities in the production of certain products than other countries of the region can offer. (Mohanty 2003)

Islam and Clarke (2002) integrate cost-benefit analysis of economic development in a emergent economy in manipulating the adjusted GDP, expressed as the cost-benefit (CB)-adjusted GDP. They wind up that GDP can be used as a sign of social welfare if the GDP approximation is commenced within a cost-benefit analysis framework.

Hicks (1940) and Pigou (1962) initiated using real national income/GDP as a measure of social welfare. Whilst Pigou recog nised that welfare was more than just the sum of economic activities that GDP measures and thus was not a barometer "or index of total welfare" (Pigou, 1962, p. 12) The application of welfare economic tools to development economics ensures that "development is not only a matter of long run growth" (Sen, 1999, p. 45). Rather, it can take into account the opportunities and entitlements of people to ensure that their human development can occur both in times of high and low economic growth (Sen, 1984).

Methodology
This research has accomplished with analysis on secondary data. Data has been collected from financial websites. Energy consumption and GDP of all countries has brought together and then further accumulate them regionally. Two types of software have utilized to make this research comprehensive, Statistical Software for Social Sciences and Microsoft Excel. Furthermore, Graphical representation has prepared for more concise review of data. Coefficient of variances has applied to corroborate the most consistent years. Moreover, many statistical tests like ANOVA, LSD and Regression has applied to validate the results.

Limitations
Some consumption variables were in Barrels and some in Tons. Moreover, data of consumption commodities of some countries were not given for few years.


Empirical Results

Prior to moving toward testing of hypothesis and inferential study of data, there is graphical representation for a precise review of data. Following is the Line chart for GDP including all regions:

Chart No. 1: GDP (in million Dollars) of all Regions
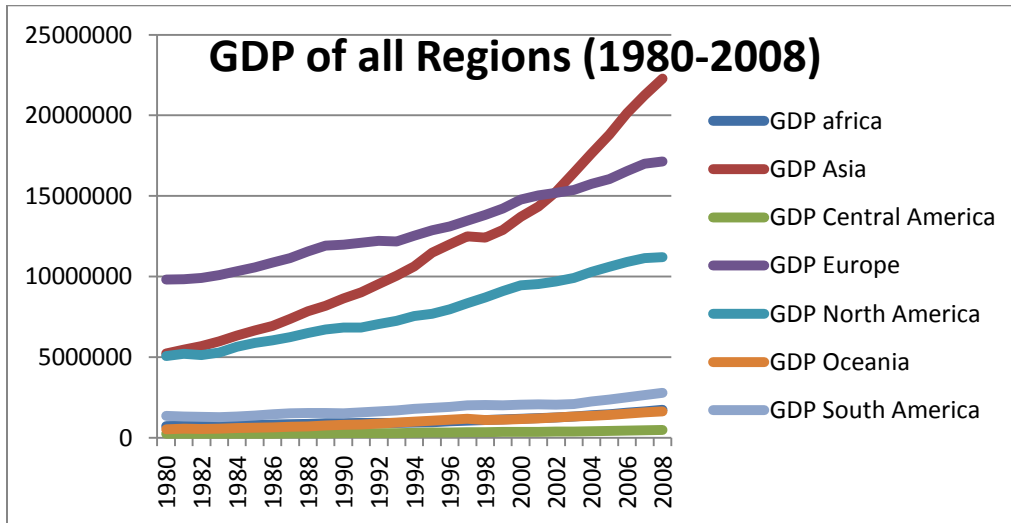
The above chart no. 1 shows the GDP of all Africa, Asia, Europe, Oceania and Central, North and South America from 1980-2008. The line of this chart shows that Central America had least GDP as compared to other regions. GDP of Africa and Oceania was overlapping and had approximately same growth. GDP of South America had slightly greater growth as compared to Oceania, Africa and Central America. However, GDP growths of North America, Asia and Europe were far above the ground. Asia had some appreciated GDP growth as it slashes the GDP of Europe after year 2000.

Chart No. 2: Total Average Consumption of Regions
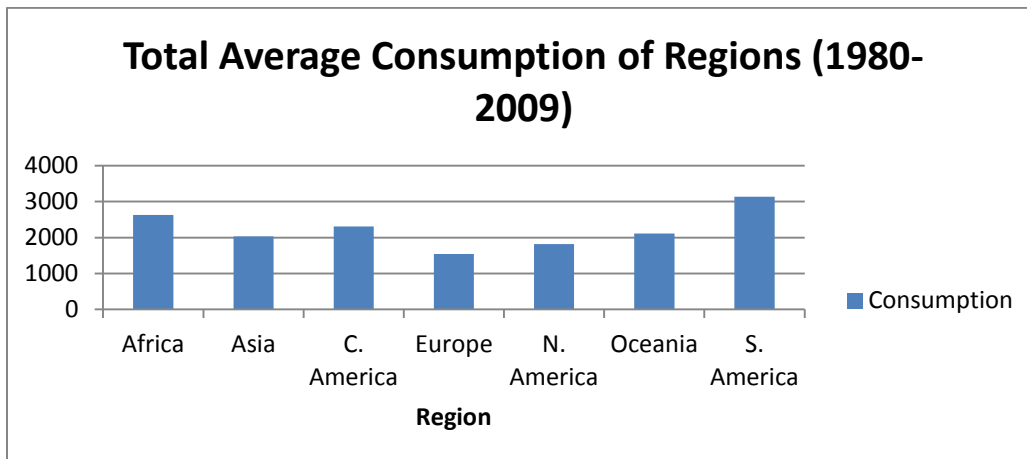
Note: C. America= Central America and the Caribbean, N. America= North America, S. America= South America

The Chart no. 2 shows the total average consumption of all regions for two decades. The commodities of consumption includes Coal, Crude oil, Distillate fuel, Dry natural gas, hydroelectric power, Jet Fuel, Kerosene, Liquefied Petroleum gases, Motor Gasoline, Nuclear electrical power, Geothermal, Solar, Wind, Wood waste, Other Petroleum and Residual fuel. The bars of this chart show that South America had leading consumption and Europe had nominal energy usage as compared to other regions which are made known in table above.

Measuring Consistency with Co-efficient of Variance

Co-efficient of variance has applied to be acquainted with consistent years regarding consumption of energy. C.V. can be evaluated by using following formula:

Table No. 1: Consistency measure for consumption

Years	Coal	C. Oil	D. Fuel	D. N. G.	H. P.	J. Fuel	Kerosene	L. Gases	M. G.	N. E. P.	O. E.	O. P.	R. Fuel
1990	181.97	70.192	138.22	102.38	55.07	110.24	147.7074	130.8921	138.47	99.806	132.9	164.21	136.01
1991	179.95	68.519	138.59	98.889	54.25	111.25	143.5954	137.4131	137.17	102.23	128.02	168.4	135.92
1992	180	65.873	138.74	102.86	57	167.76	74.02174	155.8792	137.25	107.13	121.33	169.1	135.22
1993	178.76	65.873	139.59	97.945	56.34	171.96	71.05263	150	138.41	147.25	120.54	170.07	135.88
1994	178.57	66.154	140.02	96.575	55.51	116.29	65.0519	162.1951	138.92	103.95	116.03	170.58	135.76
1995	178.67	66.667	140.83	95.333	55.15	175.72	61.29032	161.4104	139.16	144.29	107.34	163.77	135.02
1996	177.21	66.912	216.63	94.805	54.9	175.38	63.86364	162.1083	141.8	142.46	104.72	154.52	135.06
1997	176.68	66.912	216.65	92.208	54.13	173.6	58.41463	153.7906	141.79	138.74	99.457	161.88	135.1
1998	175	64.493	217.04	92.208	53.39	168.94	57.55479	149.0532	140.62	138.59	96.429	165.84	135.12
1999	177.38	65.493	216.88	91.772	52.63	173.05	58.08019	157.084	140.15	140.73	94.964	166.97	135.42
2000	178.73	65.972	217.33	89.157	51.86	161.54	76.71033	149.0066	216.13	140.65	92.763	160.34	135.21
2001	181	65.972	217.57	85.714	51.25	158.07	76.22283	146.3821	216.52	139.79	90.295	164.09	135.15
2002	180.54	66.438	217.82	84.659	49	134.54	81.1617	145.1404	135.91	140.54	91.589	212.48	135.1
2003	182.28	69.595	218.33	85.714	47.9	134.55	78.02198	143.7649	136.08	141.23	92.096	168.54	135.76
2004	181.62	68.182	218.16	85.484	48.63	134.79	83.83518	149.5971	135	139.96	95.039	162.23	135.42
2005	179.84	68.59	217.87	82.653	48.41	134.82	83.02752	143.3333	135.69	138.74	96.751	159.6	135.21
2006	134.94	81.022	153.08	98.802	67.81	108.27	87.13592	132.5737	109.46	156.51	108.78	154.76	123.89

Note: C.Oil= Crude Oil, D.Fuel= Distillate Fuel, D.N.G. = Dry Natural Gas, H.P. = Hydroelectric Power, J. Fuel= Jet Fuel, L. Gases= Liquefied Petroleum, M.G. = Motor Gasoline, N.E.P. =Nuclear Electric Power, O.E. = Other Electric Power, O.P. =Other Petroleum, R. Fuel= Residual Fuel

To evaluate the above results, firstly S.D. and Means of all consumption variables has determined and then C.V. for all years has calculated. Table no. 1 shows C.V. from year 1990-2006. Results show that Distillate Fuel and Nuclear Electric Power were consistent in year 1990,

Crude Oil and Kerosene in year 1998 and Coal, Jet Fuel, Motor Gasoline and Residual Fuel shows consistency in 2006. Other consumption variables with consistent years can be reviewed in the table.

ANOVA

ANOVA has applied to analyze the variances and to compare the means for all regions. The hypothesis for this test can be as follows:

H_0: Africa=Asia=Central America and the Caribbean= Europe= North America= Oceania= South America

H_1: At Least one Region has different Means

ANOVA for GDP

Taking GDP as dependent variable following is the table for ANOVA:

Table no. 2: ANOVA for GDP					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3894071735936400.00	4.00	973517933984100.00	125.27	0.00
Within Groups	1095746888800420.00	141.00	7771254530499.48		
Total	4989818624736830.00	145.00			

Table no. 2 shows highly significant value that is 0.00, which is less than 0.05. Hence, it can be concluded for this test that H_1 can be accepted. It means there is at least one region that have different mean, in case of GDP. However, to hit upon the different means, LSD has applied.

LSD for GDP

LSD is Post Hoc test to determine the difference in means. Following is the LSD table for GDP:

Table no. 3: LSD test for GDP				
Dependent Variable: GDP				
(I) Regions	(J) Regions	Mean Difference (I-J)	Std. Error	Sig.
Africa	Asia	-10102394.33	725958.75	0.00
	Europe	-11959964.89	732085.10	0.00
	North America	-6800593.39	732085.10	0.00
Asia	Central America	10832768.73	725958.75	0.00

	& the Caribbean			
	Europe	-1857570.56	725958.75	0.01
	North America	3301800.94	725958.75	0.00
Central America & the Caribbean	Europe	-12690339.29	732085.10	0.00
	North America	-7530967.79	732085.10	0.00
Europe	North America	5159371.50	732085.10	0.00

Table no. 3 shows that Africa has significantly different mean while contrasting with Asia, Europe and North America. Similarly, Asia has different mean values with Central America, Europe and North America. Central America has different means with Europe and North America. Moreover, Mean difference value of Europe with North America is also specified.

ANOVA for Consumption

Table no. 4: ANOVA for Consumption						
Dependent variable (Consumption)		Sum of Squares	df	Mean Square	F	Sig.
Coal	Between Groups	5874213.83	6.00	979035.64	20.36	0.00
	Within Groups	9664579.65	201.00	48082.49		
	Total	15538793.48	207.00			
Crude Oil	Between Groups	6422727.87	6.00	1070454.65	40.91	0.00
	Within Groups	5259117.94	201.00	26164.77		
	Total	11681845.82	207.00			
Distillate Fuel	Between Groups	10202815.83	6.00	1700469.30	35.94	0.00
	Within Groups	7380933.29	156.00	47313.67		
	Total	17583749.12	162.00			
Dry Natural Gas	Between Groups	2607305.37	6.00	434550.89	16.36	0.00
	Within Groups	5338494.83	201.00	26559.68		
	Total	7945800.20	207.00			
Hydroelectric Power	Between Groups	11372314.59	6.00	1895385.77	171.29	0.00
	Within Groups	2013948.65	182.00	11065.65		
	Total	13386263.25	188.00			
Jet Fuel	Between Groups	4107449.40	6.00	684574.90	19.90	0.00
	Within Groups	5365616.96	156.00	34394.98		
	Total	9473066.35	162.00			
Kerosene	Between Groups	1145792.97	6.00	190965.49	7.10	0.00
	Within Groups	4198650.20	156.00	26914.42		
	Total	5344443.17	162.00			

Liquefied Petroleum Gases	Between Groups	2113109.35	6.00	352184.89	10.14	0.00
	Within Groups	5417663.04	156.00	34728.61		
	Total	7530772.40	162.00			
Motor Gasoline	Between Groups	12126525.34	6.00	2021087.56	125.85	0.00
	Within Groups	2505199.00	156.00	16058.97		
	Total	14631724.34	162.00			
Nuclear Electric Power	Between Groups	9995300.44	6.00	1665883.41	67.05	0.00
	Within Groups	4521831.33	182.00	24845.23		
	Total	14517131.77	188.00			
Other Electric Power	Between Groups	114860.88	6.00	19143.48	28.97	0.00
	Within Groups	120279.97	182.00	660.88		
	Total	235140.85	188.00			
Other Petroleum	Between Groups	5831954.81	6.00	971992.47	44.69	0.00
	Within Groups	3392788.34	156.00	21748.64		
	Total	9224743.15	162.00			
Residual Fuel	Between Groups	6358005.96	6.00	1059667.66	2106.41	0.00
	Within Groups	78478.80	156.00	503.07		
	Total	6436484.76	162.00			

Above table no. 4 shows ANOVA table presuming energy consumption as dependent variable. The results of this test show highly significant values for all variables. All consumption variables are less than 0.05. Consequently, it can be said that at least one region has different mean from others. For further proceedings of result LSD has concerned.

LSD for Consumption

Since the LSD table for consumption was so extensive, therefore it has segregated into three parts.

Table no. 5: LSD for Coal, Crude Oil, Distillate Fuel, Dry Natural Gas and Hydroelectric Power					
Dependent Variable	(I) Country codes	(J) Country codes	Mean Difference (I-J)	Std. Error	Sig.
Coal	Africa	Asia	171.00	56.62	0.00
		Central America	-289.55	56.62	0.00
		Europe	171.80	56.62	0.00
		North America	-182.63	56.62	0.00
		South America	142.73	57.62	0.01
	Asia	Central America	-460.55	56.62	0.00
		North America	-353.63	56.62	0.00
		Oceania	-138.93	56.62	0.02
	Central America	Europe	461.35	56.62	0.00
		Oceania	321.62	56.62	0.00

		South America	432.28	57.62	0.00
	Europe	North America	-354.43	56.62	0.00
		Oceania	-139.73	56.62	0.01
		Africa	182.63	56.62	0.00
		Asia	353.63	56.62	0.00
		Europe	354.43	56.62	0.00
	North America	Oceania	214.70	56.62	0.00
		South America	325.36	57.62	0.00
Crude oil	Africa	Central America	-508.39	41.77	0.00
	Central America	Asia	490.42	41.77	0.00
		Europe	494.19	41.77	0.00
		North America	489.39	41.77	0.00
		Oceania	508.82	41.77	0.00
		South America	507.29	42.50	0.00
Distillate Fuel	Africa	Asia	569.97	64.20	0.00
		Central America	448.82	65.58	0.00
		Europe	647.76	64.20	0.00
		North America	649.25	63.59	0.00
		South America	271.36	65.58	0.00
	Asia	Oceania	-497.54	62.79	0.00
		South America	-298.61	64.20	0.00
	Central America	Europe	198.94	64.20	0.00
		North America	200.42	63.59	0.00
		Oceania	-376.40	64.20	0.00
		South America	-177.47	65.58	0.01
	Europe	Oceania	-575.33	62.79	0.00
		South America	-376.40	64.20	0.00
	North America	South America	-377.89	63.59	0.00
Dry Natural Gas	Africa	Central America	-269.16	42.08	0.00
	Asia	Central America	-328.93	42.08	0.00
		Oceania	-111.59	42.08	0.01
	Central America	Europe	317.07	42.08	0.00
		North America	318.97	42.08	0.00
		Oceania	217.34	42.08	0.00
		South America	340.71	42.82	0.00
	Europe	Oceania	-99.73	42.08	0.02
	North America	Oceania	-101.63	42.08	0.02
	Oceania	South America	123.37	42.82	0.00
Hydroelectric Power	Africa	Asia	-379.16	28.63	0.00
		Europe	-544.88	28.63	0.00
		North America	-543.53	28.63	0.00

		South America	-340.42	28.63	0.00
	Asia	Central America	428.69	28.63	0.00
		Europe	-165.72	28.63	0.00
		North America	-164.37	28.63	0.00
		Oceania	395.65	28.63	0.00
	Central America	Europe	-594.41	28.63	0.00
		North America	-593.06	28.63	0.00
		South America	-389.95	28.63	0.00
	Europe	Oceania	561.37	28.63	0.00
		South America	204.46	28.63	0.00
	North America	Oceania	560.02	28.63	0.00
		South America	203.11	28.63	0.00
	Oceania	South America	-356.91	28.63	0.00

Table above (table no. 5) includes LSD test for energy consumption variable. In case of, Coal consumption Africa has mean difference values comparing with Asia, Central America, Europe, North America and South America. Other comparison has done and showed in the table with significant different means. Assuming Crude Oil consumption as dependent variable, Africa has significant different means with Central America and Central America has difference with Asia, Europe, North America, Oceania and South America. Analysis of Distillate Fuel, Dry Natural Gas and Hydroelectric Power consumption has also mentioned in the table with mean difference between different regions.

Table no. 6: LSD for Jet Fuel, Kerosene, Liquefied Petroleum Gases and Motor Gasoline					
Dependent Variable	(I) Country codes	(J) Country codes	Mean Difference (I-J)	Std. Error	Sig.
Jet Fuel	Africa	Asia	-387.07	54.74	0.00
		North America	125.77	54.21	0.02
	Asia	Central America	469.30	54.74	0.00
		Europe	305.29	53.54	0.00
		North America	512.84	53.00	0.00
		Oceania	391.41	53.54	0.00
		South America	407.45	54.74	0.00
	Central America	Europe	-164.00	54.74	0.00
	Europe	North America	207.55	53.00	0.00
	North America	Oceania	-121.43	53.00	0.02
Kerosene	Africa	Asia	-183.59	48.42	0.00
	Asia	Central America	279.82	48.42	0.00
		Europe	188.18	47.36	0.00
		North America	219.23	46.88	0.00
		Oceania	152.36	47.36	0.00

		South America	244.09	48.42	0.00
	Central America	Oceania	-127.46	48.42	0.01
Liquefied Petroleum Gases	Africa	Central America	123.27	56.19	0.03
		North America	168.28	54.48	0.00
		South America	-204.30	56.19	0.00
	Asia	Central America	121.60	55.01	0.03
		North America	166.62	53.26	0.00
		South America	-205.96	55.01	0.00
	Central America	Europe	-178.89	55.01	0.00
		South America	-327.57	56.19	0.00
	Europe	North America	223.90	53.26	0.00
		Oceania	129.13	53.80	0.02
		South America	-148.68	55.01	0.01
	North America	South America	-372.58	54.48	0.00
Motor Gasoline	Africa	Asia	476.64	37.40	0.00
		Central America	344.24	38.21	0.00
		Europe	529.53	37.40	0.00
		North America	524.02	37.04	0.00
		South America	-181.91	38.21	0.00
	Asia	Central America	-132.40	37.40	0.00
		Oceania	-473.88	36.58	0.00
		South America	-658.55	37.40	0.00
	Central America	Europe	185.30	37.40	0.00
		North America	179.78	37.04	0.00
		Oceania	-341.48	37.40	0.00
		South America	-526.14	38.21	0.00
	Europe	Oceania	-526.78	36.58	0.00
		South America	-711.44	37.40	0.00
	North America	Oceania	-521.26	36.21	0.00
		South America	-705.92	37.04	0.00
	Oceania	South America	-184.67	37.40	0.00

Resuming LSD test for consumption variables, first one is about Jet Fuel consumption in table no. 6. Results show that Africa has mean difference with Asia and North America, Asia with Europe, Oceania and Whole America, Central America with Europe, Europe with North America and last but not least North America with Oceania. Furthermore, Results of testing Kerosene consumption shows that Africa and Asia have different means, Asia has different mean as compared to Europe, Oceania and entire America. Central America is also different from

Oceania. Moreover, Liquefied petroleum gases and Motor Gasoline consumption has also analyzed and there regional differences with mean are also given in the table.

Table no. 7: LSD for Nuclear Electric Power, Other Electric Power, Other Petroleum and Residual Fuel					
Dependent Variable	(I) Country codes	(J) Country codes	Mean Difference (I-J)	Std. Error	Sig.
Nuclear Electric Power	Africa	Asia	-324.70	42.90	0.00
		Europe	-265.53	42.90	0.00
		North America	-634.62	42.90	0.00
		Africa	324.70	42.90	0.00
	Asia	Central America	333.47	42.90	0.00
		North America	-309.93	42.90	0.00
		Oceania	333.47	42.90	0.00
		South America	323.50	42.90	0.00
	Central America	Europe	-274.30	42.90	0.00
		North America	-643.39	42.90	0.00
	Europe	North America	-369.09	42.90	0.00
		Oceania	274.30	42.90	0.00
		South America	264.34	42.90	0.00
	North America	Oceania	643.39	42.90	0.00
		South America	633.43	42.90	0.00
Other Electric Power	Africa	Asia	-25.03	7.00	0.00
		Europe	-50.30	7.00	0.00
		North America	-67.72	7.00	0.00
	Asia	Central America	22.99	7.00	0.00
		Europe	-25.28	7.00	0.00
		North America	-42.70	7.00	0.00
		Oceania	19.84	7.00	0.01
		South America	16.85	7.00	0.02
	Central America	Europe	-48.26	7.00	0.00
		North America	-65.68	7.00	0.00
	Europe	North America	-17.42	7.00	0.01
		Oceania	45.11	7.00	0.00
		South America	42.13	7.00	0.00
	North America	Oceania	62.53	7.00	0.00
		South America	59.55	7.00	0.00
Other Petroleum	Africa	Asia	164.12	43.53	0.00
		Central America	118.54	44.47	0.01
		Europe	230.46	43.53	0.00
		North America	230.11	43.11	0.00
		South America	-366.95	44.47	0.00

		Africa	-164.12	43.53	0.00
	Asia	Oceania	-88.90	42.57	0.04
		South America	-531.08	43.53	0.00
	Central America	Europe	111.91	43.53	0.01
		North America	111.57	43.11	0.01
		South America	-485.50	44.47	0.00
	Europe	Oceania	-155.23	42.57	0.00
		South America	-597.41	43.53	0.00
	North America	Oceania	-154.88	42.14	0.00
	Oceania	South America	-442.18	43.53	0.00
Residual Fuel	Africa	Asia	466.13	6.62	0.00
		Central America	115.09	6.76	0.00
		Europe	467.30	6.62	0.00
		North America	468.23	6.56	0.00
		Oceania	316.97	6.62	0.00
		South America	23.49	6.76	0.00
		Africa	-466.13	6.62	0.00
	Asia	Central America	-351.04	6.62	0.00
		Oceania	-149.16	6.47	0.00
		South America	-442.64	6.62	0.00
	Central America	Europe	352.21	6.62	0.00
		North America	353.15	6.56	0.00
		Oceania	201.88	6.62	0.00
		South America	-91.60	6.76	0.00
	Europe	Oceania	-150.33	6.47	0.00
		South America	-443.81	6.62	0.00
	North America	Oceania	-151.26	6.41	0.00
		South America	-444.75	6.56	0.00
	Oceania	South America	-293.48	6.62	0.00

At this instant, there is last table (Table no. 7) of LSD applied to energy consumption. It starts with nuclear electric power as dependent variable. Its result shows that Africa has significantly different mean values as compared with Asia, Europe and North America. Furthermore, Asia has mean difference with Oceania and entire America. Central America is different from Europe and North America, Europe with North America, South America and Oceania and lastly North America with Oceania and North America. Additionally, other electric power, other petroleum and residual oil are also scrutinize and there outcomes are evidently revealed in the table with p-values, S.E. and Mean different values.

Regression Analysis

Multiple Linear regression has manipulated ensure positive and negative effect between GDP and energy consumption.

Table no. 8: Coefficient of determination for Regression Model

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.960(a)	.922	.912	1688476.43775

a Predictors: (Constant), consumption(Residual Fuel), consumption(Liquefied Petroleum Gases), consumption(Crude Oil), consumption(Jet Fuel), consumption(Kerosene), consumption(Dry Natural Gas) , consumption(Coal), consumption(Other Petroleum), consumption(Nuclear Electric Power), consumption(Geothermal, Solar, Wind, and Wood Waste), consumption(Hydroelectric Power), consumption(Distillate Fuel), consumption(Motor Gasoline)

Table no. 8 shows the value of coefficient of determination which is 0.922. It means the model is 92% satisfactory and up to standard. Now there is ANOVA for this model and hypothesis can be as follows:

$H_0: \beta_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = \beta_9 = \beta_{10} = \beta_{11} = \beta_{12} = \beta_{13} = 0$

$H_1: \beta_0 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq \beta_8 \neq \beta_9 \neq \beta_{10} \neq \beta_{11} \neq \beta_{12} \neq \beta_{13} \neq 0$

Table no. 9: ANOVA for Regression Model

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3298149865262857.000	13	253703835789450.600	88.989	.000(a)
	Residual	279393362720310.900	98	2850952680819.500		
	Total	3577543227983168.000	111			

a. Predictors: (Constant), consumption(Residual Fuel), consumption(Liquefied Petroleum Gases), consumption(Crude Oil), consumption(Jet Fuel), consumption(Kerosene), consumption(Dry Natural Gas) , consumption(Coal), consumption(Other Petroleum), consumption(Nuclear Electric Power), consumption(Geothermal, Solar, Wind, and Wood Waste), consumption(Hydroelectric Power), consumption(Distillate Fuel), consumption(Motor Gasoline)
b. Dependent Variable: GDP

Table no. 9 demonstrates that the value for this test is 0.00 which is highly significant and less than the standard value of 0.05. It implies that Null Hypothesis has rejected and alternative hypothesis has accepted.

Table no, 10: Coefficients for Regression Model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4407776.200	1369750.046		3.218	.002
	consumption(Coal)	-3643.665	652.280	-.217	-5.586	.000

consumption(Crude Oil)	500.755	1016.683	.023	.493	.623
consumption(Distillate Fuel)	6429.041	7663.954	.324	.839	.404
consumption(Dry Natural Gas)	-2816.412	2126.902	-.072	-1.324	.189
consumption(Hydroelectric Power)	14919.035	1992.349	.754	7.488	.000
consumption(Jet Fuel)	2773.795	797.033	.140	3.480	.001
consumption(Kerosene)	-3221.139	956.900	-.117	-3.366	.001
consumption(Liquefied Petroleum Gases)	1562.412	898.312	.064	1.739	.085
consumption(Motor Gasoline)	-16428.445	12828.040	-.620	-1.281	.203
consumption(Nuclear Electric Power)	-4247.209	738.119	-.238	-5.754	.000
consumption(Geothermal, Solar, Wind, and Wood Waste)	103.760	6815.914	.001	.015	.988
consumption(Other Petroleum)	4278.880	5122.405	.101	.835	.406
consumption(Residual Fuel)	-1153.557	5095.716	-.041	-.226	.821

a. Dependent Variable: GDP

Regression coefficients have shown in table no. 10, the last table of this study. Model has designed by presuming GDP as dependent variable and energy consumption commodities as independent variables. The OLS model for regression is as follows:

GDP= β_0 + β_1 (Coal) + β_2 (Crude Oil) + β_3 (Distillate Fuel) + β_4 (Dry Natural Gas) + β_5 (Hydroelectric Power) + β_6 (Jet Fuel) + β_7 (Kerosene) + β_8 (Liquefied Petroleum Gases) + β_9 (Motor Gasoline) + β_{10} (Nuclear Electric Power) + β_{11} (Other Electric Power) + β_{12} (Other Petroleum) + β_{13} (Residual Fuel)

By putting values from table no. 10, a new model can be formulated which has shown below:

GDP= 4407776.200 - 3643.665 (Coal) + 500.755 (Crude Oil) + 6429.041 (Distillate Fuel) - 2816.412 (Dry Natural Gas) + 14919.035 (Hydroelectric Power) + 2773.795 (Jet Fuel) - 3221.139 (Kerosene) + 1562.412 (Liquefied Petroleum Gases) - 16428.445 (Motor Gasoline) - 4247.209 (Nuclear Electric Power) + 103.760 (Other Electric Power) + 4278.880 (Other Petroleum) - 1153.557 (Residual Fuel)

Above model shows that increase in one unit of coal consumption can decrease GDP by 3643.665. Crude Oil, Distillate Fuel, Jet Fuel, Liquefied petroleum gas, geothermal, wind, Solar, wood waste and other petroleum consumption has positive effect on GDP. Additionally, Hydroelectric Power is most crucial factor effecting GDP positively, as increase of one unit in hydroelectric consumption can increase GDP by 14919.035. Nevertheless, Motor Gasoline has most significant negative effect on GDP, as increasing in one unit can decrease GDP by

16428.445. Dry Natural Gas, Kerosene, Motor Gasoline, Nuclear electric power and Residual Fuel are also negatively affecting components.

Conclusion

It is concluded that consumption is generally the largest GDP element and this study ensures it. There are many types of consumption though the focus of study is on energy consumption. However, previous studies show no conformity or no relationship of gross domestic product with personal consumption expenditure. The study substantiates that Central America has least GDP as compared to other regions and Asia has the highest one. South America had leading consumption and Europe had nominal energy usage as compared to other regions.

Coal, Jet Fuel, Motor Gasoline and Residual Fuel shows consistency in year 2006. Moreover, Analysis of variances shows different mean while comparing regions presuming all variables dependent one by one. Furthermore, Hydroelectric Power consumption has most negative and Motor Gasoline consumption has most negative impact on gross domestic product.

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A FORCE-FIELD PERSPECTIVE ON DISSENT BEHAVIOR: THE INTERACTION BETWEEN EMPLOYEE NEGATIVE PERCEPTION AND GROUP POSITIVE CLIMATE

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ABSTRACT

Despite the development of previous literature on employee dissent, little is known about the employee's inner state when deciding to express dissent. Drawing on force-field theory, this study tries to explain the psychological mechanism of employee dissent. The theoretical model of this study proposes that employee dissent is motivated by four internal driving forces: organizational risk perception, organizational decline perception, psychological contract violation, and relative deprivation. Moreover, contextual factors and the psychological safety climate strengthen the effects of the positive four internal driving forces and employee dissent.

Keywords: Employee dissent, Force-field Theory, psychological safety climate.

INTRODUCTION

Dissent is viewed as a negative expression but it is also a critical phenomenon in organizations. Dissent may be broadly defined as expressing disagreement or contradictory opinions about one's organizational practices and policies [45]. In addition, the expression of dissent, which entails not merely voicing discontent, but also an effort by individuals in the workplace to protest and/or to change the organizational status quo [27].

Research indicated that dissent could facilitate and enhance decision quality [17-18; 35]. Van Dyne, Cummings, and Parks (1995) viewed employee dissent as challenging extra-role behavior [97]. Employee dissent against the consensus of the group and organization has a

constructive function as groupthink [45]. Hence, employee dissent may generate positive outcomes in terms of long-term organizational development. Moreover, highly ethically motivated dissenters will desire to prevent improper policies and illegitimate practices in order to protect an organization's well-being [27; 84].

However, flawed policy may not refer to ethical issues; it could concern personnel matters, such as unfair distribution and mistreatment [48]. Researchers point out that employee dissent is not only concerned with organization benefits [18; 35; 82; 84; 90], but also involves personal gain [14; 23; 79; 93; 95]. Hence, dissent could be viewed as a reflection of employees' needs and expectations. When employees' expectations and needs cannot be satisfied, they may raise dissent [28; 32; 45].

Over the past decade, researchers have focused on identifying individual antecedents to dissent, such as demographic variables [49], self-efficacy [72], competence, and loyalty [18], ethical ideology [27], and felt obligation [58; 84]. However, these factors are insufficient for employees to express dissent. The antecedent factors of employee dissent may include individual personality, psychological factors, which were caused by trigger events, and contextual factors. Therefore, the interacting effects between personal factors and contextual factors on employee dissent need to be further explored.

draws on force-field theory [56], this paper explores the psychological mechanisms of employee dissent and proposes a theoretical model (Figure 1). We argue that employee dissent is caused by four psychological factors -- organizational risk perception, organizational decline perception, psychological contract violation, and relative deprivation. Furthermore, the relationships between these psychological factors and employee dissent will be moderated by a contextual factor ― psychological safety climate.
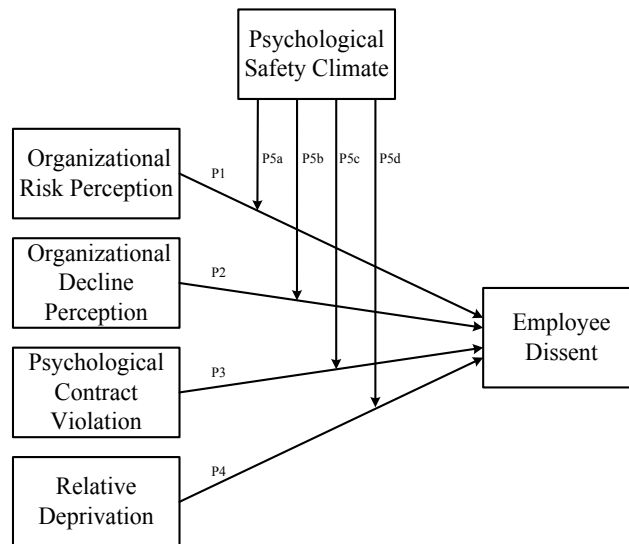
Figure 1 Theoretical Model

THEORETICAL DEVELOPMENT

Overview of Force-field Theory

Lewin (1939) developed force-field theory and argued that the forces within and between environment and individual are major determinants to individual behavior in a given time [56]. It can be expressed simply by the formula: B = F (P, E), human behavior is a function of both the person and the environment. Again, he further explained that a field is the life space and psychological space, which contain the person and his/her psychological environment [57].

According to Lewin's conceptualization, the life space is a place where a variety of energies are distributed and the constellation of these energies influence individual behavior. Forces can stem from a person (so called internal forces) and from the context in which an individual perceives (so call external forces). Moreover, force is a vector that characterizes direction and magnitude. Forces have different influences on directions and characteristics. Forces that promote an individual to act and approach a goal, have positive valence; forces which hinder an individual's actions and prevent the pursuit of a goal, have negative valence. These various forces together form a resultant force. Individuals may change their behaviors, when they are driven by a resultant force to pursue their goals. On the contrary, the resultant force with a negative direction acts as a barrier to the individual's progress toward their goal.

Life space can be viewed as a "tension system" [54]. That is, a system, which is a quasi-equilibrium process [106] is said to be in a state of tension whenever a need exists.

McGrath (1976) suggested that the tension is an imbalance between need and response [62]. Tension does not refer merely to an anxiety state, but rather to the preparation and excited state of an act, which could provide individual energies in pursuit of the goal [85]. Needs may motivate people to achieve his/her goal. Once the goal has been achieved, there is a lessening of the tension and a re-establishment of equilibrium. Hence the concept of tension is equal to needs; the release of tension may be viewed as the satisfaction of needs [54]. Therefore, we argue that employee dissent is motivated by tension, which derives from the employees' negative perceptions when their expectations and needs are unsatisfied.

Model Formulation

According to Lewin's (1939) force-field theory, we simultaneously integrate internal and external forces into our model to deepen the understanding of the psychological process of dissent behavior [56].

The content of dissent, inherently an opposite position [27; 34; 75; 91; 102], usually includes explicit disagreement and confrontation with one's supervisor [29], might cause conflict with one's supervisor [16], damage relationships with others [59], entail a greater degree of personal risk [68], and might have other costs [105]. Hence, most employees are less likely to raise dissent unless they cannot tolerate something. In other words, there might be a lack of motivators, or the magnitude of restraining forces are greater than the driving forces, both of which result from internal and external forces in one's life space.

Early investigations suggested that employee dissent is positively associated with discontent [21; 28; 32; 36; 45; 105; 109], which is a subjective perception and results from incongruence between one's expectations and gains, such as improper organizational policies and practices [27; 84], poor organizational performance [21; 81], organizational decline [10], unjust treatment, or inadequate compensation [7; 25; 45]. We conclude that the factors involved are organizational risk perception, organizational decline perception, psychological contract violation, and relative deprivation. They are all negative perceptions that may be viewed as internal driving forces, which could disrupt the equilibrium of an individual's tension system and motivate an individual to release the tension in order to recover from an unstable state.

Employee dissent often involves potential personal risk and costs because expressing disagreement or contradictory opinions could be perceived as negative feedback [5], and the dissenter may be labeled as a troublemaker by supervisors and/or peers [74]. Moreover, within a bureaucratic or centralized organizational structure, top management may feel threatened or challenged by individuals who dislike an established policy or action within the organization [51]. Supervisors could ignore the message and even rate dissenters at a lower performance level in order to suppress dissent in the workplace. Milliken, Morrison and Hewlin (2003) suggested that employees may withhold information about potential problems

or issues because they fear negative consequences [65]. Therefore, context and climate provide important cues for employees to evaluate the costs of dissent behavior and restrain their behavior.

On the contrary, employees working in an organization that provides a personally non-threatening and supportive climate should be more likely to take the risk of proposing a different ideal [4]. According to Edmondson's (1999) perspective, group psychological safety goes beyond perceiving and experiencing high levels of interpersonal trust; it refers to a work climate characterized by mutual respect, thus people are comfortable expressing their different opinions [19]. This climate has been found to affect perceived context favorably, which increases employees' willingness to speak up. Hence, we consider the favorable context as a kind of external driving force, which can promote employees to raise their divergent views.

We propose that employee dissent results from the combination of internal and external driving forces. The theoretical model depicted in figure 1 shows the relationships between the four negative perceptions and employee dissent, and how these perceptions are predicted to interact with positive group climate.

Employee Dissent

Graham (1986) defined dissent as employees in the workplace striving to protest and/or to change the organizational status quo because of their conscientious objection to current policy or practices that might violate laws or ethics [27]. Dooley and Fryxell (1999) defined dissent as when employees openly express contradictory opinions about organizational practices, or express disagreement with the strategic decision-making process [18]. Dissenters are often highly ethically motivated and want to contribute to the organization's wellbeing [84]. Moreover, the concept of dissent is extended by Kassing (1998) and is defined as "Expressing disagreement or contradictory opinions about organizational practices, policies and operations [46]." Kassing (1998) suggests that employees do not necessarily express dissent because of an ethical motivation, but rather in order to protect their rights and wellbeing. Employees might raise objections when they perceive their interests are being threatened [46]. This paper is in line with Kissing's original conceptualization of dissent.

Employee Negative Perception and Dissent

Force-field theory is viewed as a psychological mechanism that explains how multiple psychological factors contribute to individual behavior [55]. We draw on its rationale to theorize that employee dissent could be jointly explained by four negative perceptions; organizational risk perception, organizational decline perception, psychological contract violation, and relative deprivation, which are precipitated by particular events in

organizations.

Organizational risk perception

According to Kruglanski et al. (2012), the magnitude of a potential driving force derives from the combination of goal importance [52]and the pool of available physical and mental energies [38; 107; 110] that are generally applicable in pursuit of the goal [8; 43-44; 67]. Survival, development, and profitability are important goals of organizations that drive employees to invest [73]. An employee will strive to prevent that which he/she perceives as threatening to the organization.

Risk perception is a subjective judgment [88]. Risk perception is defined as a "combination of uncertainly and seriousness of outcome" [6]. It can be categorized as five types: financial, performance, physical, psychological, and social risk [39]. Scott (2004) drew on the socio-technical model to categorize perceived risk as strategic risks, organizational risks, and policy risks [83].

Rimal and Real (2003) have suggested that risk perception may be thought of as a self-protective behavior [76]. Slovic et al. (1982) notes that risk perception evokes a feeling of dread and elicits a visceral feeling of terror [88]. Fear-arousing stimuli cause an individual to eliminate a response pattern that might produce aversive consequences and establish response patterns that might prevent the occurrence of objectionable events [78]. The higher the perceived risk, the more the individual will want the risk reduced [88]. Therefore, risk perception might predict employee dissent.

Risk perception acts as a motivational factor and an internal driving force, and those with a high risk perception can be expected to engage in more extensive preventive behaviors because of their risk-induced excessive fear [12]. Employee dissent is just like an alarm that warns people of the dangers in a situation. When an employee faces improper policies or practices that might violate laws or ethics, he/she will perceive organizational risks and expect potentially serious consequences. In order to protect the organization's reputation or others from harm, and to reduce their own visceral feeling of fear, the employee will express disagreement [96] and prevent the action from being carried out [58; 104]. Hence, as mentioned above, organizational risk perception is expected to be able to affect employee dissent.

Proposition 1: Organizational risk perception is positively related to employee dissent.

Organizational decline perception

Organizations go through four stages in their life-cycles; start-up, growth, maturity, and decline [73]. Generally, organizations invest more resources in business growth, which is

viewed as the organization's normal state [103], while organizational decline, which is actually important for organizations and individuals, is often neglected.

Organizational decline has been variously described in terms of size dimensions due to a reduction in the total market or a decrease in the organization's ability to compete with others in the market [103]. Decreasing organizational resources are a phenomenon of organizational decline [9]. Zammuto, Cameron and Kim [108] regard environmental deterioration as organizational decline; they specifically refer to, a reduction of market shares, a finance deficit, and a decrease in product demand [66]. Weitzel and Jonsson (1989) define organizations entering a state of decline as their failure to anticipate, recognize, avoid, neutralize, or adapt to external or internal pressures that threaten the organization's long-term survival [101].

Several factors could contribute to decline, such as fierce competition, obsolete technology, and rigid bureaucratic hierarchies. Levine (1978) indicated that the causes of organizational decline can be categorized into four types: organizational atrophy, vulnerability, loss off legitimacy, and environmental entropy [53]. Weitzel and Jonsson (1989) suggest that organizational decline can begin in the early stages of an organization's existence or occur at any other time during its development [101]. However, the matter of critical importance to an organization is recognizing and preventing the symptoms of decline early enough to intervene and turn around the organization. Hence, organizations should frequently monitor and respond appropriately to present and future conditions.

Employee dissent could play an important role within the declining organizations because dissent could motivate the organization to pay more attention to their problems. Employees have in-depth knowledge and experience with organizational processes and practices, which make their input valuable in deciding which problem should be selected for resolution efforts [24]. Furthermore, employees become aware of insufficiencies in their organizations and at times feel the need to speak out about how their organizations function [89]. Hence, when employees perceive a decrease in their organization's performance they may urge the organization to change its existing practices.

Employee dissent can be considered a form of employee resistance [47]. Silvia (2006) indicates that threats lead directly to disagreements [87]. Employees resist in order to defend their autonomy, and to restore their freedom. Organizational decline derives from rigid bureaucratic hierarchies in which employees' competences and autonomy could be restricted. When employees experience a discrepancy between the actual and expected state of affairs, the may express a standpoint that differs from the organizational status quo. Furthermore, employees will stop objectionable practices, when they perceive existing policies or practices that are bureaucratic, passive, and insensitive [103], and which may harm their organizations

and restrain their freedom [37]. Therefore, employee dissent helps the employees feel less constrained by their workplace.

Hirschman (1970) noted that when employees encounter organizational decline, they will respond with an appropriate action, such as expressing their opinion to change the status quo [36]. Shahinpoor and Matt (2007) suggest that employees concerned about organizational development will propose novel opinions that differ from the norm [84]. Employee dissent usually occurs in situations where the employee encounters serious issues in need of change [21-22; 28; 32; 36; 45; 105; 109]. Thus, perception organization decline is expected to affect employee dissent.

Proposition 2: Perception organization decline is positively related to employee dissent.

Psychological contract violation

A contract is a commitment between employer and employee in writing, which is based on equality and a relationship of reciprocal exchange between two parties. The contract specifies mutual obligations, reduces uncertain risks of employers and employees, and guides both parties on expected behavior and conduct. However, the specific content of a formal contract merely maintains a limited employment relationship, and some mutual obligations are for the most part implicit and may not frequently be discussed. These implicit commitments need to be maintained by a psychological contract [50; 61].

Rousseau (1989) defined the psychological contract as " the individual's beliefs about mutual obligations, in the context of a relationship between employer and employee [79]." The psychological contract is an unwritten agreement between the employer and employee. The psychological contract assumes an exchange relationship with expectations and obligations for both parties. The psychological contract is a subjective [33] individual perception of the obligations of an employee towards the organization and the obligations of an employer towards the employee [3]. Weick (1979) noted that the psychological contract is an implied contract, which involves shared norms of behavior and expectations for the future [100]. Especially, employees will behave in a way that can meet the expectations of the organization, and they believe that they will get rewarded for that behavior in the future. When an organization fulfills its commitment, employees put more effort into their organization. Conversely, if the organization's actions are inconsistent with the belief in a reciprocal obligation, then a perception of violation will be generated [71; 86; 94].

Rousseau [79] described that the reaction of a contract violation is "an intense reaction of outrage, shock, resentment, and anger." Morrison and Robinson (1997) further explained that violation consists of cognition and emotion, the former reflects a mental calculation of what one has received relative to what one was promised; the latter conveys a strong emotional

experience [69]. When employees subjectively perceive that the organization has failed to fulfill and violated its promises of the psychological contract, the employee will experience feelings of betrayal and deep psychological distress [79].

Previous researchers have examined that when employees encounter a contract violation, their satisfaction with the job can decline [99]. Robinson and Rousseau (1994) have pointed out that a psychological contract violation results from an imbalance in the exchange relationship between the employee and the organization. Hence, violations decrease trust [77]. Employees initially hold high expectations and behave with good conduct, meeting their organization's standards. When the psychological contract is violated, the responses are likely to be more intense. Kassing (1997) noted that employees could propose dissent when they lose rights or benefits. Turnley and Feldman [95] have examined that contract violation motivates employees to express their opinions. Because employees feel betrayed, they protest to their supervisor or management in order to maintain favorable job conditions [21; 79] and to mitigate psychological distress [11]. Therefore, contract violation is expected to be able to affect employee dissent.

Proposition 3: Psychological contract violation is positively related to employee dissent.

Relative deprivation

Another issue in terms of an employee's gains is fair distribution. Adams (1965) , equity theory, asserted that employees seek to maintain equity between their inputs and outcomes and the perceived inputs and outcomes of others [2]. Employees will experience distress if they perceive themselves as under-rewarded [92]. Thereby, a sense of unfairness is relative to other references. Relative deprivation [13; 80; 98] occurs when an individual compares himself to others, and fraternal deprivation occurs when an individual compares his own reference group to other groups. Crosby (1976) stated that the term relative deprivation has two meanings [13]. First, it refers to the proposition that one's sense of grievance is not a monotonic function of one's actual situation in an absolute sense. Second, the concept of relative deprivation is used to refer to one type of anger emotion one feels when making a negatively discrepant comparison.

Previous research has suggested that relative deprivation is associated with the inequity of a social system [15], resource distribution and social movement [1; 26; 30-31; 63], and the 1960s Urban Riots [64]. Recently, researchers have suggested that relative deprivation is positively related to a lack of satisfaction in the workplace, which may cause discontent and distress [60]. Relative deprivation may facilitate employee expressions of dissent and cause employees to protest against their organizations.

Proposition 4: Relative deprivation is positively related to employee dissent.

Group Positive Climate and Dissent

Many studies support the notation that organizational climate or group climate play an important role in organizational behaviors. Organizational climate refers to shared perceptions among members within work units or organizations regarding the unit's formal and informal policies, practices, events, and procedures [40]. Organizational climates help employees understand what behaviors are expected and rewarded [111], and may affect their attitude, beliefs, decision making, and outcomes [41]. The present paper proposes that group member perceptions of psychological safety could influence the positive relationship between employee dissent and its antecedents.

Group psychological safety climate

According to Edmondson (1999), group psychological safety is defined as a shared belief that the group is safe for interpersonal risk taking [19]. Group psychological safety involves and simultaneously goes beyond interpersonal trust; it describes a group climate characterized by interpersonal trust and mutual respect in which people are comfortable being themselves. In these climates group members feel supported and respected by their leaders and peers, and members are willing to speak up honestly without risking embarrassment, rejection or punishment [42]. Hence, this climate might be viewed as an external driving force. Edmonson, Bohmer and Pisano (2001) found that if group members perceive a favorable work environment and a climate of psychological safety, they are more likely to ask questions and to speak up about concerns [20]. Thus, we expect that the positive relationship between the four factors and employee dissent will be strongly affected by group psychological safety.

Proposition 5a: Group psychological safety climate moderates the positive individual-level relationship between perceived organizational risk and employee dissent, creating a stronger relationship when a group's psychological safety climate is relatively high.

Proposition 5b: Group psychological safety climate moderates the positive individual-level relationship between perceived organizational decline and employee dissent, creating a stronger relationship when a group's psychological safety climate is relatively high.

Proposition 5c: Group psychological safety climate moderates the positive individual-level relationship between a psychological contract violation and employee dissent, creating a stronger relationship when a group's psychological safety climate is relatively high.

Proposition 5d: Group psychological safety climate moderates the positive individual-level relationship between relative deprivation and employee dissent, creating a stronger relationship when a group's psychological safety climate is relatively high.

CONCLUSION

The present study formulates a model whereby individual, contextual, and social forces influence employee dissent. The paper makes three main contributions. First, it increases our knowledge of employee dissent by shedding light on the joint influences of internal, external, and social forces on this kind of behavior. Second, it reveals that employee dissent is caused by work-related issues as well as by unfairness and mistreatment. Third, the paper shows how force-field theory can help to create a richer model to get a more complete understanding of the determinants of employee dissent.

Practically, the current study is not to encourage employees to express their dissent, but to help managers understand the causes of dissent behavior. Rather than being merely a verbal vent, employee dissent is the effort by individuals in the workplace to stimulate change in a problem-focused manner. If managers deem a dissenter a troublemaker, it may deepen the discontent of the dissenter, and lead to the deterioration of the employment relationship, reduce the trust between employees and managers, and even cause confrontation and conflict, which could be reported to audiences outside the organization. Furthermore, organizational leaders can create a communication environment that favors the open expression of employee's opinions, in which even the proposition of different ideas may not feel uncomfortable. O'Leary [70] suggested that the dissenter should not be repressed, but instead should be treated with tolerance and respect. Employees who are valued in organizations are more likely to provide valuable input [58]. By means of understanding the inner process of employee dissent, managers may convert dissenters' ideas, competences, and potentials into resources for organizational improvement.

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Conception to Harmonization: Barriers in International Competitiveness Research

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INTRODUCTION

The first problem is one of conceptual controversy. The idea that political jurisdictions compete amongst themselves is seen by some as a misrepresentation of competitiveness, though this idea is generally accepted by regional economists as well as site selection consultants who make their living from this competition. Even granting the existence of jurisdictional competitiveness, there is controversy about the appropriateness of measuring it quantitatively, using a variety of social, economic and business indicators. The genesis of and problems in two such indexes, the global World Competitiveness Report and the US Development Report Card for the States are outlined.

The second problem relates to the inclusion of sub-national units in these competitiveness comparisons. This has been done most extensively in the State indexes in the United States, though some of the jurisdictions compared in the World Competitiveness Report are technically regions rather than countries. A group of researchers attempted an extensive cross-national sub-national comparison by assembling statistics that compared Atlantic Canada as a purported single jurisdiction with the 50 US States and with 48 countries and regions around the world. The idea was to use a methodology derived from other parts of the world to try to get a better feel for the Region's competitive strengths and weaknesses. During the exercise, it became clear that both the choice and use of indicators create problems in and by themselves. Methodologically, the attempt to provide quantitative benchmarks is fraught with peril.

The third problem concerns the statistics used in these attempts to measure jurisdictional competitiveness. The general layout of the studies mentioned above is based on converting statistical indicators to rank order by jurisdiction and then rolling up these rank orders into some kind of super-rank order. There are problems with the differing definitions that countries, states and provinces use for their statistics, different levels of difficulty in acquiring the data and differing time-series that are used.

Regardless of these problems, numerical comparisons of competitiveness continue to be popular and politically influential, as one can see in the UN reports that have consistently ranked Canada as the best place to live. People like comparisons, even if the data and the methodologies used in compiling them leave much to be desired.

PROBLEM 1: ACCEPTING AND MEASURING JURISDICTIONAL COMPETITIVENESS

The term jurisdictional competitiveness implies that national and sub-national jurisdictions engage in a form of competition that results in improvements to the incomes and lives of those who

inhabit these jurisdictions. Jurisdictions may be compared in terms of their "competitiveness" by looking at their patterns of policy that affect the natural competitiveness of the firms or parts of firms that are resident in their territories. Only rarely do jurisdictions use policy changes to compete directly. Instead, jurisdictions may be seen as hosts, whose policy patterns are evaluated by firms either as part of locational decisions, financial investment decisions or even decisions by local entrepreneurs concerning start-ups.

Elements of competition between jurisdictions are most pronounced in the area of industrial attraction, or "smokestack chasing". Jurisdictions are encouraged in these cases to engage in a kind of bidding for the siting of a new facility by a geographically-dispersed firm. The competition is characteristically over the provision of a start-up subsidy, but often the deciding factors in the competition can be outcomes from other policies, such as labor regulations, training availability, etc. These investment acquisitions by a successful jurisdiction may not have a significant effect on overall employment or income, but they do act as signals to many others that the jurisdiction may be a place from which to compete more effectively.

Even though jurisdictions are monopolies for all intents and purposes, there are limits set to the patterns of policies they can devise. In this, they are not much different from corporate monopolies, which have a wide, but never unlimited, range of prices and behaviors available to them. Jurisdictions are constrained by tradition, by the interconnectedness of many policies and by public acceptance. As the people of Russia and Eastern Europe have found out, it takes many years to make serious changes to a pattern of government intervention.

International competitiveness indexes

A number of ideas went into the creation of statistical indexes of the competitiveness of national jurisdictions. The first is the gradual development of a statistical base that covers at least the major economies of the world. The effort to develop this base began after World War II with the creation of GATT, the World Bank and the OECD. GATT required information on the policies affecting the movement of goods, services and finance around the world if it was to pursue the goal of freer trade. The World Bank was concerned with the financial health and the development prospects of countries and needed some consistent information to accomplish its tasks. The OECD, coming out of the Marshall Plan, needed to monitor the progress of the war-torn European economies first, and then later became concerned with the economic underpinnings of the developed economies. The interaction of these bodies with their member countries helped to move them along the path of standardized methods of economic measurement.

Methodologically, the picture is more complex. The quantitative approach to competitiveness owes something to the attempts of Robert Solow and Edward Denison in the United States to measure the factors that could account for US economic growth (Denison, 1962a). Growth accounting established that technology, heretofore rather overlooked in economic growth, played a critical role. Further, Denison showed that growth accounting left a residual after the major factors of human and natural resource productivity were measured, which gave the extra push to the American economy. At an international level, he showed it to be possible to replicate his growth accounting work for other countries and then to compare the results (Denison, 1962b).

A final addition to the set of ideas that went into the genesis of competitiveness indexes was the work of country risk analysts in the 1970s. Country risk analysis was an attempt to provide multinational corporations, banks and governments some reliable estimates of the stability of governments when coups and revolutions abounded and the movement of regimes from right to left and back again represented grave danger to long-term investments (Kobrin,1979). Following the decolonization movements of the 1950s and 1960s, the sheer number of countries, their policies and their potential became more than corporation heads could handle. The country risk analysts married the concept of bond ratings as it had been practiced in North America to the analysis of country stability.

In 1981, the Swiss sponsors of the Davos World Economic Forum created the best-known of the competitive indexes in the World Competitiveness Report (WCR) (1995a).[1] In the WCR, the notion of ranking countries by their overall "competitiveness" seems to have been a derivative of the country risk rating idea. In this case the risk has to do with the possibility that a multinational corporation may find its facilities located in a country where general inefficiencies and relatively poor government policy may be such as to harm its future competitiveness and profits. It is not surprising that the staff of the WCR has made great efforts to develop information sources in countries such as Poland, Hungary and India in recent years in order to add their profiles to the list of countries in the WCR. Instead of using an accounting framework, the WCR was developed around a set of proxies, probably because of cost considerations. A series of indicators was collected around a number of concepts called "factors" and these were then aggregated into a rank-order index. The factors are related to human and natural resource quality and use, technology, government intervention, finance and trade. The WCR methodology does not have the accounting preciseness that is so impressive about Denison's work, but it does allow for international comparisons of a sort.

It must be acknowledged that the WCR is not without its critics. First, the notion that countries can be seen as competitive is debated among academics and commentators on the international economy. On one side is the argument that companies compete, but countries do not. The contending view holds that, in a global economy, where investment and trade are becoming less regulated, countries compete by acting as

better or worse hosts to both domestic and international firms.[2] Clearly the producers of the WCR subscribe to the latter view. The 1994 WCR quotes the OECD on international competitiveness:

> "Competitiveness is the degree to which a country can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining and expanding the real incomes of its people over the long term.."(WCR, 1994)

The staff producing the WCR provided a slightly different definition in 1995:

> "World competitiveness is the ability of a country or a company to proportionately generate more wealth than its competitors in world markets."(WCR, 1995b)

There is concern that the WCR ranking suggests a zero-sum game, in which the winners grow at the expense of the losers. It is important to note that this perception seems to ignore the growth in the world economy as well as the idea that the rankings point to potential or ability and not to per capita incomes or wealth. The runners are in a race with no finish line.

National competitiveness

Competiveness indexes for parts of countries have had a different origin, though the "product" greatly resembles the WCR. The economic impetus of World War II was spread out among the regions of the United States. In particular, the war fuelled the economy of California, besides providing large numbers of new jobs in the Middle West. Both regions were subject to considerable migration once the war was ended. In response, States in the South and West began to take a more active role in attracting industry from these prosperous regions. The development of the Interstate Highway system in the 1950s and the commercialization of relatively inexpensive air conditioning opened up these regions to businesses that could use truck transportation and wanted cheaper labor. The aggressiveness of these States in promoting their advantages produced success in, for example, North Carolina, where the proportion of the employed labor force in manufacturing went from one of the lowest just after the War to the highest in the country by the end of the 1980s. Whether the movement of new investment to the Sunbelt was "normal" or whether it was due to the effort of the State governments is inconsequential: by the 1970s, nearly every State in the country was actively trying to attract and retain industry (McNiven, n.da).

There were a number of spin-offs from this public activity, many of which revolved around the industrial real estate acquisition. Companies looking for new sites employed site location specialists, who in turn worked with the State governments and real estate agents to present a number of land and

financial packages to the prospective industrial migrants. All of these consultants and agents began to advertise their attractions or services in specialized publications.

In 1979, Alexander Grant & Company began to publish an annual ranking of the US States which attempted to evaluate each State's "manufacturing climate". Popularly known later as the Grant Thornton Guide, it rated the States on 22 factors believed by manufacturers as fundamental measures of a State's ability to provide a productive business environment. The Guide was focused on the cost of doing business and the availability of specified resources, which made a certain locality attractive to manufacturing interests (Grant Thornton Consultants, 1979).

The Guide was designed to be general and overarching in its approach to State manufacturing climates. It provided measures for costs and availability of manufacturing resources. Ideally, it was meant to provide businesses with an evaluation tool to be used when making location decisions. Initially, it emphasized the importance of wages and levels of unionization to manufacturers. As changes within the economy affected the criteria used by management to choose site locations, the Guide itself began to change. It had been criticized for emphasizing a "third world" approach to economic growth. States were rewarded with high rankings if they had low taxes, no trade unions and exhibited a general low-cost approach to doing business.

The first Corporation for Enterprise Development ranking study was initiated in 1985 in response to criticisms of the Grant Thornton model of industrial attraction. In part, this was due to a shift in industrial development policy after the recession of 1981-2, which turned much of the North into the "rust belt". Northern States did not feel it possible to simply react to their conditions by raiding the Sunbelt for companies that had moved there in the preceding decades. Instead, their focus was more on new business creation and the development of technology -intensive clusters where once steel and auto plants dominated. A secondary focus was on tradable services (McNiven, n.db).

The resulting 1987 Development Report Card for the States (DRC) (1995) was designed to measure the economy of individual States. Published annually since then, it also attempts to measure the various strengths, weaknesses and potential of their overall economies. It is not primarily focused on the costs of doing business.

Fundamental to the structure of the DRC is the premise that the results are not just aimed towards companies looking for a relocation site. In fact, the DRC is intentionally geared towards State policy analysts to be used for their own self-evaluation of the strength of their State's economy. The DRC followed the trends of the 1980's to focus on a State's economy's ability to grow and create jobs on its own without relying on business relocations. Strengthening the State economy also included developing the human, educational and infrastructure resources available. Typically, States which have a history of relying on low-wage, massive tax

incentives and subsidies as the foundation of their economic development policy have not done as well in the DRC as in the earlier Grant Thornton Guide.

What the DRC does not do is measure directly what the State government people are doing or suggest how they should go about fixing the deficiencies reported. The underlying premise of the DRC is that State policy can affect some kind of change within the economy, but it remains up to the individual State policy planners to devise their own strategies.

Controversies

Jurisdictional competitiveness tends to be disparaged by many professionals as attributing too much influence to government policy in business investment decision-making. Yet, it is clear from existing research that new investment decisions and locations are heavily influenced by a variety of factors, many of which are based on government policy. Examples are trained personnel, quality of living environments, including personal security and good schools, transportation, water and sewage systems. Taxation and regulations also play a role in these decisions.

Another concern focusses on the utility of statistical indexes to compare relative competitiveness. The convergence of modem economies in terms of per capita income, use of technology and access to finance argues that the differences in rankings internationally are likely to be slight. This is also borne out by the narrow differences when the rankings in the WCR are accompanied by a bar chart showing their relative differences by score. Except for the first one or two ranks each year, the next dozen or fifteen scores are clumped in a narrow range that is put in rank order. The top 15 or so countries are quite stable, only changing places with each other. Some of this shift may be due to policy changes, but it is likely that most of it is driven by differences in business cycles and the attendant mood of those who answer the questionnaire that makes up a third of the weight of the overall country scores. It would seem reasonable that these factors bear little on competitiveness and compensation should be made for them. However, this would only add to the reasons why annual comparisons probably do not say as much about the world in which we live as we would like.

The DRC measures differences among a group of jurisdictions that is even more convergent than those on the international scene. While there are significant differences between States in terms of earned per capita income, these tend to narrow considerably when compared with the average for the country, that is, the figure used in international comparisons. Further, the range of policies available to individual States is constrained by the federal system that all States share. Taxation systems, welfare programs, infrastructure development and other policies are all standardized to a great degree.

 Where the DRC attempts to try to measure future success or failure in terms of development policy, it faces a further obstacle to short-run or annual validity. Once the benefits accruing to a

jurisdiction's firms from the efficient use of labor and capital are manifest, the trick of applying new organizational or technological approaches to gain a further increase in productivity appears to require significant long-term social changes. The difficulty of understanding what these changes have to be, as well as in figuring out ways to affect them, would seem to be another impediment to the utility of these indexes.

PROBLEM 2: INDEXING SUBNATIONAL JURISDICTIONS

The Comparison with the World

The World Competitiveness Report (WCR) has been published since 1981. From 1989 to 1996, it was prepared as a joint effort of the World Economic Forum, best known for its "Davos forum" held each winter in Davos Switzerland, and the International Institute for Management Development (IMD), a graduate business school with facilities in Lausanne and Geneva Switzerland. IMD was started with the assistance of Nestlé Corporation and is now among the top ten business schools in the world in terms of revenue. Sales of the WCR are presently over $1 million per year. In 1996, the two groups had a falling-out and the IMD continued to publish the WCR while the World Economic Forum began to publish a competing index. [3]This section only follows the WCR from 1989 to 1995.

All seven of the Reports examined had the same general structure. Each began with introductory remarks and analysis, followed by an overall ranking of national competitiveness. A larger section made up of details on each country's performance on either 10 factors (1989 and 1990) or 8 factors followed the ranking. Next came an essay or group of essays by business people and/or academics. Finally, the detailed criteria, rankings, and score for each country were laid out. This "data section" was the largest part of the WCR.

The core of the WCR is a ranking of countries on the basis of their imputed competitiveness. While there is extensive literature on competitiveness, and nearly each volume of the WCR contains discussions and homilies on the subject, the WCR attempts to rank the competitive performance of countries by aggregating a large number of criteria. There is no independent literature that tests the method behind the WCR, but its rankings seem to reflect most observers' "gut-feel" of the relative positions of countries on this type of scale.

Over the years, three alternate typologies of countries were attempted. In 1989 and 1990, the WCR was supplemented by a section prepared by Professor Joseph deCruz of the University of Toronto that conducted an export shift-share analysis of each country studied, based on 1982-1987 export data from 71 traded products. Presumably, there should be some correlation between export trends and international competitiveness, but this connection was never formally explored in these two Reports. Throughout the 1989

- 1993 periods, attempts were made to diagram where countries lay on a four-celled matrix of market economy strength and an individualist/cooperative ethos. This was examined both at the level of countries and at the level of individual factors. Again, no attempt was made to formally connect these concepts to the overall raison d'être of the WCR. In the 1993-1995 editions, an attempt was made to draw up "balance sheets" of those criteria in the WCR that represented strengths and weaknesses of each individual country. This balance sheet approach is derived directly from the WCR and implies some policy suggestions for each country's leaders, though little was done to formally analyze or discuss this self-ranking.

The number of countries ranked in the WCR grew from 32 in 1989 to 48 in 1995. The ranking of countries is done by means of an aggregation, or "roll-up" of selected criteria.[4] Some criteria may change emphasis from time to time. For instance, in 1990, executives were asked whether lobbying in their country "accelerated" government decision-making. Presumably, a "yes" answer was a good thing. By 1994, the question had become one where respondents were asked whether lobbying "distorted" government decision-making. Here, a "no" answer was desirable.

Criteria were also added and their use changed year by year. In 1989, the WCR claimed to include 292 criteria; by 1995 there were 378. The criteria (both the data and questionnaire types) are developed so that nearly all provide country rankings. Regardless of whether the differentials between countries on a given criterion are narrow or wide, the countries are given a unit rank (first, second, third, etc.). The criteria are then rolled up into factors, originally 10, but reduced and reorganized in 1991 to 8. Countries are re-ranked at the factor level and the overall international ranking is fashioned from the result. Of the 378 criteria, only 294 are included in the ranking process. The rest are judged to be too unreliable for this purpose. The 294 criteria are aggregated, or "rolled up" into 55 sub factors; which are then "rolled up" into 8 factors that, in turn, go into the making of the overall rank.

Over the years, the criteria weights themselves were subject to a number of changes, though none seemed to have significantly altered the data content of the WCR. For instance, some criteria were double-or triple-weighted in the 1989 edition, but by 1992 this approach had been abandoned in favor of an equal ranking of all criteria. In 1991, a new type of weighting crept in when it was decided to weigh those criteria developed from survey questionnaires as equal to 1/3 of the weight of all criteria, when the number of survey-derived criteria generally ran 35 – 40 percent of the total criteria.

Criteria are also weighted as a result of their being included in sub factors and factors during the "roll up" process. In 1989, the factor with the smallest number of useable criteria included 16, while the largest included from 29 to 42, a somewhat more even spread. This move to more equal numbers of criteria per factor occurred when the number of factors was reduced from 10 to 8 in 1991.

|Insert table 1 about here|

The producers of the WCR have had to face numerous data problems over the years. One such problem lies in the nature of the WCR's survey questionnaire. The survey done each year is of the mail-out variety. It is devised for quick response, with clear short questions followed by a 1-6 scale, on which the respondent is asked to indicate where the respondent feels his or her country fits. As in any survey responses are subjective in nature. Clearly, asking Swiss or Austrians, for example, about their country's seaport facilities either results in no answer at all or an evaluation of ports such as Trieste, Genoa or Marseilles. Asking a Canadian about relative tax incidence and structure will probably evoke a comparison with the United States, while a French respondent may be thinking of taxes in Germany as the framework for his or her answer. Beyond this, lies the problem of sampling. The WCR questionnaire was sent to 21,000 executives around the world, of which 3292 responded. Only 70 were Canadian responses. The overall response rate to the questionnaires varied from a low of 11.5 percent in 1991 to a high of 21 percent in 1993, for an average of 16.75 percent over the seven years. IMD reported that approximately 70, or 2 percent of the 1995 returns, came from Canada.

As well, the "hard" data in the report has been derived from a variety of sources over time. Since the 1994 edition, the majority of the data has come from the OECD. Before 1994, annual reports from different countries were used which contained different time lines for data as well as different definitions. Ranking Canadian, Japanese, American and French unemployment figures solely on the basis of their reported numbers, for example, would give a misleading understanding of this indicator absent any harmonization of the national methodologies.

These data problems, while potentially significant, should not be unexpected. Trying to collect vast amounts of harmonized data from dozens of countries is beyond the scope of most public international agencies. As well, a detailed global survey of business people is a massive as well as expensive undertaking. Despite the immensity of the task, the WCR data is at the practical state-of-the-art level today.

PROBLEM 3: HARMONIZING MEANINGFUL STATISTICS

This section is focused on the problems of gaining what might be called an accurate comparison, from a statistical point of view, of the competitiveness of Atlantic Canada relative to US States and a number of countries. Both the overall methodologies and the meaning of the numbers collected and aggregated caused problems once they had been rigorously analyzed. The Development Report Card for the States appears to have an intellectual coherency that the World Competitiveness Report lacks. As well, because its data came from 50 states in the same country, measurement and the meaning of what was measured were more consistent, though not completely so.

The problems considered here are more closely related to the nature of the data itself, rather than to the intellectual underpinnings that justified the choice of criteria and the ways in which they were aggregated. Eleven problems are presented below that illustrate the difficulties faced in trying to integrate Atlantic Canada into the statistical profiles of the US States and the world. They do not constitute an exhaustive list, but do illustrate the most important statistical problems that the researchers faced. We should also note that the quest for accurate, comparable numbers was primarily a task of searching and collecting. Most of the needed statistics were found in a useable form for this exercise, yet there were enough problems that they absorbed an inordinate amount of time.

Unemployment

A typical harmonization problem arose in the treatment of unemployment. In terms of the numbers of unemployed, Atlantic Canada ranked absolutely last in 1995 in unemployment when compared to the 50 States. The definition for unemployment is the same for both countries - the unemployment rate represents the number unemployed as a percent of the civilian labor force.

In the 1995 DRC, West Virginia ranked 50th with an unemployment rate of 8.9 percent while Atlantic Canada slid off the scale at 51st with 14.8 percent. Questions surrounding this indicator relate not so much to the definition of the indicator but more to the interpretation and understanding of what lies beneath the measure.

What constitutes the number of unemployed has much to do with the policy of unemployment benefit eligibility and unemployment benefits received. In Canada, unemployment benefits are delivered through a federal program, so for the most part, eligibility requirements and duration have been consistent nationally. In the US, unemployment is primarily a State-level responsibility, so the eligibility for unemployment insurance and benefits available varies by State. The duration of unemployment benefits was also much shorter in the US in 1995, generally consisting of a maximum of 26 weeks under a State funded program with Federal extended benefits provided to those eligible for an additional 13 weeks. The duration of the Canadian unemployment benefits program, prior to recent legislative changes, was 52 weeks. A person may not be counted as unemployed in either country once he or she drops off the benefit rolls, so, presumably the Canadian unemployment numbers could be 25 percent higher just because Canadians can stay "unemployed" for statistical purposes 25 percent longer than Americans. Also, American (per 100,000 people) prison populations are very much higher than those in Canada and both countries agree that prisoners are not unemployed.

Crime

There were several instances where comparable measures were determined between US and Canadian data when several data sources were used to make-up the data set. The American indicator for

crime rate was taken from FBI data that included "serious crimes" such as murder, rape, robbery, assault, burglary, larceny, and motor vehicle theft.

In contrast, sources for these crimes in Canada were taken from two locations. The US term "serious crime" is a combination of Canadian data on "Violent Crimes" and "Property Crimes". Canadian Violent Crime includes homicide, attempted murder, assault and other sexual offenses while Canadian Property Crime includes break & entering, motor vehicle theft, and theft. Statistical data used for the Atlantic Canada measurement was taken from Statistics Canada's Canadian Crime Statistics.

Employment and Earnings

An instance where the collection of data by one statistical agency differs from another was found in the calculation of the Traded Sector Strength measure in the DRC. This measure is based on employment and earnings data. The US SIC employment information includes agriculture, fishing and self-employment where the Canadian data does not. Information on agriculture, fishing and self-employment is derived from personal income tax returns. All other employment is collected via corporate income tax returns.

A difference in data collection also showed up in data on earnings. The Canadian data covered only wages and salary employment and income while the US data covered employment and earned income from all sources. This would likely distort the data in two ways. First, many wage and salary earners have a small business on the side, which is income not captured in the Canadian employment data. Second, the US data included full-time unincorporated proprietors and their income, while the Canadian data does not. For purpose of the traded sector strength measure, these differences were likely to underestimate traded income for Atlantic Canada and adversely affect its ranking on this score.

Air Pollution

Many of the urban areas of the United States are plagued by air pollution. In Canada, except for Vancouver, most of our air pollution problems are imported, that is, blown in from the US. Even Toronto's problems are derived largely from the American cities to its southwest, while most of the air pollution recorded in Atlantic Canada tends to drift in from the eastern seaboard of the United States.

Because of the potential for federally-imposed penalties on economic development, the States have an incentive to produce and maintain good numbers on their problems, while in Canada much air pollution is regarded as a largely scientific phenomenon. Numbers collected because there might be a real regulative or economic penalty attached to the results are more focused than those collected because there might be some scientific interest.

In the end, good numbers were only available for certain types of air pollutants in Atlantic Canada. The others were either nonexistent or collected in a manner that was unusable for comparisons with different States. The question of the harmonization of environmental statistics is not

just one that vexes the NAFTA officials; it appears from internet searches that this is a problem that exists worldwide and that a lot of effort is going into developing harmonized statistics on the environment.

Poverty

Sometimes political sensitivity translates into questions of definition. One measure within the 1995 DRC looks at "poverty rates". The U.S. Census Bureau determines several different cut-offs for poverty depending upon various criteria such as geographic region, family size, race and income. For what can only be assumed as sensitivity issues surrounding the terminology of poverty, Canada does not define a "poverty rate" but instead refers to it as "low-income cut-offs". Low-income cut-offs are determined on the basis of size of area residence by family size. Although Statistics Canada's low-income cut-offs are commonly referred to as official poverty lines, they have no recognized status and are not promoted as poverty lines. Low- income cut-offs were selected on the basis that families with incomes below these limits usually spent 50 percent or more of their income on food, shelter and clothing.

Business Finance

In the DRC, the availability of loan funds for local business is an important criterion for estimating the development potential of the States. Because of US policy decisions that have maintained a fragmented banking system, there being approximately 12-15,000 state regulated banks while Canada has a few nationally regulated institutions, financial resource statistics for a given State are rational to collect and use. The Canadian banking system has been allowed to develop on a national basis, so that the few banks in Canada rank with the largest in the United States. Trying to estimate the availability of funds at the subnational level is therefore a different process and has a different meaning in Canada.

Calculating a measure such as loans to bank equity is a much different exercise and on the Canadian side, not as precise. The banks in Canada do not allocate their equity on a provincial basis. Assigning equity geographically by allocating shareholdings is an impossible task if only because so much equity is held in mutual funds. While the Bank of Canada Review does calculate some balance sheet figures provincially, such as assets and liabilities, equity is not allocated. Instead, a Regional equity figure had to be derived from the national chartered bank equity value divided by the Atlantic Provinces' contribution to national GDP.

Gross and Net Job Creation

The quality of the statistics is often related to the need for them by policy-makers and by those who would influence their decisions. The most convoluted problem encountered in this research had to do with the estimation of gross new job creation by age of business. When the media publicize new job creation, the figure given is generally a net number, i.e., there are X thousand more jobs in Canada this month than last. This method of reporting hides the dynamics of job creation and loss. As best anyone can

make out, a normal economy in a normal part of the business cycle will lose about 6 percent of its jobs per year, gross. "Job growth" is generally shorthand for the net amount above the growth required to replace those jobs lost. Thus there can be gross job growth and net job loss (or growth) at the same time. One wants to know where the new jobs are coming from, irrespective of whether there are enough new ones to replace those lost. Gross job growth identifies the dynamic areas of the economy.

Canada, does produce numbers relating to new and old businesses and gross job growth. These can be derived from figures based on business income tax returns and, for all practical purposes, may be construed as being 100 percent of such actual activity. The US figures used in the 1995 DRC were based on figures provided by Cognetics, Inc., a consulting company in Boston that specializes in research into small and new businesses. Buried in the notes of a report of theirs, which was used by the DRC researchers, was the comment that the US federal government's figures on this subject were of such poor quality that the consultants had used Dun and Bradstreet figures instead. Even these, they noted, probably only captured 40 percent of the actual activity.

Data measurement problems arise from this comment. First, there is no assurance that the 40 percent level is consistent across the States, so that the measure could vary internally. Second, the Canadian data quality was as close to 100 percent as could be estimated. In the end, in order to provide some comparability the Canadian figures had to be "dumbed down", so that these numbers could fit the 40 percent quality level of the US data. Atlantic Canada scored high on this measure anyway, but had the real Canadian figures been used, the Region would have been off the scale, something that was clearly unrealistic.

Infrastructure

While federal states have a lot in common, there are also significant differences as well. One of these is in federal/state or provincial fiscal relations. In the more centralized federation of the US (relative to Canada) there are federal assistance programs for sewers and highways that do not exist in Canada. As such, the State jurisdictions have an incentive to collect numbers that help them qualify for this aid. For example, in 1992, State sewage treatment needs were documented for publicly owned wastewater treatment facilities in terms of meeting estimated populations for the next 20 years, in millions of dollars per capita. This was collected from the States by the United States Environment Protection Agency and submitted to Congress in the 1992 Needs Survey Report to Congress. Similarly, the structural deficiency of bridges was collected and submitted to Congress by the Eleventh Report of the Secretary of Transportation to the U.S. Congress, Highway Bridge Replacement and Rehabilitation Program, 1993. Highways are regularly rated on their serviceability and reported by the U.S. Department of Transportation, Federal highway Administration, in the annual publication, Highway Statistics. All of these were used in the 1995 DRC.

In Canada, these same statistics need to be gathered from provincial governments who fear that numbers on the technical deficiencies of bridges and highways and the proportion of their population that has access to sewers may prove to be politically embarrassing. As a consequence, where American statistics on these items evoke suspicions because they may be biased toward the deficiency side of the ledger, in order to access more federal funds, the equivalent Canadian numbers (the technical definitions appear to be internationally harmonized engineering standards) are treated as virtual state secrets.

Education

Another problem in comparable data usage is to look at the way the DRC and the WCR use different statistics to measure a factor that has the same name in both indexes. Take, for example, education. In the DRC, education statistics are used as an indicator of human resource potential of those already within the workforce. The DRC looks at high school graduates as a percentage of enrolments, the percentage of heads of household with at least 12 years of education and the percentage of heads of household with at least four years of college. The DRC is attempting to measure the capacity of the current labour force.

Perhaps the complexity of determining comparable statistics across nations limits the WCR in the types of statistics available to measure education adequately. The WCR indicators place emphasis on per capita public expenditures of education, secondary school enrolment, higher education enrolment and the relevant pupil-teacher ratio for primary and secondary schools. These measures are measuring the current levels of education enrolment. In effect, the measures look at the future potential of the workforce. So, "education" means quite different things in these two indexes.

National/Regional Problems

The linking of Atlantic Canada to the World Competitiveness Report presented further problems. The Development Report Card for the States had the virtue of comparing sub-national units with each other. Adding Atlantic Canada as a State was a task of aggregating four Provincial units into one Regional unit. The Region's population and economy were both larger than those of many States, but smaller than many others: so from that perspective, it fit right in.

Presenting the Region as a country in the WCR was the antithesis of the difficulties with the DRC in terms of collecting appropriate statistics. The problem here becomes one of distorting the Regional profile. Many statistics used in the WCR criteria are ones where there is no way to distinguish national numbers from regional ones. Certain regional statistics on sector specific data, such as those on automobile assembly and tire production, were held confidential by Statistics Canada because there was only one auto assembler (then) and one tire manufacturer in the region. Others, relating to money

supply, some social programs and bank activity, are national in scope and impact and cannot be broken out by region. (For example national statistics were used for the following indicators: Official Reserves, Interest Rates, Stock Market Capitalization, Financial Risk Rating, Size of Banks and, Employee's Compulsory Social Security Contribution).

Other figures, when developed according to WCR usage, give the region a definite positive "spin". This is especially true for criteria related to taxation and government expenditures in the Region. Clearly, if federal expenditures are put aside, the size of government in the Region is rather small. The resulting indicators, though rather positive, were not wholly satisfactory, but a more detailed analysis would have been a project in itself.

Using national figures for a significant number of criteria in the WCR did help to boost Atlantic Canada's ranking somewhat. However, this statement entails making some assumptions about what these numbers might look like if Atlantic Canada were, in fact, a country.

Number Quality

One of the more disconcerting discoveries about researching international competitive numbers within the WCR is that the harmonization process for a lot of the numbers used in the "hard data" criteria of the report was either primitive or non-existent. The WCR used to depend heavily on national statistical yearbooks, whose numbers may have been years out of date. In truth, the 1995 WCR, as well as the 1995 DRC, was not a snapshot of the world in 1995, or even of 1994, but of what might be called, a collage of the latest data available.

The WCR depends, to a great extent, on OECD country reports for its comparable economic indicator series. Yet even these figures are only partially harmonized, that is, the numbers count the same phenomena in the same way over the same time span, sometimes. It may be that these data only become useful when the rankings are viewed over a relatively long time span. One then at least gets the consistency of otherwise inconsistent findings,

To be fair, the WCR has had to deal with what is available from national and international agencies. The numbers are better than relying solely on opinions, but there is a lot of improvement that is needed. We really understand very little about how the world really works; all the numbers seem to do is give us an illusion of solidity.

CONCLUSION

This section has focused on the problems that exist in trying to produce statistics for Atlantic Canada that could allow the region to be compared with State jurisdictions in the United States and with a number of countries and territories around the world. While the intent was to classify and describe these problems, some observations on statistics and their harmonization can be made.

It would seem that different jurisdictions develop statistics for domestic use, that is, as an aid to policy making and evaluation. In a benchmarking exercise, the emphasis has to be on the comparative aspect of statistics; that is, finding numbers that signify the same categories of things or behavior across jurisdictions. These two purposes, use and comparison, do not necessarily coincide. Statistics for use are embedded in a broad policy context within a jurisdiction; statistics for comparison are withdrawn from this context.

At this point there is some reason to expect better harmonization in North American numbers on environmental and labor issues, given the special NAFTA agencies in these areas. Other categories of trade statistics may be harmonized simply as a matter of procedures and agreements, such as that to develop a consistent, continental SIC Code set. However, given the disharmonization in areas that relate to economic benchmarking, it would be a difficult task to accurately benchmark the various States, Provinces and Regions of the three countries in order to get a view of them. At the global level, the thin veneer of numbers produced by the OECD and the UN hide the reality that there are few consistent measures across space and time that truly contribute to our understanding of global trade and economic dynamics. Harmonization has barely started as a process at the international level.

NOTES

[1] The World Competitiveness Report (Lausanne and Geneva Switz.: IMD and WEF, annual,1989-1995) These are the years studied for this research.

[2] The two classic sides of the argument are Michael Porter, The Competitive Advantage of Nations (New York: Free Press, 1990) and Paul Krugman, "Competitiveness: A Dangerous Obsession", Foreign Affairs 73(2) March/April 1994 pp.28-44. Porter is now involved with the World Economic Forum's indexing publication, along with Jeffery Sachs.

[3] The IMD now publishes The World competitiveness Yearbook while the World Economic Forum publishes The Global Competitiveness Report.

[4] While Dalhousie researchers did their own reverse engineering of both the reports used for comparative purposes, others have also done so. See, for instance, Muhittin Oral and Habib Chabchoub, "An Estimation Model for Replicating the Rankings of the World Competitiveness Report" in the International Journal of Forecasting 13(4) Dec. 1997 pp527-537.

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WCR 1989-1995 The World Competitiveness Report

WCR 1994 The World Competitiveness Report

WCR 1995 The World Competitiveness Report

Who's Creating Jobs? 1995 (Cambridge MA: Cognetics. Inc.)

TABLE 1

FACTORS MAKING UP COMPETITIVENESS

1989	**1995**
1) Dynamism of the Economy	1) Domestic Economic Strength
2) Industrial Efficiency	2) Management
3) Market Orientation	3) Finance
4) Financial Dynamism	4) People
5) Human Resources	5) Government
6) Impact of the State	6) Infrastructure
7) National Endowment Utilization	7) Internationalization
8) International Orientation	8) Science & Technology
9) Future Orientation	
10) Socio-Political Stability	

INTERNET MARKETING FOR WEIGHT LOSS SURGERY

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ABSTRACT

In order to provide the medical information of bariatric surgery for obesity patients, the bariatric center in a hospital pay attention to do internet marketing from the customers' view.   When customers search the information for bariatric surgery, they are usually confused by the message on the website which demonstrates usually from the providers' view.   This research used the focus group to integrate the message which needed to be showed on the internet and to rearrange the topic for the convenience and precise in a reasonable way.   The result showed that the topic of information for bariatric surgery would be rearranged by the indication of the surgeries, the process of hospitalization, and the related interactive communication for the surgeries.   Moreover, the supporting groups or some blogs which were established by the operated patients could persuade and help the potential patients to make the decision.   The conclusions of this study is that the website information should provide the options of bariatric surgery, show the hospitalization process, and encourage the interactive communication among the blogs which are established by the patients who had ever received bariatric surgery.

Keyword: internet marketing, obesity, bariatric surgery,

INTRODUCTION

In order to provide the medical information of weight loss surgery for obese patients, the bariatric centers pay a lot of attention to do effective Internet marketing.   When customers search for weight loss surgery information, they are usually confused by the message on the web.   Because many searchers dissatisfied with the content on the internet, bariatric centers need to rethink the following questions.   What does the information is available for target customers? How do the target customers look for the information of weight loss surgery through the internet?   The issue would be discussed in the following section.

THEORETICAL BACKGROUND

The disease related to obesity may be substantial, e.g., diabetes, hypertension, heart disease and high serum cholesterol (Paeratakul, Lovejoy, Ryan, & Bray, 2002). There's several method to improve body weight, e.g., diet, exercise, medication, or even surgery. Especially the morbid obesity would be the indication for weight loss surgery, also called bariatric surgery. Weight loss surgery could decrease patient's mortality in morbid obesity (Christou et al., 2004). When obese adults receive bariatric surgery, their glycemic control would also be improved (Michael, 2008). Bariatric surgery also could reduce medication use for major disease categories (Cremieux, Ledoux, Clerici, Cremieux, & Buessing, 2010). Therefore, the bariatric surgery has become the option for weight loss.

The quality of health-related information on the internet is highly variable (Purcell, Wilson, & Delamothe, 2002). Many people use the internet to find health-related information (Bansil, Keenan, Zlot, & Gilliland, 2006). Although doctors think the information on the internet may mislead patient's perception and behavior, doctors still need to face the questions which patients search for on the internet. If doctors could distinguish the quality of information, they could pursue patients to select the good quality information. Moreover searching with Google may also help doctors to diagnose difficult cases (Tang & Jennifer Hwee Kwoon, 2006).

Not all information on the internet could offer the same level of advantage. It needs careful design to ensure that key messages could clearly communicate to their users (Hurling, Fairley, & Dias, 2006). Finding the proper colorectal cancer information resources would be useful to healthcare professional (John, 2006). Good quality information with familial adenomatous polyposis is difficult to obtain on the internet (Soobrah & Clark, 2012). Grewal, Williams, Alagaratnam, Neffendorf, and Soobrah (2012) indicated that internet information on vascular surgical conditions and procedures is poorly written and unreliable. Health professionals should make the information on the internet easy to read, access, and use. The aim of this study is to provide high quality information for those who search on the internet to solve overweigh and obesity problems.

METHODOLOGY

This study adopted a focus group design and attempted to find the information which is appropriate or not from the customer's view. The seven members of the focus group are patients who had received bariatric surgery before within a bariatric center. The bariatric center is a division of a hospital which is a large scale hospital and has more than 1000 beds in Taiwan. Moreover, this study also invited one member of medical staff to join the focus group because the member could promote the discussion in the focus group. The researchers thought the interactive dialogue would be helpful to explore the necessary information from both medical staff and patients.

Multiple sources which come from both medical staff and patients will help researchers to clarify the focus of attention.

FINDING

Generally speaking, the medical information on the internet should all the information which patients need to make their decision making and decrease their anxiety. Although medical staff will provide the information from their professional view, it's better to describe the process which patients would experience. Researchers just want to know the perception of patients both before and after their operations. The related suggestion could be divided into three parts: original arrangement of information on the internet, searching experience of patients, and rearrangement of information on the internet.

Original arrangement of information on the internet

The content arranged by functional division. The concerned focus of information for patients may be quite different from that for medical staff. Original arrangement on the internet was showed by medical specialty which the health assessment, internal medicine, surgery, nutrition, and fitness provided their information separately.

The original arrangement on the internet was hard to understand by patients. The reason may come from medical specialty according to functional division in a bariatric center. For example, the suggestion of nutrition on the internet may be as follows:

- Nutrition needs to be adjusted according to different days after bariatric surgery.
- The detail of nutrition would be different during different stages after bariatric surgery.
- The nutrition during maintain stage should be the part of patient's life and become their eating habit.

In addition to the information of nutrition, patients could hardly understand the whole process after bariatric surgery. Because patients didn't have a whole picture for the process, they couldn't catch the proper time to follow the instruction which included internal medicine, wound care, nutrition, fitness, and so forth. Much separate information may confuse patient's perception and behavior and result in some conflicted instructions among the specialties.

The proper information hard to find. If all information was provided separately, patients need to think the way to integrate by themselves. Because the original arrangement is designed by separate specialty, patients can't find the necessary information easily. If patients want to know the wound care, nutrition, fitness, immediate or late following process after bariatric surgery, they would spend a lot of

time to search for the necessary information on the internet.   Patients must have done the hard work to coordinate different information by themselves.   This will make patients anxious and uncertain.

If the medical staff didn't think the whole process for their coordination, there would be more or less deviation between the planned procedure and real procedure.   So even if patients had finished the integration of information on the internet, the integrated information may be different from the real procedure operated by medical staff.

The whole process hard to understand for the bariatric surgery.   Compared to the medical staff, patients usually owned less information. If the information must be collected or organized by patients, the whole process may be misunderstood during the integration. Therefore, the result will be the uncontrollable perception and quality evaluation about the process of bariatric center.

The information on the internet is not user-friendly. In other words, the necessary information didn't be given comprehensively on the internet and patient would feel uncertain about the process. This study indicated that the useful bariatric information on the internet should be focused on the needs of customers which the information should be integrated.

Searching experience of patients

According to the thought of patients, information on the internet should let patients know the facility and faculty, especially the team work for weight loss. Next, patients need information to help their decisions which contain the advantage and disadvantage about the different type of treatment.   Consequently, the details which contain preoperative, intraoperative, and postoperative procedure could decrease the anxiety of patients. In addition to the information provided by medical staff, patient will want to know the positive or negative experience that other patients had undergone the operations.

But there's still a problem: "How detail should be demonstrated?" Some patients told that they wanted to know the detail about the procedure of sending patients to operation room, but not the detail like the operation instrument used during operation. They concerned the complication and any other changes that would cause inconvenience of her life after bariatric surgery.   To reduce the uncertainty, the information on the internet should demonstrate at least the whole process which contains preoperative, intraoperative, and postoperative procedure.

Rearrangement of information on the internet

According to above opinions, the item on the internet will be demonstrated as

following: tangible facility, professional faculty, treatment option, whole procedures in the bariatric center, news and activities, related connection, and contact us.

Tangible facility. Tangible facility demonstrated the facility which included the ward, equipment, instrument, and operation room.

Professional faculty. Professional faculty showed the complementary task of professional team which contains doctors for internal medicine, surgery, psychology, urology, gynecology, plastic, metabolism, and other medical staff like case manager, professional nurse, research assistant, and so forth.

Treatment option. The severity of overweigh or obesity begins from calculation of BMI, the consumption of diet and exercise. If the overweigh needs to be fixed, medical option priority should be diet and exercise, internal medicine. Morbid obesity should be considered by bariatric surgery consequently. The surgical types would provide sufficient information for patient's option which would contain surgical principle, surgical type, effectiveness, duration for the prognosis, vitamin deficiency, surgical risk, surgical time, and length of stay in a hospital.

Whole procedures in the bariatric center. Patient needs know the information about the outpatient, inpatient, and discharge. The inpatient procedures contain the preoperative, intraoperative, postoperative procedures. Patients will concern about the detail of these procedures.

News and activities. Bariatric center could show patients the evidence for their treatment result. News and activities will be helpful. Besides, video from TV or successful story would be persuasive for the decision making of patients.

Related connection. Even after surgery, the social support would still be the important factors for the success after bariatric surgery. To decrease the uncertainty and negative imagination, opinion leaders play an important role for the decision making and taking the action. Some opinion leaders will have their own blog, facebook, or other discussion forum on the internet which could provide the customer's view to decrease the uncertainty and to help continuous weigh maintain after bariatric surgery. Moreover, bariatric center also have established the obesity support association to support the patients and to maintain the effect after bariatric surgery.

Contact us. If there's any problems, patients need to know the telephone, address, and clinic hours for connection. The special-purpose phone line will be suitable for those potential customers and even for those patients who will receive the operation or will need more information after bariatric surgery.

After rearrangement of information on the internet, the website of bariatric center is

widely spread by word-of-mouth. Other patients who need to know the comprehensive process will search the information provided by the bariatric center in Taiwan. The website becomes an important source of bariatric surgery information. The result is unexpected and the web had become the reference for most patients who want to understand the whole process.

CONCLUSION

To describe the information of web separately by specialty is easy for the medical staff.   But the information which had not been integrated would confuse the users. To describe the information on the internet should be the integrated information which must be integrated by specialty previously and put into customer's consideration. This study shows that a better way is to describe the process which follow the decision making, preoperative procedure, intraoperative procedure, postoperative procedure, and discharge process.

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A STUDY OF THE RELATIONSHIPS AMONG ORGANIZATIONAL GOVERNANCE MECHANISMS OF R&D, LEARNING ACTIVITIES OF COPS AND R&D PERFORMANCE

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ABSTRACT

This study explores the effects of several governance mechanisms at organizational level ("span of integration", "quality of professional status" and "psychological safety") on the employees' learning activities ("practicing", "observation" and "conversation") and if these employees' learning activities can contribute to the firm's R&D performance. A questionnaire survey was designed to test the research hypotheses. The results find that: 1) Among the three constructs of governance mechanisms of R&D, only "qualification of professional status" has positive impacts on all the observation, conversation, and practicing aspects of learning activities of the CoPs. And, both "span of integration" and "psychological safety" have positive impacts on the observation and conversation aspects of learning activities of the CoPs, but have no impacts on the practicing aspect of the CoPs. 2) The "practicing" aspect of the CoPs has a positive impact on R&D performance, while both "observation" and "conversation" have no impacts on R&D performance.

Keywords: Communities-of-practice (CoPs), Psychological Safety, R&D performance

INTRODUCTION

How to manage the R&D activities is a major concern for companies of today. They need some sorts of institutes to synthesize their employees' expertise, typically by using cross-functional project teams to execute many types of R&D tasks. At firm level, there are some most used governance mechanisms aiming to elevate the firm's R&D performance, such as the design of organizational structure of cross-functional teams, the span of integration of the projects, the allocation of responsibilities both for teams and their team members, and the associated qualification of professional status of team members, among others.

Senge (1990) stated that "the team that became great didn't start off great – it learned how to produce extraordinary results". From this point of view, the effectiveness of team approach depends on the presence and efficacy of learning behaviors among team members (Moorman and Miner, 1997; Dougherty, 1992). Social learning theorists suggest that communities provide a foundation for sharing knowledge, and communities of practice (CoPs) are considered to be a type of learning community (Lave and Wenger, 1991). Hence, this study posits the learning activities of communities of practice in the firms as a major mediating factor on the causal relations between these governance mechanisms and the R&D performance.

Although pooling people with disparate expertise into a group may provide a physical environment for the exchange, sharing, and learning of their specialties and skills, some scholars argue that the social-psychological aspects of these settings might exert significant impacts on the realization of

learning behaviors of their members. For instance, Detert and Edmondson (2011) contend that implicit voice theories present subtle barriers to organizational learning. In short, voice's benefits are primarily collective (organizational), but individuals bear voice's costs. Even when managers do not behave in ways that actively stifle voice, implicit voice theories can block valuable knowledge from being shared (Detert and Edmondson, 2011). In this study, we will apply Edmondson's (1999) psychological safety as an integrated factor of these social-psychological parts of R&D environments to see if different levels of psychological safety have any impacts on the dynamics of members' learning behaviors.

In sum, the purposes of this study are to investigate learning activities of CoPs in the firms (including "practicing", "observation" and "conversation") and their mediating effects between governance mechanisms of R&D (including "span of integration", "quality of professional status" and "psychological safety") and R&D performance. Figure 1 depicts the relationships among these researcher variables.

Governance mechanisms of R&D ● Span of integration ● Qualification of professional ● Psychological Safety	→H1→	Learning activities of the CoPs ● Observation ● Conversation ● Practicing	→H2→	R&D Performance
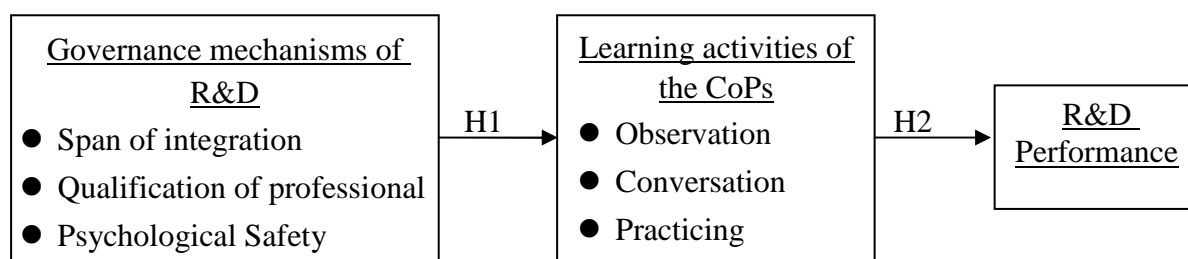
Figure 1   Research Framework

LITERATURE REVIEWS

Governance mechanisms of R&D

This study will first select some aspects of R&D's governance mechanism from previous studies about how an organization manages its R&D activities, and uses these aspects as variables of governance mechanisms of R&D. They are depicted as followings:

■ **Span of integration**
The integration of an organization is always a major concern of organizational research. In R&D, monitoring is aided by the practice that researchers normally work in groups of peers (Latour and Woolgar, 1979 in Hoecht, 2004) and physically work within the spatial boundaries of their organization. However, recent research on innovation (Verburg, Orrt, and Dicke, 2006) emphasizes the coordinated process of innovation in a network of partners, and that coordination is often attained by systemic integration (with key suppliers and customers) and parallel development (of components or modules of the innovation). Thus, whether an organization is disposed to expand or narrow the span of integration is an important aspect of the organization's governance mechanisms.

■ **Qualification of professional status**
Because organizations' members are typically with different experiences and professional expertise, how to transfer senior members' experience and professional expertise to junior members is an imperative of R&D management. In theory of CoPs (Lave and Wenger, 1991), a system of professional status of their practitioners is depicted as master-apprentice relationships, with an

emphasis that the master is a model showing the apprentice how a mature practitioner is like instead of a teacher of professional kills. Hence, the existence of a senior-junior qualification (or, certification) mechanism to justify or legitimatize members' professional status is the foundation of organizational learning. Thus, we use this system of conveying qualification of professional status as a governance mechanism of R&D in this study.

■ **Psychological safety**

Asking for help, admitting errors, and seeking feedback are most important in learning by reflection process. But from participants' stance these behaviors may bring to themselves an image of incompetent and place themselves at risk. These individual tacit beliefs about interpersonal interaction will inhibit learning behavior and give rise to ineffectiveness in work settings. Therefore, to be a place truly conducive to learning, the environment must be, as Ayas and Zenuik (2001) has described, "a space where people feel comfortable practicing learning without the fear of failure, a space where they can raise difficult issues, a place where they do not resort to defensive behavior". Edmondson (1999) introduces the construct "team psychological safety" and define it as a shared belief held by members of a team that it is safe for interpersonal interaction. Edmondson (1999) argued that such an environment must have a climate characterized by interpersonal trust and mutual respect in which people are comfortable being themselves, and members must hold similar perceptions of it. As psychological safety is perceived by all team members and derived from the same shared experiences of all members, it should converge in a team (Edmondson, 1999).

Learning activities of the CoPs

In this study it can be seen that the theory of CoPs focuses on learning within professional groups. The important core theme of CoPs is how a person who called novice learns to become an expert through interaction within an emphasis on the loci of that learning process (Lave and Wenger, 1991). Thus, learning in CoPs involves evolving forms of mutual engagement, understanding and sharing the enterprise, and developing a repertoire of the community (Wenger, 1998; Avery and Carlsen, 2001). It typically contains the following parts:

■ **Observation**

CoPs are considered to be a type of learning community (Lave and Wenger, 1991). Social learning theorists suggest that communities provide a foundation for sharing knowledge. It is believed that individuals can learn by observing and modeling other people. Bandura (1977) emphasizes that observing other people's behavior allows for a safer and more efficient way of acquiring complex behaviors or skills than learning by trial and error. It provides a safe environment for individuals to engage in learning through observation and interaction with experts and through discussion. Just like the works allocated to low-status members are more peripheral than those to high-status members, but these low-status members usually can learn something through observing work practice of high-status members. Thus, on work practice, observation is also an important kind of participation in CoPs.

■ **Conversation**

In the potential of conversations between inside and outside, through the perspective of an outsider to help members see the opportunities, and would conversation with the community leaders and core members, the results of this dialogue, it would let CoPs which understand this issue and the legitimacy of the people, who have new opportunities, and efficient to do the seeds of change. Communities are, in many cases, about "knowing a man who can", and they enable conversations that transfer knowledge around the group (Pierce, 2002). Lave and Wenger (1991) describe that CoPs for troubleshooting would develop a shared body of knowledge based on stories and anecdote that circulated within the communities, this situation is much like apprenticeship learning which is also

"supported by conversations and stories about problematic and especially difficult cases (p. 108)". Thus, a community of practice (CoP) is a set of people informally bound together through common interest and language with the goals of open conversation, and exchange and retention of pertinent knowledge.

■ Practicing

Learning is the process of becoming a member of the CoPs. The motivation to learn is the motivation to become a member (Galagan, 1993). In the CoPs the newcomer is not only a learner, learning in situation, but also an active participant in the social community. As a member of a social structure the newcomer is accepted and "legitimate", even though being located in the peripheral zone. Lave and Wenger (1991) term it "situated legitimate peripheral participation," because learning must occur in the context where it will be used (situated), allowed to occur (legitimate), and new members learn from watching and practicing from the edges of the group (peripheral participation). For example, Lave (1992) illustrates the CoPs view via Yucatec Mayan midwifery. Young Mayan girls watch as their elder relatives assist births. Eventually, she is allowed to help with the easier tasks, gradually watching, learning, and practicing increasingly difficult techniques. Ultimately, she becomes an experienced midwife, and assists the training of other girls. Thus, in the CoPs there are one activities of learning which it would through practicing to acquire the skills and expertise.

HYPOTHESES

The relationship between Governance mechanisms of R&D and learning activities of the CoPs (H1)

Because a firm's governance mechanisms of R&D are used to shape the organizational environment in which the firm's members execute their R&D tasks, well-designed governance mechanisms can provide members with rich interactions and many knowledge exchange opportunities, and may induce members' learning activities. In this study, governance mechanisms of R&D are a multi-dimensional factor consisting of three variables: Span of integration, Qualification system of professional status, and Psychological safety.

Learning in teams is driven by interpersonal perceptions and concerns, and that a lack of psychological safety can inhibit experimenting, admitting mistakes, or questioning current team practices (Edmondson, 1999). Team members are more willing to communicate truthfully and reflect directly on previously un-discussable issues in teams with high team psychological safety rather than in teams with low team psychological safety (Isaacs, 1999). Therefore, in a high-level psychological safety environment, the learning activities of the CoPs would be enhanced. In sum, the H1 consists of three hypotheses described on the followings.

> *H1: Governance mechanisms of R&D will positively impact Learning activities of the CoPs.*
> > *H1-1: Governance mechanisms of R&D will positively impact Observation*
> > *H1-2: Governance mechanisms of R&D will positively impact Conversation*
> > *H1-3: Governance mechanisms of R&D will positively impact Practicing*

The relationship between learning activities of the CoPs and R&D performance (H2)

In essence, R&D performance is rested on the effective syntheses of expertise of a firm's employees. To promote R&D performance, the employees must exchange, discuss, and combine their knowledge. Learning activities of CoPs in firms are exactly the means employees may apply to enhance this knowledge processing dynamics. In empirical, scholars have observed that the same team dynamics

that promote performance also support learning and behavioral change (Katzenbach and Smith, 2003). Sarin and McDermott (2003) also find that group learning has a strong positive effect on the innovativeness and speed to market of the new products. Therefore H2 is depicted as

H2: Learning activities of the CoPs will positively impact R&D Performance
   H2-1: Observation will positively impact R&D Performance.
   H2-2: Conversation will positively impact R&D Performance
   H2-3: Practicing will positively impact R&D Performance.

THE SURVEY

A questionnaire survey was designed to explore the relationship among these research variables. The targeted respondents of the questionnaires are R&D members in companies belonging to technology industry (electronic components and computer, communication, and optical products manufacture), traditional manufacture industry (mechanical equipments and metallic material manufacture), Internet and information services, and some national research institutes. Their R&D works span among applied research, new product development, improvement of products, and new technique. In this study, we sent 280 copies of questionnaires by e-mail and post and received 202 returned questionnaires. Among them, 24 were abandoned for their incomplete answers. This resulted in 178 valid questionnaires and a respondent rate of 63.6%. The data quality of each research variables is tested by using Cronbach's alpha reliability test and then by confirmative factory analysis (CFA) method. AMOS 5.0 software was used to implement CFA tests and to test hypotheses in the linear structural equation model of the research framework.

RESULTS

Reliabilities and CFA tests

During the process of reliabilities tests, we delete some of the items that are inconsistent with most other items and result in lower reliabilities of the focal research constructs. The results of reliabilities tests (Cronbach's coefficient alpha) indicate that all research constructs are larger than the 0.7 criterion and are acceptable in our exploratory study. The results of CFA tests also indicate that the data of the samples largely have a good fitness with research constructs. Thus the data are deemed as suitable for the following hypotheses tests.

Research Model test and Hypotheses tests

AMOS is used as a statistical tool for evaluating the fitness among survey data and the linear equation model of the research framework (the research model) and for testing the hypotheses including the relationship between Governance mechanisms of R&D and learning activities of the CoPs (H1) and the relationship between learning activities of the CoPs and R&D performance (H2).

In testing H1, Span of integration positively associates with observation ($\beta=0.36$, $p=0.009**$) and conversation ($\beta=0.23$, $p=0.05*$), but its impact on practicing is insignificant ($\beta=0.19$, $p=0.134$). Quality of professional status positively associates with all three constructs of learning activities of CoPs: with obervatioin ($\beta=0.34$, $p=0.029*$), conversation ($\beta=0.44$, $p=0.002**$), and practicing ($\beta=0.67$, $p=0.000**$). Psychological safety positively associates with observation ($\beta=0.34$, $p=0.014*$) and conversation ($\beta=0.28$, $p=0.28*$), but its impact on practicing is insignificant ($\beta=-0.05$, $p=0.683$). Thus, H1 is partly supported. In testing H2, only practicing exerts a positive effect on perceived

R&D performance (β=0.58, p=0.000**), while both observation and conversation have no significant impacts on R&D performance. Hence, H2 is only partly supported.
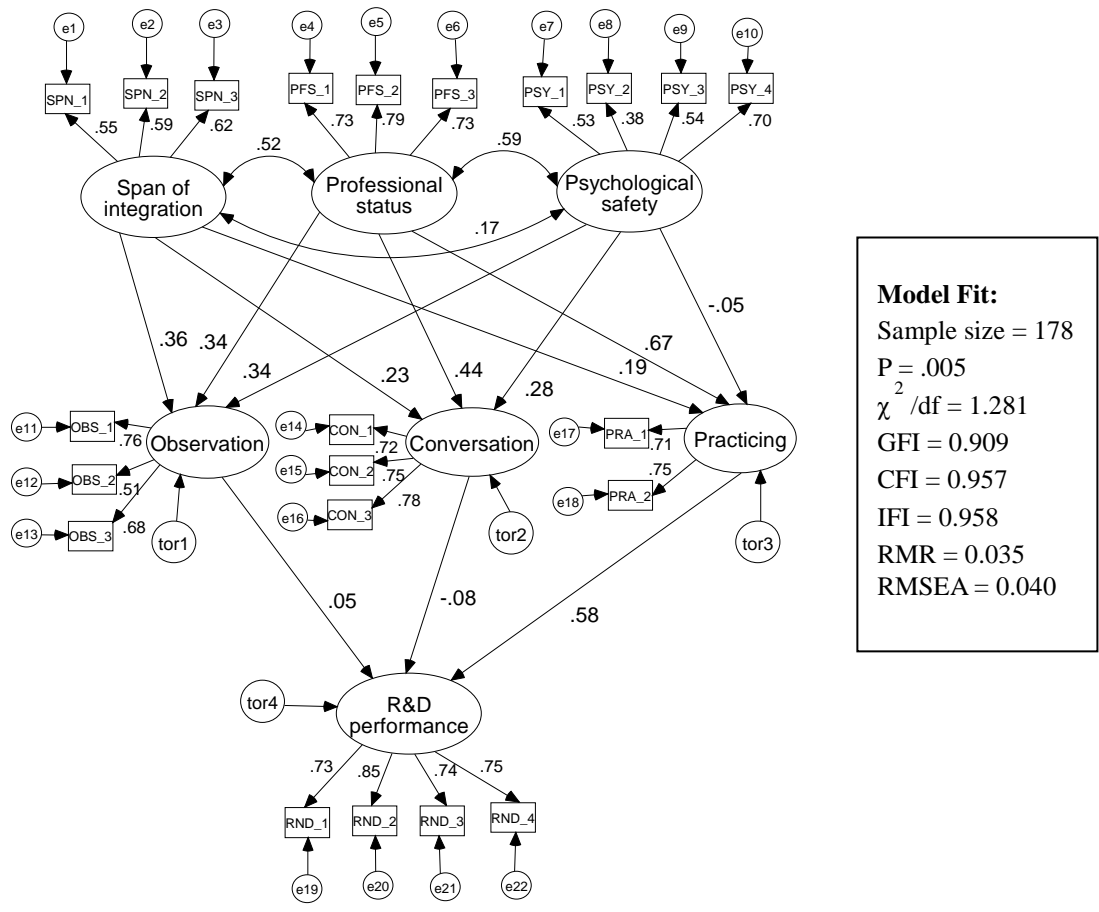
Figure **   The results of research model testing

CONCLUSIONS

(1) Organizational governance mechanisms do have impacts on learning activities of the CoPs
Among the three constructs of governance mechanisms of R&D, only "qualification of professional status" has positive impacts on all the observation, conversation, and practicing aspects of learning activities of the CoPs. And, both "span of integration" and "psychological safety" have positive impacts on the observation and conversation aspects of learning activities of the CoPs, but have no impacts on the practicing aspect of the CoPs.

(2) Learning activities of the CoPs have some impacts on R&D performance
The "practicing" aspect of the CoPs has a positive impact on R&D performance, while both "observation" and "conversation" have no impacts on R&D performance.

* References upon request

The Impact of Vertical Line Extensions on Parent Brand Evaluation －Perspective of Product Innovation

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ABSTRACT

The objective of this study is to examine the impact of vertical line extensions on the evaluation of the parent brand from the perspective of product innovation. A 2(extension: upward and downward) x 2(innovation information: with and without) x 2(extension degree: price increase/decrease 25% and 50%) x 2(price class: high and low) between-subjects factorial design was employed to test consumers' responses to vertical line extensions. Students at a University in central Taiwan were recruited via convenience sampling, resulted to 758 valid samples. The results showed that the upward line extension without product innovation information has positive impact on parent brand evaluations only in 50% price increase but not on 25%, while the negative impact of the downward extension also only happens in 50% price decrease but not for 25% price decrease. However, adding product innovation information to downward extension products can change the negative evaluations of parent brand to positive evaluations significantly for both 25% and 50% price decrease.

Key Words: Vertical Line Extensions, Product Innovation, Brand evaluation

INTRODUCTION

The vertical line extensions have been identified as one of the brand growth strategies by marketers via providing a price range of products under an existing brand name (Keller 1993). It usually extends to different variants in the same product category, but at different price points. Note that upscale/downscale extensions do not infer "superior" or "inferior" quality compared to other products in the same segment, but products with higher/lower prices, and more/fewer features compared to the parent brand. In practice, line extensions are more frequently used by the marketers than category extensions or new brand launches (Keller 1999；Kirmani, Sood and Bridges, 1999). In contrast, academic research has focused mainly on category extensions

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(Nijssen, 1999) and line extensions are still an under-researched area.   On the other hand, a substantial amount of studies on reciprocal transfer from extension product to the parent brand under category extension context (Broniarczyk and Gershoff 2003；Morrin 1999), but little research has been conducted from line extensions perspective (Randall, Ulrich, and Reibstein 1998).

Most of previous researches suggest that vertical extensions have a directionally consistent impact on price image, such that upscale extensions increase price image and downscale extensions decrease price image (Kim, Lavack, and Smith 2001；Lei, de Ruyter, and Wetzels 2008). We speculate that the key reason might be the price information is the single cue which has been used in the experiment of the research. In practice, the new vertical line introduction usually accompany the product innovation either adding new sophisticated feature for its upscale extension or reducing some trivial attributes but strengthening on new key feature. However, not only few study focus on the impact of product innovation on the vertical line extension, but the information of product innovation was often missed in the manipulation statement of experiment. According to Sinapuelas and Sisodiya's (2010) recent study on retail packaged goods, the higher the level of innovativeness of a new line extension, the higher is the parent brand equity. Boisvert's (2012) findings in the service context show that extension innovativeness partially mediates the effect of extension quality on attitudes toward the parent brand, while parent brand innovativeness moderates the effect of extension innovativeness. Therefore, the objective of this study is to examine the impact of vertical line extensions on the evaluation of the parent brand from the perspective of product innovation.

LITERATURE REVIEW

By broader definition, brand extension is defined as using the same brand name to introduce different products either in the same or different categories. But from the narrower perspective, the brand extension is limited to the different category extension only (Keller and Aaker, 1992; Kim and Lavack, 1996; Kirmani, Sood, and Bridges, 1999; Sullivan, 1990). For the same category extensions, it is defined as another term call (product) line extensions which include either vertical extensions or horizontal extensions. Vertical line extension normally attempts to use different prices either upward or downward to enter different market segments, whereas horizontal line extensions involve line stretching (at the same price) by simply providing a new version, flavor, package, or new feature for meeting consumer's need for variety. By means of upscale extensions, a superior version of the main product can target the

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premium sector of the market. On the other hand, downscale extensions often entail both a lower quality level and a lower price point that suits the necessities of the value market (Aaker, 1997; Kirmani et al., 1999; Liu, 2002).

For the category extension, Loken and John (1993) report that lower-quality extensions have negative brand evaluation regardless of brand fit with the new category. Ahluwalia and Gürhan-Canli (2000) have similar findings which indicate that lower-quality brand extensions have neutral to negative effects on brand evaluation, whereas higher-quality extensions have neutral to positive effects. However, the different finding from Zimmer and Bhat (2004) indicate that neutral to positive effects happen across brand extensions of varying quality levels and fit.

The perceived fit of category brand extension plays a key role for the extension evaluation. However, despite the perceived fit between original and extended categories is missed for line extension, the up and down price extensions create different impact for the brand evaluation. Lei, De Ruyter, and Wetzels's (2008) findings from two empirical studies in the hotel industry indicate that consumers perceive higher risks in step-up extensions than in step-down extensions, but a parent brand receives more positive evaluations after the introduction of a step-up extension than that of a step-down extension. Furthermore, they find that a higher-quality upward extension improved brand evaluation, whereas a lower-quality downward extension reduced it. Kirmani, Sood, and Bridges (1999) report that the evaluations of line extension happen differently due to the ownership effects and brand positioning. For prestige brand like BMW, owners rate it higher but nonowners rate it lower when upward extension. However, for non-prestige brand like Acura, owners rate it the same but nonowners rate it higher. Randall, Ulrich, and Reibstein (1998) find that a bicycle brand's quality levels were sometimes correlated with a price-based brand-equity proxy but that the number of product versions within a product line was negatively correlated with that proxy. As for horizontal line extensions (same quality but new flavor, version or size), most of the research report the positive effects on helping building business growth (Berger, Draganska, and Simonson 2007; Draganska and Jain 2005).

An empirical investigation using a survey methodology conducted by Boisvert (2012) indicate that extension innovativeness positively mediate the relationship between the new extension and the parent brand. In addition, high equity brands benefit more from innovative line extensions while low equity brands benefit more from the solo advertising of their line extensions. Furthermore, parent brand perceived

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innovativeness negatively moderates the impact of extension innovativeness on attitudes toward the parent brand.

A substantially lower or higher price for the extension product can provide the signal to the consumer that the new extension product is totally different market segment from the existing products. But this also provides different image of the quality–price perception for the parent brand. Musante (2007) argues that "the greater the difference between the brand's traditional price range and the price positioning of the new product, the less the perceived fit is." In the upscale extension, Musante finds that a new product closer in price to the original offering achieves higher rating than a substantially more expensive alternative.

HYPOTHESES

H1a：Without product innovation information, upward line extension will have positive impact on its parent brand evaluation.

H1b：Without product innovation information, downward line extension will have negative impact its parent brand evaluation.

H2：With product innovation information, both upward and downward line extension will all have positive impact on its parent brand extension.

H3a：Without product innovation information, the positive impact of upward line extension will increase when the extension range increase.

H3b：Without product innovation information, the negative impact of downward line extension will increase when the extension range increase.

H4：The positive impact of stating product innovation information for both upward and downward line extension will increase when the extension range increase.

H5：For upward/downward line extension, the positive impact of product innovation information will be higher significantly than that without product innovation information.

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METHODOLOGY

A 2(upward and downward extensions) x 2(innovation information: with and without) x 2(extension degree: price increase/decrease 25% and 50%) x 2(price class: high and low) between-subjects factorial design was employed to test consumers' responses to vertical line extensions. Two control groups of two products were used as base line to check the effects of the experiments. Motorcycle (US$2,667) and TV game player (US$333) were chosen to represent high and low price products respectively. A fictitious brand name YSH was used for the experimental products to avoid possible impact of original brand image. Students at a University in central Taiwan were recruited as research subjects via convenience sampling, resulted to 758 valid samples which were randomly assigned to the experimental conditions.

Questionnaires were administered in classroom during the first or the last 10 minutes of the class. We asked participants to imagine that a company tried to launch a new extension product and need their evaluation first. At the first part of the questionnaire, participants would read the basic information of the company, the product function and price. Then, they would see the extension information. For those extensions without mentioning the innovation information were stated with new price and premium or economy versions for upward and downward extension respectively. But the different innovation information was put on each type of extension. For example, new online function and new smell function were the innovation of TV game player for 25% and 50% upward extensions respectively, and adjustable size and portable light design were the innovation for 25% and 50% downward extensions. After viewing the information of new product line introduction, participants were asked to provide their attitude evaluation toward the extension product and parent brand. The measurement of brand attitude was a three-item evaluation included likability, desirability, and attractiveness with 7 points Likert scale range from extreme disagree to extreme agree. The items were averaged to form a composite measure (α= .94). For control group, participants just read the basic information the company without any extension information, which provide the base line for examining the experimental effects.

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Table 1 The experimental design

Products	Extension direction	Extension degree	Price (NT$)	w/o innovation	w/ innovation
TV game player	Upward extension	+25%	12,500	premium	New online function
		+50%	15,000	premium	New Smell function
	Downward extension	-25%	7,500	economy	Adjustable Size
		-50%	5,000	economy	Light and portable
Motorcycle	Upward extension	+25%	100,000	premium	Satellite GPS
		+50%	120,000	premium	Air-condition function
	Downward extension	-25%	60,000	economy	Folding function
		-50%	40,000	economy	Carry box design

RESULTS

At the first part, the effect of traditional line extension without stating innovation information was examined. The results reported in Table 2 indicate that the upward extensions have positive impact on the parent brand (versus control group) for both TV game player (4.37 vs. 3.94 t=1.989, P=0.05 for +25% and 4.52 vs. 3.94, t=2.755, P=0.007 for +50%) and motorcycle (4.05 vs. 3.87, t=0.838, P=0.404 for +25% and 4.44 vs. 3.87, t=2.580, P=0.012 for +50%). Meanwhile, consistent with our expectation, the downward extensions have negative impact on the parent brand for both TV game player (3.64 vs. 3.94 t=1.436, P=0.155 for +25% and 3.47 vs. 3.94, t=2.081, P=0.040 for +50%) and motorcycle (3.53 vs. 3.87, t=1.452, P=0.150 for +25% and 3.40 vs. 3.87, t=2.016, P=0.047 for +50%). The significant effects were expressed especially for the 50% price increase and decrease extensions. Thus, both H1a and H1b are supported. It appears that the single cue of price upscale and downscale extension will affect the parent brand image differently.

The second part of the analysis is to assess the effects of stating the innovation information on the manipulation of line extension. From the report shown on Table 2, the upward extensions, as expected, have positive impact on the parent brand for both TV game player (4.40 vs. 3.94 F=3.195, P=0.077 for +25% and 4.90 vs. 3.94, F=21.565, P=0.000 for +50%) and motorcycle (4.26 vs. 3.87, F=2.915, P=0.091 for +25% and 5.01 vs. 3.87, F=29.476, P=0.000 for +50%). The significant effects happened not only for 50% price upward extension but also for 25%. Meanwhile, the

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effect of 50% price upward extension was higher than that of 25% price upward extension. On the other hand, the downward extension did not have negative impact, but have positive impact on the parent brand for both TV game player (4.50 vs. 3.94 F=5.238, P=0.025 for +25% and 4.45 vs. 3.94, F=4.544, P=0.036 for +50%) and motorcycle (4.55 vs. 3.87, F=7.305, P=0.008 for +25% and 4.41 vs. 3.87, F=4.504, P=0.037 for +50%). This indicates that stating the innovation information not only reduces the negative dilution image for the downward extension, but also builds significant positive brand image versus control group. Thus, H2 is supported.

Next, the different effects between 25% and 50% upward and downward extension were examined. We found that there was significant difference between 25% and 50% upward extension for both TV game player (4.40 vs. 4.90 F=4.009, P=0.042) and motorcycle (4.26 vs. 5.01, F=7.978, P=0.000) when stating innovation information. However, the impact was not significantly different between 25% and 50% downward extension for both TV game player (4.50 vs. 4.31) and motorcycle (4.55 vs. 4.41), when stating innovation information. As for those groups without stating information, the impact of parent brand attitude did not have any significant difference between 25% and 50% upward and downward extensions, even though the effects of 50% upward and downward extensions had significant higher than the control group but not for the groups of 25% upward and downward extensions. Thus, both H3a and H3b are not supported, but H4 is partially supported.

Finally, we compare the differences for upward and downward extensions between stating innovation information and without stating innovation information. For upward extension, the positive impact was not significantly difference between with and without innovation information for both TV game player (4.40 vs. 4.37, F=0.009, P=0.924) and motorcycle (4.26 vs. 4.05, F=.984, P=0.324) when the price was up 25%. However, when the price was up 50%, the effects of stating innovation information were significantly higher than without stating group for both TV game player (4.90 vs. 4.52, F=3.418, P=0.068) and motorcycle (5.01 vs. 4.44, F=8.749, P=0.004). This indicates that the impact of stating innovation information will be bigger when the degree of upward extension bigger (from 25% to 50%). Thus, H5 is partially supported.

Table 2 The results of analysis

		Low price		High price	
		w/o Inno	w/ Inno	w/o Inno	w/ inno
Upward	+50%	4.52*	4.90**	4.44*	5.01**
Upward	+25%	4.37*	4.40*	4.05	4.26*
Control		3.94	3.94	3.87	3.87
Downward	−25%	3.64	4.50*	3.53	4.55**
Downward	−50%	3.47*	4.31*	3.40*	4.41*

Ps The statistics demonstrate the significant difference vs. control group.

* P<0.05, **P<0.01

TV game player

Motorcycle
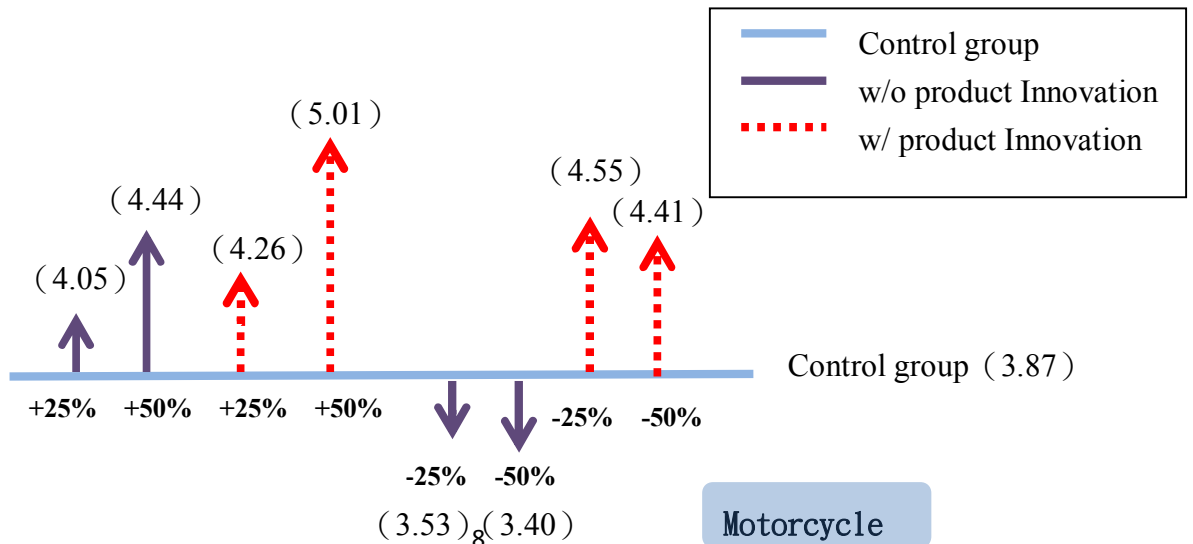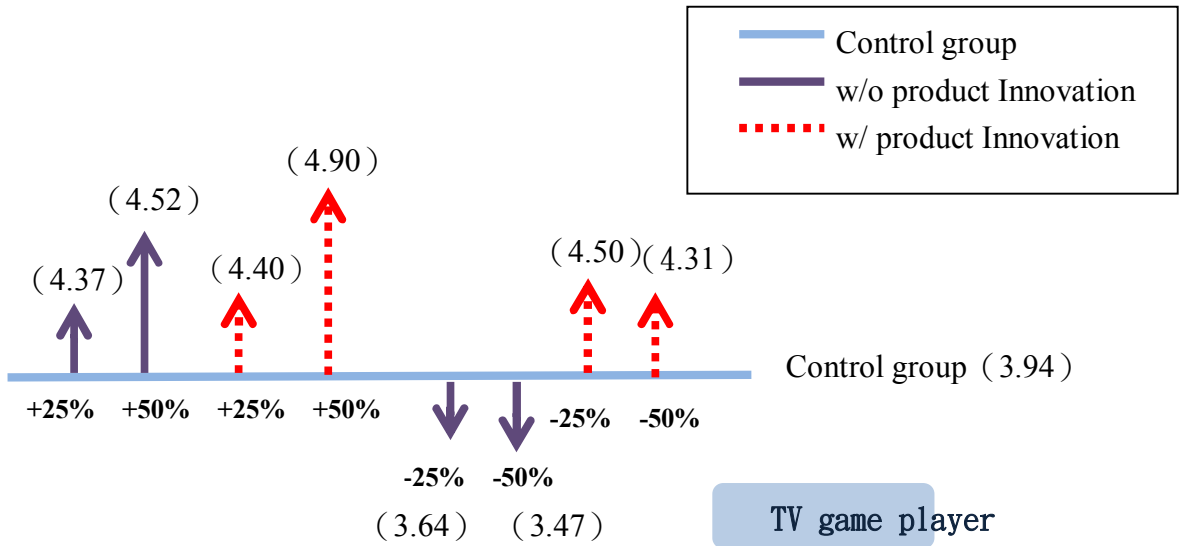
CONCLUSIONS AND IMPLICATIONS

The results showed that the upward line extension without product innovation information has positive impact on parent brand evaluations only in 50% price increase but not on 25%, while the negative impact of the downward extension also only happens in 50% price decrease but not for 25% price decrease. However, adding product innovation information to downward extension products can change the negative evaluations of parent brand to positive evaluations significantly for both 25% and 50% price decrease. As for upward extension, the reinforcement effect of product innovation only happens for 50% price increase but not for 25% price increase. The situation is almost the same for both two products in different price level.

Theoretically, this study brings new insights as well as closing an important theoretical gap in the literature regarding the complex dynamic effects of innovativeness in a context of a vertical line extension during launch as it reciprocally impacts attitude toward the parent brand. In practice, marketers must be careful to communicate the innovativeness of a new product because that can dynamically influence reciprocal attitudes toward the parent brand.

Reference upon request

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DO THE DIFFERENT MANAGEMENT PATTERNS MAKE THE PERFORMANCE DIFFERENT? – THE EMPIRICAL STUDY OF SUCCESS FACTORS ON HOSPITALS IN TAIWAN

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ABSTRACT

The purpose of this study is to explore the triangular relationship among work values, leadership style, and innovation capacity, and to realize if the three variables could affect the performance, and how these characteristics influence the operating performance. This study took hospitals that were qualified by Taiwan Joint Commission on Hospital Accreditation in 2007 as our samples, and the research object were leaders of TMT (Top Management Team) in hospital (including superintendent、vice superintendent or director of management center). We adopted structured questionnaire to survey with 100 valid samples.

The conclusions of this study are that the two properties of family firms and agent-managed firms are complement to each other. We proposed that family firms should to strengthen the innovational capacity; external views and ideas should be more referral. While family firms employ professional managers, the board should empower appropriately to professional managers, and to establish reasonable reward system and punishment mechanism. Professional managers should also obey the ethics in the workplace to enhance the hospital's operating performance and achieve ultimate goal.

Keywords：management pattern, professional managers, work values, leadership style, innovative capacity, performance.

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INTRODUCTION

Taiwan medical industry encountered severe conflict in its environment since the launch of national health insurance system in 1995. According to the data from the statistic of the Dept. of Health, from 1996 to 2010 the number of public hospitals dropped from 95 to 82 and from 692 to 426 for private hospitals. The hospitals practicing western medicine suffered the most significant loss. This explicitly described that other than the externality factors, such as rising medical service competition and consumer awareness, medical institutions of all levels confronted the internal issues like the change of management styles. In response to national health insurance system, hospitals also adjusted their management strategies, including transforming into Medical Corporation Aggregate Hospitals or the contractors of public hospitals, for sustainability and future development.

The institutional attributes of Taiwan hospitals can be classified into family business and non-family business; the manager attributes can be the professional manager of the family business, recruited professional manager for the family business, and the professional manager for non-family own business. Their work value, leadership style and innovation capacity vary; therefore, their management performance vary accordingly. This study explores the differentiation of medical industry from the perspectives of management attribute, work value, leadership style, innovation capacity, and hospital performance.

LITERATURE REVIEW

Family business

The definition for family business by researchers is quite extensive. So far, there isn't a consistent standard for it. However, most documents define it from the perspective of ownership. Chua, Chrisman, and Sharma [1] indicated the definition of family business lies in the fact whether the family possesses the ownership or the control over management. Barns and Herson [2] considered the business whose ownership controlled by an individual or a family as a family business. However, it is not sufficient to judge it only from ownership; it should be taken from the perspective of management control. Some researchers defined it by the degree of family member involvement. Astrchan, Klein, and Smyrnios [3] believed that family members' involvement and degree of influence should be considered in defining a family business. From the definition by Chandler [4], family business not only exist in the classic enterprises that ownership and operating concession are merged. In the "modern enterprises" with two rights separated, it can be considered a family business as long as the individual or family control the major decisions making like financial policy, resource allocation, and manager selection while maintaining a close personal relationship with the manager. Therefore, this study adopts the definition by Chandler: The business founder and his/her closest partners (or families) control the majority of ownership. They keep tight personal relationship with the managers and retain the major decision making rights, especially in financial policy, resource allocation, and senior manager selection.

Professional manager

Management master Drucker once pointed out when a family business develops to a certain degree, it would be necessary to introduce professional manager for its management. The emergence of professional manager is to answer the need for professional management Therefore, appointing professional manager is a not only a major trend of modern business management, but also a symbol of mature business management. When a family business

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starts introducing professional managers, it indicates the separation of ownership and management. Berle and Means [5] proposed the classic exposition of separating business ownership and business operating concession, which is considered by many scholars as the necessary path to business modernization. The emergence of separating business ownership and business operating concession system is of revolutionary significance to business and its managers. It means the professional managers with managerial talents can own the business operating concession. When operation right is separated from merged ownership and operating concession, it enables professional managers to exercise their expertise in management and promote efficiency.

Work value

Schwartz [6] indicated work value derived from the definition of value and have close relationship with life value. In another word, work value stems from and based on value . The classification of work value varies; however, it can be induced to internal value and external value. This study evaluates employee work value based on their value on their work.

Leadership style

New leadership theory emerged in early 1980s and is still thriving. Charismatic leadership and transformational leadership are the two most well-known styles. Charismatic leadership indicates the leaders with charismatic quality and behavior can induce other members' identification and influence them. Under uncertain situations, charismatic leaders can inspire subordinates to surpass themselves and accomplish the task assigned. Transformational leadership was first brought up by Burns [7] in 1978. The basic concept is dividing leadership type into transformational leadership and transactional leadership. Later Bass [8] further expanded Burns theory and classified leadership style into transformational leadership and transactional leadership. Transformational leadership style means leaders help the subordinates understand the importance to the organization the necessity for them to accomplish the tasks assigned and help the organizations to reach the targets. Meanwhile, leaders help subordinates understand their own growth, development and achievement needs and inspire subordinates to endeavor for fulfilling organizational goals. Transactional leadership rewards high-performers and reprimands low-performers; i.e. transactional leaders increase the intended behaviors and decrease or reprimand the unintended behaviors.

Innovation capacity

In a global competitive environment, innovation capacity is the key factor in adapting to new limitation and grasping new opportunity [9]. A business in short of this capacity shall be eliminated from the market. Holt [10] proposed that innovation is a process which innovatively employing new knowledge or related information to form new product or new procedure. Innovation is considered a progress that breaks through traditional practice, and innovation capacity is to bring forward the novel ideas. The major difference of the two is that innovation concretely implements the concept and brings forward the result; innovation capacity is the capacity of expanding in the existing realm to create new things and new ideas.

Hospital performance indicator

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In face of the changing medical system and health insurance policy, to sustain hospital management, hospital performance management has been taken more seriously. There isn't a consistent definition for performance; however, performance can be seen as the measurement for the target reached. The purpose is to understand if the business performance meets the expected efficiency and effectiveness. This study defines hospital performance as: A hospital quantifies all its business performances, including those in financial and non-financial dimensions, to understand the over operation performance.

METHODOLOGY

This study aims to investigate the influence of hospital attributes on work value, leadership style, and innovation capacity to explore if these three elements have any impact on the hospital performance and to understand if medical institution attributes affect hospital performance.

Hypotheses

1. *The impact of medical institution attributes on work value, leadership style, and innovation capacity*

   Locke & Henne [11] proposed personal work value affects one's work willingness and further affects one's effort extent and work performance. Different management attributes and managers also demonstrate different work value. Therefore, this study proposed hypothesis 1: With different medical institution attributes, there is a significant difference in the work values of the managers. There is a significant correlation between leadership style and business culture background. That is, different hospital management attributes and managers will lead to different leadership styles. Therefore, we proposed hypothesis 2: With different medical institution attributes, there is a significant difference in the leadership traits of the managers. Santomero & Trester [12] proposed that innovation capacity is to break the existing patterns and overcome social and cultural barriers to introduce novelty. Therefore, innovation capacity is the key factor in business development and growth. This study thus proposed hypothesis 3: With different medical institution attributes, there is a significant difference in the innovation capacity of the managers.

2. *The impact of work value on hospital operation performance*

   The work value is the persistent conviction and standard in judging work affairs, behaviors, or goal when one is at work. This is manifested in work performance and pursuing work target. That is, personal work value will be exhibited in work behavior and affect work performance. Therefore, this study proposed respectively hypothesis 4: The goal value of work value has a significant impact on hospital performance; and hypothesis 5: The tool value of work value has a significant impact on hospital performance.

3. *The impact of leadership style on hospital operation performance*

   Other than extraordinary leadership quality, a successful leader also needs to exhibit highly effective leadership style. Leadership style has a significantly positive impact on work performance. Thus, this study proposed hypothesis 6: Transformational leadership has a significant impact on hospital performance, and hypothesis 7: Transactional leadership has a significant impact on hospital performance.

4. *The impact of innovation capacity to hospital operation performance*

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In a hypercompetitive environment, innovation is one of the leading competencies for a business to maintain its sustainability and competitive advantages [13]. The overall innovation capacity of a firm has a positive impact on its operation performance. Thus, this study proposed hypothesis 8: The innovation capacity has a significant impact on hospital operation performance.

Research subjects

The scope of this study is the regional hospitals accredited by Taiwan Joint Commission on Hospital Accreditation (TJCHA) in 2007. The aim of the study is to explore the impact of medical institution management attributes on work value, leadership style, and innovation capacity and study how these factors affect the hospital operation performance. The research subjects are the executives of the surveyed hospitals (including presidents, vice presidents, or management center directors) and the study employed a structural questionnaire in data collection. The survey process lasted from April 9 to April 27, 2012.The questionnaires were distributed to 469 hospitals through mail; 126 copies were returned. After eliminating the invalid questionnaires due to incomplete responses, 100 valid replies were collected; the returned rate is 21.32%. The results indicated that all of the scales achieved satisfactory reliability (Cronbach's $\alpha > .70$).

RESULT

Distribution of the surveyed hospitals

The scope of the research includes public hospital, private hospital, juridical person hospital and medical corporation aggregate hospital, with private hospitals consisting 57% of the total hospitals surveyed. This study classified the hospital operation into merged ownership and management and separated ownership and management. Through data analysis, we learned that 65% of the surveyed hospitals employed merged ownership and management, while 36% of family business hired professional managers.

The impact of medical institution operation attributes and manager's leadership styles

This study takes the medical institution operation attributes as the independent variables and the manager's leadership styles as the dependent variables to conduct one-way analysis of variance. The results showed there is no significant difference between varied institution attributes and manager's transformational leadership. However, there is significant difference between varied institution attributes and manager's transactional leadership. That is, the transactional leadership quality of a non-family business manager is significantly higher than family business manager. Therefore, we found that hypothesis 2 is partially supported.

The impact of the goal value of work value on hospital performance awareness

This study takes self-improving orientation, self-realization orientation, and self-esteem orientation as the independent variables, hospital operation performance awareness as the dependent variable. The results shows self-esteem orientation has a significantly positive effect on the hospital operation performance awareness. Thus, hypothesis 4 is partially supported.

The impact of tool value of work value on hospital operation performance awareness

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This study takes social interaction orientation, organization safety and economy orientation, stability and anxiety-free orientation, leisure time and convenience orientation as the independent variables and hospital operation performance awareness as the dependent variable. The regression analysis results shows organization safety and economy orientation has significantly positive effect on the hospital operation performance awareness. Thus, hypothesis 5 is partially supported.

The impact of the transaction leadership on the hospital performance awareness

This study takes expedient reward, active exception management, and passive exception management as the independent variables and hospital performance awareness as the dependent variable. The regression analysis results show transactional leadership has a significantly positive effect on the hospital performance awareness; expedient reward has a significantly positive effect on hospital performance awareness; passive exception management has a negative effect on hospital performance awareness. Thus, hypothesis is partially supported.

The impact of innovation capacity on hospital performance awareness

This study takes innovation capacity as the independent variable and hospital performance awareness as the dependent variable. The regression analysis results show innovation capacity has a significantly positive effect on hospital performance awareness. Thus, hypothesis 8 is supported.

DISCUSSION

The discussion in this section is based on the data analysis from the questionnaire survey. It is divided into three parts. The respective discussions are 1) medical institution management attributes and manager's personal traits; 2) manager's personal traits and hospital operation performance awareness, and 3) medical institution management attributes and hospital operation performance awareness.

Medical institution management attributes and manager's personal traits

1. Medical institution attributes and the manager's leadership style
This study believes non-family business managers are concerned of the employment retention and colleague evaluation; they thus exhibit both transformational and transactional leaderships. As Bass [14] mentioned the best leader is the one demonstrates both leadership styles.

2. Medical institution attributes and the manager's innovation capacity
This study infers the cause for family business to value innovation capacity less than non-family business is that they can be easily trapped in the myth of following traditions. This corresponds to the observation of Chang (2006) that the inferiority of family business often leads to effective innovation mechanism.

3. Manager's personal attributes and manager's leadership style
After one-way analysis of variance, this study found diversity in the passive exception management of the transactional leadership. We believe the non-family business managers

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tend to expect their subordinates to be sufficient with problem-solving capacity. They will step in to solve the problem only when the subordinates failed to reach the expected standards. Thus, non-family business managers have higher consideration for passive exception management.

Manager's personal traits and hospital operation performance awareness

1. The work value in manager's personal traits and hospital operation performance awareness

   Based on the regression analysis, this study found the self-esteem orientation in purpose value has a significantly positive effect on hospital performance, which indicates that the sense of achievement and self-affirmation from work satisfaction has a positive effect on hospital performance. The organization safety and economy orientation in the manager's tool value has a significantly positive effect on hospital performance, which means to effectively promote hospital operation performance, managers has higher consideration for reasonable financial rewards and sound organizational system.

2. Manager's leadership styles and hospital operation performance

   Based on the regression analysis, this study found the expedient reward in transactional leadership has a significantly positive effect on hospital performance, which indicates managers believe an adequate reward and reprimand system is effective in promoting hospital performance. The passive exception management in transactional leadership has a negative effect on hospital performance, which indicates though managers respect the subordinates' autonomy, it however may lower the hospital's efficiency and performance and bring significantly negative effect. Therefore, this study infers that transformational leadership exercises charisma, vision, and moral to lead the subordinates. Professional managers are the result of ownership and management separation. The basic presumption is that professional managers are individualistic and egoistic; it's difficult for a manager with only transformational leadership to lead his subordinates. Therefore, it will take incentive scheme to inspire better performance.

3. The innovation capacity in manager's personal traits and hospital operation performance

   Based on the regression analysis, this study found the manager's innovation capacity has a significant positive effect on hospital performance, which indicates that to promote hospital performance, managers better exhibit their innovation capacity.

Medical institution management attributes and hospital operation performance awareness

1. Institution attributes and hospital performance awareness

   After one-way analysis of variance, this study found different institution attributes don't make any significant difference in hospital performance awareness. However, from the mean obtained, we found family business hospitals have higher performance awareness than non-family business hospitals. Therefore, this study infers that because family businesses value their sustainability, they are more active in bringing in operation performance.

2. Manager's attributes and hospital performance

   This study classified manager attributes into the professional manager of the family business, the professional manager for the family business, and the professional manager for non-family own business. The results showed the manager's attributes make no significant

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difference on hospital performance. However, judging from the mean, the professional manager of the family business has the highest operation performance, followed by the professional manager of non-family business, and the professional manager of the family business has the lowest performance. This is inconsistent with the pervasive perception that after separating ownership and management, professional managers create better performance. As previously stated, this study believes that the professional manager of family business is given the mission of making sustainable development; thus they have higher value for operation performance. However, introducing professional managers did not relatively enhance family businesses performance. This study infers that even though professional managers are recruited, family business still partially control the management. The recruited managers may not be given the chance to fully demonstrate his expertise yet is held responsible for the outcome.

CONCLUSION

The attributes of family business and the attributes of professional manager are complementary. It is recommended that family business should enhance their innovation capacity and give the outside opinions and ideas more thought. When family businesses introduce professional managers, it is appropriate to authorize the managers and establish adequate reward and reprimand mechanism. The professional managers should also observe the workplace ethics and bring in the ultimate purpose of promoting hospital performance.

Managers of various medical institutions attributes, whether it is family type or non-family type, believe the self-esteem orientation in goal value, organization safety and economy orientation of manager's tool value, expedient reward of the manager's transactional leadership, and innovation capacity can effectively enhance hospital operation performance. Therefore, the practice of these factors, whether it is enhancing self-realization, adequate incentive measures, or staff training and development, should be strengthened and systemized to enhance the performance. Also, it is suggested that the probability of passive exception management should be lowered to actively detect the problems and make proper correction.

To conclude, it is recommended that family business should enhance their training in innovation capacity. Give more consideration to the external opinions and ideas; what worked before cannot guarantee future success. If family businesses decide to bring in professional managers, they should consider how to adequately delegate authority to effectively promote hospital performance.

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The Business Model for Tele-health care Service: the Case in Taiwan

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ABSTRACT

Population aging, life expectancy and even economic inequality and health inequality have become a serious problem in Taiwan. There are two main issues here: one is dramatic change of family structure, the other is health care for the elderly. On one hand, it is a social problem. On the other hand, this also results in a potential opportunity for providing medical business for the elderly or weak minority in term of social welfare as well as business model.

Due to long life expectancy, low fertility, the population of elder above 65 years old is over 11% in Taiwan. This figure will shoot up to 14% in 6 years and up to 20% in 2025. Therefore, the potential business to provide elderly people with health, residence, economy, social adaptation and leisure such as senior center, catering service, day care or medical service is demanding and promising. In addition, the Taiwanese aborigine tribe is the minority which is about 2% of total population of Taiwan. The aborigines inhabit the eastern half of Taiwan which consists mostly of mountainous terrain with weak economic conditions. Most of them have a lower life expectancy and need government supports, especially for health care. This study will investigate the area of Hualien, located in eastern part of Taiwan, where the most aborigine tribe lives in mountain area with poor transportation facility. In addition, the medical institutions are less equipped in most area except downtown. In this case, it is good to design a telehealth care model for this area. If the model works, then it will be easily applied to other area with better condition.

This study will use data-mining to get the demographic data and medication record from patients in Hualien. It is essential to get the support from Hualien Hospital. The feedback and communication between hospital and subject sample or even patient is also critical to make this model effective. All the health care data about target sample will convey to hospital through cloud computing. The hospital will give comments about medication after a careful analysis. An initial investment is required to set up a basic instrument at home for each sample flame. A clear presentation or demonstration is also needed to make all health measurement right on track.

Keywords：Tele-health care, Data Mining, Population Aging, Low Fertility, Family Structure, Economic inequality, Health inequality

I. INTRODUCTION

The government of Taiwan has been proactively developing cloud computing technology to resolve the lack of resources at small and medium scale hospitals and to promote intelligent cloud-based medical service via the big computing capacity of cloud technology. For cloud terminal applied at health care service, the word "terminal" is about those physiological measuring devices connected to the users, whereas the word "cloud" is about performing real-time analysis on large quantities of data from patients staying at home, providing complete and timely medical information to caregivers, and detecting problems as early as possible to provide timely treatment. The increasing number of terminal devices in the service network provides patients with more and more comprehensive care and better assistance for their everyday life. In *The Innovator's Prescription: A Disruptive Solution for Health Care*, Clayton Christensen (2008) pointed out three elements of innovative health care service model. The first one is the technology facilitating factor that combines information communication technology with home-based physiological measuring

devices as well as video conferencing to create a low-cost care service in which health care personnel can use their cell phones or computers to check their patients. The second element is an innovative operation model in which information system makes electronic home-based service procedure possible and connects patients to health care personnel, family members and community volunteers, who collaboratively take care of these stay-home patients and help them receive treatment at home. Basic service is about managing personal health-related files by recording individual's physiological measurements taken at home in a computer or cellphone and combining the information with clinical or medication records. A high level application service is about carrying out remote medical consulting, offering more personalized diet and health recommendations based on personal health care records, improving the accessibility and instantaneity, and constructing a new value network.

Hualien and Taitung are at the mountain part of Taiwan, and because many people have moved out from these areas and transportation inconvenience, a huge health care service gap can be observed between urban and rural areas—overcompetitveness in the urban area, but insufficient medical resources at those remote areas. For long, the government has worked on subsidizing mobile clinics at remote areas as well as using information communication technology to improve health care service at those areas. Those senior citizens at remote areas tend to have a lower technology acceptance, and as a result, community volunteers are important in helping residents there be more willing in using these medical devices, i.e., increasing their acceptance. With population aging and the promotion of community-based health care policy by the government, hospitals have begun implementing tele-health care and collaborating with local community clinics. These hospitals have medical specialists see patients remotely and give medical instructions to local nursing personnel to take care of the patients. Furthermore, local home-based care assistance networks, including medical devices, meal service, transportation, and shopping, has been integrated by information system to provide collaborative tele-health care service and to build a less expensive health care service model.

When promoting remote area care policies, the government of Taiwan has to consider the decision-making model of the use of remote area health care, especially in terms of the instantaneity and accessibility of medical resources as well as personal and family ability, which can affect the family decision-making model. For work, many family members cannot live together, but studies have shown that senior care requires family and community support. Changes in the social environment have weakened not only the trust between people but also the mutual aid system existed in conventional families and communities. Therefore, to promote tele-care service, it is important to enhance community mutual networks. In this study, the researchers will 1) apply data mining to develop senior health care use prediction model and to exploit the possibility of family health record platform; 2) use internet communities to examine the possibility of developing tele-care network; 3) examine the tele-health care strategic alliance operation model based on transaction cost and apply information and communication technology for developing a cloud-based health care service model.

II.   CONCEPTUAL FRAMEWORK: TeleHelthCare Business Case Planning Model

The excellent health care service in Taiwan is famous worldwide. The government hopes to provide tele-health care service via the internet, but the service has scarcely been used and more value added for assisting daily living, such as residential meal delivery, car pool, shopping and other residential services, should be exploited. The public will be more willing to use tele-health care service if a collaborative care service network can be established. A social network for senior citizens can be set up to encourage elderly people participating social activities, developing social capital, and helping each other. Internet communities enable people capable of offering service to assist patients needing help. The goal of the study is to use the social capital theory to develop a mutual assistance mechanism for internet community-based care.

Asides from improving tele-health care service, cloud-based service also offers a better commercial opportunity from forming a network integrating various services assisting daily living. Patients need not only medical care service but also other services assisting their daily living. In this case, the internet can be used to link needs to services to create a network providing people at remote areas with living assistance and care services. With cloud technology, various new services have been developed for needs of living assistance and this advancement has fundamentally altered tele-health care service. Health care service has regional characteristics, and with cloud technology development, tele-health care becomes more readily available, which will modify individually tailored disease prevention plans and medical behavior. Eventually, medical service model with personal health as the payment condition will replace the current treatment-based health insurance payment model. In recent years, cloud technology has been widely applied in the health care industry, and the major reason is population aging, which increases health care demands. Countries around the globe have been doing their best in reducing medical cost while improving health care quality. By integrating internet technology applications, the popularity of cloud-based health care information platform for sure will be greater and may even replace the current health care operation model. In the current health care model, patients enter the health care system only when they are ill and receive only partial treatment from physicians, i.e., treatment is formulated based on the symptoms of patients when visiting their physicians. In other words, there is neither continuous treatment or follow-up for improvement, clarifying the cause of illness, nor post-recovery treatment and care. One can say that the current health care service model lacks a health-promoting value.

Among medical technology innovation and development trends, the integration of genetic engineering and information technology has exerted critical impacts on the health care service industry. Considering different people having different types of diseases and symptoms, the use of genetic engineering for formulating appropriate drug treatment and prevention will be critical in preventive medicine. A prerequisite of the development of preventive medicine is to clearly grasp causes of diseases and risk factors; past medical history of family members and living habits are especially important. It is therefore indispensible for developing family health record to link to electronic medical history saved in medical institutions.

Figure 1 Cloud-based tele-health care service

According to information provided by past medical history and medication record as well as the lifestyle, diet and exercise habits of patients, health care teams can develop and implement preventive medicine and geriatric home care. As medical cloud technology transforms current health care service to a cloud-based one, patients' health care record and clinical visit record become sharable. Whether it is medical history, health condition, daily living habits or diet, they can all be transmitted to the cloud-based medical information platform via cell phones or computers. In other words, patients' clinical record, physicians' medical notes, medication purchase records, as well as the records of physiological parameters such as heart beats, blood pressure, body weight, body fat, dietary recommendations, and recommended food/meals can all be integrated. Medical teams can view and analyze the data and formulate specific health recommendation for each patient, and the data acts as a communication means bridging medical teams and patients. The model of could health care service is presented below.

According to the literature review, the study observed internet communities and developed a research framework consisting of five dimensions for analysis, which are individualized health care demands and predictions, community-based care services, medical institutions care cost, life-supporting innovative applications and services, and changing the health care payment model. A prediction model has been developed based on the various dimensions of needs, while the concept of transaction cost is employed to explore strategies for tele-health care, integration of community-based support network, and development of cloud-based tele-health care service. Health care is a distinctive service market, while medicine is a highly specific asset. The goal of tele-health care is to reduce the frequency of doctor visit, which can increase uncertainty of hospital business. If people have no loyalty to their hospitals, health care resources overall are likely to be wasted. For the internal care service provided by hospitals, the study has set up the following structure for analysis (Figure 2):
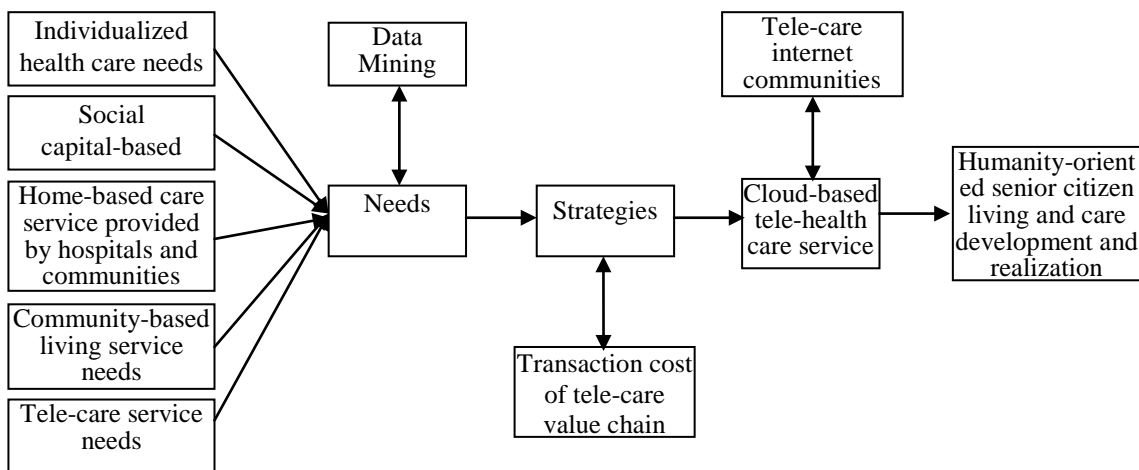
Figure 2 Cloud-based tele-health care service frameworks

III. IMPLICATIONS OF THE STUDY

The study will achieve the following goals:

Data mining will be used to investigate the decision-making model of the use of tele-health care. The research scope covers the followings: 1) Classification and prediction decision-making tree will be developed for households participating in the home tele-care program of Department of Health. The study will carry out cluster analysis using questionnaire design and develop tele-care use prediction based on the decision-making tree after identification and naming; 2) Tele-care efficacy model based on family decision making will be developed. Demands and feasibility of

tele-care service will be analyzed.

For developing the tele-care service demand prediction model, the research scope covers the followings: 1) The concept of social capital will be used to explore feasibility of using the internet for developing community network; 2) A collaborative community-oriented care service model will be developed.For developing a family health record platform, the research scope covers the followings: 1) Family-centered health care record platform will be set up; 2) A feedback mechanism will be established to elevate satisfactory of health care of remote areas.

The study will use factor analysis to extract key factors of "health care accessibility scale" and "tele-care use option factor scale". Meanwhile, clustering will be carried out to make the result from the decision-making tree easier to be interpreted. Clustering will also be applied on "tele-care use" to give the decision-making tree clear and definite target classification labels. Clustering analysis will be applied on segmenting care service demands for comparing with the decision-making tree. Chi square test will be performed to further describe each segment and to test if there are significant differences between segments on the use of tele-care. By doing so, those variables that can effectively differentiate tele-care service can be obtained. The method of decision-making tree of data mining will be used to classify users from different areas with different cultural background and having different tele-care needs. Classification technology will be applied to classify users into groups with similar characteristics or of a same type and to evaluate their tele-care use model via the corresponding communication model to enhance their approval of and confidence in tele-care. The study will adopt the algorithm approach of decision-making tree of data mining to find out key factors affecting the use of community- and home-based care service by users from different areas and to develop a predictive model of users participating in the tele-care program. The acquired results can be used by government or health care agencies as a reference for promoting their administrative policies.

For households participating in the tele-health care program of Department of Health, "physiological measuring device" is used to instantly transmit the measured physiological parameters to the remote monitoring platform for integration. Different public health centers are also incorporated into the research project to provide home-based care service. Public health nurses provide the care service using the established "aboriginal people health care database." By establishing the "aboriginal people health care platform," hospitals can understand health history of aboriginal patients as well as their family members and provide these patients with appropriate medical care. In the future, an integrative, cloud-based aboriginal health care system can also be constructed to offer better health care service.

The 3G network has not only upgraded mobile clinic vehicles of hospitals to wireless mobile health care and service vehicles but also expanded these mobile clinics to provide home-based mobile health care service. In other words, these mobile clinic vehicles can be connected to the medical mainframe of hospitals at remote areas to form a network and to establish a long-term care monitoring platform for measuring and collecting vital signs, including blood pressure, pulses, body temperature, blood oxygen, ECG and blood glucose, of residents of remote areas. The collected data can be transmitted to and integrated in the aboriginal people health care database. Through systemic data analysis and monitoring, medical team members can actively take care the health of people. By combining community health care and public health system, a basic level care service system can be developed to provide people living in remote areas with more comprehensive and continuous long-term health care service. By constructing a family-based long-term health care operation and environment, people living in remote areas can receive better health care and health-related welfare. By combining hospitals, community clinics, and community care with individual family-oriented health care information service, individually

tailored health consultation, care and suggestions can be given. If needed, these basic health care services can be expanded as well. Meanwhile, family and relatives of patients at remote areas can also obtain the health condition of patients via the internet, and this measure improves the health care service provided to residents of remote areas.
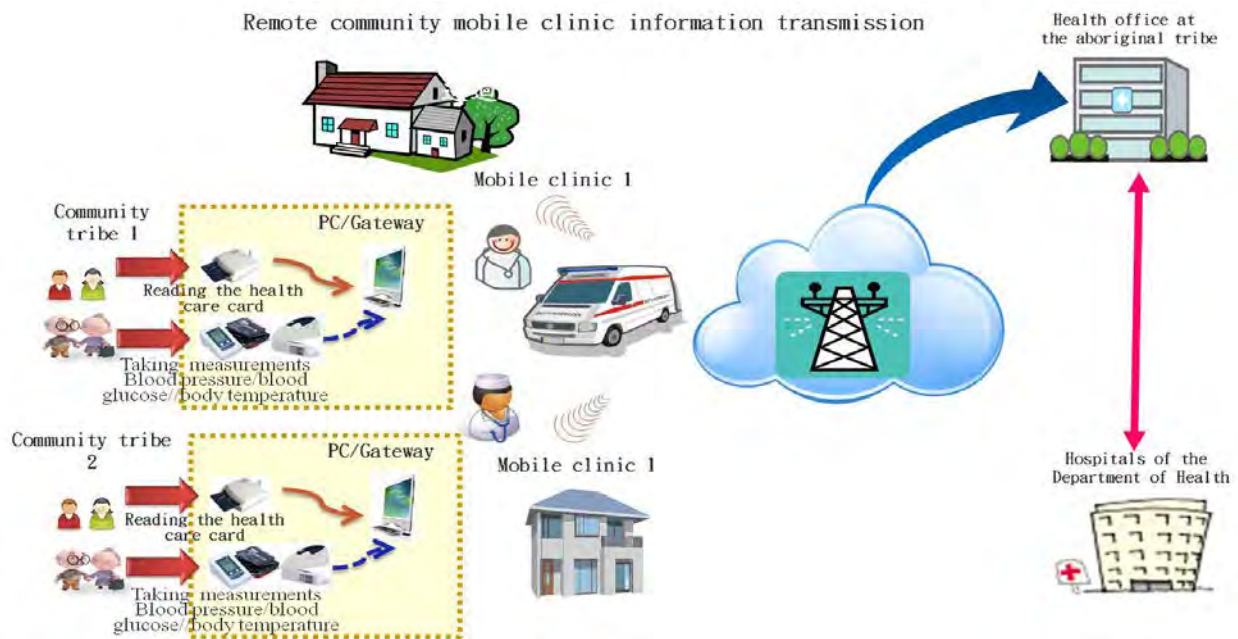

Figure 3 Remote community mobile clinic information transmission

IV. CONCLUSION

The fast development of information communication technology has changed conventional service models, and the change is beneficial by making the distribution of medical resources more evenly distributed and allowing the government to more effectively promote policies enhancing the accessibility and availability of health care service as well as to provide such services via cloud technology. Hualien is an excellent place for community care research because its characteristics, such as multiple ethnic groups, population aging trend, and urban-rural gap in medical resources, reflects the health care service environment of Taiwan in a smaller scale. In addition, the participation of two largest psychiatric hospitals in Asia is helpful for more thoroughly analyzing the research findings related to the psychological and sociological aspects of senior citizens. The study is a cross-disciplinary, industrial-oriented study examining home-, community-, and institution-based health care service for senior citizens. The study subjects are households using home-based tele-health care platform provided by Department of Health, while the study methods are the decision-making model of the use of health care service by senior citizens and data mining. The study goal is to integrate health care service for senior citizens at medical institutions with the internet community-based tele-health care platform, while information communication technology is used to set up a family, community and social exchange integrated network. Ultimately, the authors want to develop cloud-based innovative, collaborative tele-health care service and applications.

References on Request

THE STUDY OF THE RELATIONSHIP BETWEEN FUND MANAGERS' BEHAVIOR AND INDIVIDUAL INVESTOR SENTIMENT

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ABSTRACT

Fund managers and individual investors are all participants in the stock market. Their final purpose for investment is to gain the profit as well. However, they play totally different roles in the market. Rational fund managers can precede arbitrage trade when over- or under-reaction caused by investor sentiment make stock price unreasonable temporarily. On reverse side, investor greed and fear would form irrational behavior and affect portfolio allocation of fund managers. Therefore, the relationship between fund manager behavior and individual investor sentiment is an interesting issue worthy to investigate. Our research period is from Jan 2003 to December 2011, total 9 year data by quarters. All samples include 126 stock mutual fund retrieving from databank of Taiwan Economic Journal (TEJ) and Financial Statistic monthly report. Our empirical results show that individual investor sentiment has a significant effect on the behavior of fund managers. Individual investors behave as noise trader in open-end stock funds. This implies that fund manager should consider not only fundamental analysis, but also the change of investor sentiment in order to obtain better performance.

Keywords: Fund Managers' Behavior, Individual Investor Sentiment.

1. INTRODUCTION

Mutual fund has been one of the most popular financial commodities by its flexible mechanism since investment tools developed in past decades. As of September 2012, local institutional investors in Taiwan managed 365 equity funds weighting the highest proportion in the whole mutual fund markets and owned such assets close to New Taiwan Dollar 600 billion. Thus equity funds become the major traded category and the purchase and sell behavior of fund mangers are the important information for all investors.

Although both fund managers and individual investors are participants in the stock markets and pursue the investment profitability, they play totally different roles. In one hand, mutual fund mangers are employed by security investment trust firms (or fund firms), their stock-picking behaviors are subject to fund firms' internal policy and government regulation. Furthermore, the fund purchase and redemption of individual investors would result in the changes of fund flow. When individual investors are optimistic, abundant cash inflow to

funds would enforce money managers to purchase in more stocks to meet the equity fund threshold, at least 70 percent shareholdings over its net asset value. In contrast, investor pessimistic sentiment would generate the redemption of mutual funds, which enforce managers to sell out stocks for the requirement of cash outflow. Fund managers, therefore, cannot develop their capacity completely. In theory, fund managers with the support of professional team are super to individual investors in the stock-picking and timing ability while above-mentioned limitations exist in the mutual fund market.

In the other hand, individual investors exercise their investment portfolio without strict law and regulation requirements. However, they usually lack of massive professional information and investment disciplines and are easily affected by investor sentiment. Investor sentiment, resulting from investor psychology, represents subjective judgments to future market conditions and can be regarded as an irrational factor of noise trades. Investors tend to ignore negative information when their sentiment appear optimistic, or tend to overreact positive news which results in stock overvaluation, vice-versus.

Under such circumstances, rational fund managers can precede arbitrage trade when over- or under-reaction caused by investor sentiment make stock price unreasonable temporarily. On reverse side, investor greed and fear would cause irrational behavior and affect fund managers behavior. Whether these situations may result in negative influence needs to be further identified.

A growing body of literature documents either the single behavior for fund manager and the individual investor respectively or the relationship between investor sentiment and stock returns. However, few studies simultaneously investigate the relationship between fund manager interim behavior and individual investor sentiment. In Taiwan, equity trading amount of individual investors weights around 70 percent of total stock market trading amount, much higher than those of foreign markets. This specific force from individual investors is worth paying attention. Therefore, this study examines and interprets the fund manager behavior based on the changes of Taiwanese individual investor sentiment.

Our empirical results show that individual investor sentiment may significantly interpret fund manager behavior. Therefore, individual investors behave as noise trader in the open-end fund market. For the sake of our findings, fund managers should consider investor sentiment except equity fund fundamentals in order to create better performance.

2. LITERATURE REVIEW

2.1 The behavior of mutual fund manager

The purpose of fund manager behavior is theoretically to create the maximum wealth for mutual fund investors. However, the behavior of picking investment portfolios for mutual fund manager is affected by many factors except the case of professional information. According to prior researchers (Lakonishok, Shleifer and Vishny, 1992; Shu, Chen and Huang, 2005), fund managers might herd if they avoid falling behind a peer group or try to obtain sharing-the-blame effect under the consideration of reputation risk.

In addition, many researchers explain fund manager behavior from a variety of perspectives. Khorana (1996) and Chevalier and Ellison (1999) believe that managers might behave for their career concerns. Lin and Hung (2005), following the viewpoints of specific risk, investigate fund manager behavior. Li, Chen and Lin (2010) also support that manager would generate risk- adjusted behavior from the viewpoint of prospect theory. In addition,

Cremers and Petajisto (2009) examine the relationship between fund manager behavior and fund performance by using the fund characters, such as turnover rate, fee rate and fund scale to be proxy variables. They found portfolio manager might pick active shares to create better excess return and maintain the performance lasting effect. Interestingly, Pollet and Wilson (2008) found that managers would prefer to reinvest the additional capital into the original shares when their fund size grew up.

Within recent 20 years，fund manager behavior focuses on the portfolio holdings. In theory, professional money managers could predict the future return for individual stocks. They may properly select higher-return stocks in the portfolio and delete or reduce the lower-return individual stocks. In the early time, fund manager behavior is investigated under the consideration of investment strategy, such as momentum and contrarian policy. Those studies primarily discuss that whether fund managers would buy (sell) the past winners and sell (buy) the past losers. Then, the impact of fund manager behavior on fund performance is conducted.

Some recent studies show that portfolio holdings are the important reference for measuring fund manager ability. Grinblatt and Titman (1989) at first provide this concept to examine fund manager behavior. They suggest that there is a significant difference between the abnormal return of constructed portfolio holdings and the actual return of net asset value from mutual fund. This gap results from the window dressing of portfolio holdings. Kacperczyk, Sialm and Zheng (2008), Elton et al., (2010) and Puckett and Yan (2010) all find that fund manager behavior would generate hidden cost. And these agency cost could be reflected in the interim trades of fund managers. Li and Lai (2009) investigate the relationship between mutual fund flows and manager behavior through the changes of portfolio holdings. Their empirical findings display that cash inflow and outflow from investor would influence manager behavior, especially for small fund and low-turnover fund.

In sum, prior studies measure fund managers' behavior by the increase (or decrease) of portfolio shareholdings. Few studies focus manager behavior on interim trading of portfolio holdings. Therefore, this study would quantity manager behavior by the measure of periodical changes of portfolio holding.

2.2 The investor sentiment

Investor behavior has been analyzed from psychological perspective since the late 1980 when behavioral finance starts to get attention. Kahneman and Tverskey (1979) firstly propose an alternative model of decision making under risk, called prospect theory, which violates the axioms of expected utility theory. Thereafter, overconfidence theory, overreaction theory and regret theory continuously appear and become discussing points.

In theory, investors should be increasingly rational by the rapidly developing environment of financial market. Feng and Seasholes (2005) find that the reluctance of individual investors to realize losses is eliminated by a combination of sophistication and trading experience. But little investor sophistication experience eliminates an investor's propensity to realize gains. Dhar and Zhu (2006) also show that wealthier and individual investors in professional occupations exhibit less disposition effect. However, there exists the disposition effect on average, namely that investors are not totally rational. Kyle (1985) and Black (1986) regard such irrational investors as noise traders. Thus, a growing body of literature begins to discuss the issue of investor sentiment. Most studies demonstrate a significant relationship between investor sentiment and stock returns (Lee, Shleifer and Thaler,1991; Neal and Wheatley, 1998; Brown and Cliff, 2004; Baker and

Wurgler, 2006).

Among those abundant studies, Fisher and Statman (2000) believe that neither investors nor their sentiment are all alike. They group investors into three categories: Wall Street strategists (data from Merrill Lynch), writers of investment newsletters (data from Chartcraft), and individual investors (data from the American Association of Individual Investors (AAII)) and conclude that sentiment can be a tactical indicator for asset allocation and there is a negative relationship between the sentiment for each group and stock index future.

Besides dividing the different groups for investors, researchers try to look for alternative sentiment measures as proxies, including closed-end fund discount, the number of IPO, odd-lot ratio and mutual fund net redemptions and so on. These indicators seem to be independent on economical changes. However, Charoenrook (2003) point out that sentiment investor can predict the excess market returns while it is not related to economic cycles. In fact, investor sentiment is related to future returns. It may measure economical conditions and the level of investor risk aversion. Investor irrational behavior departs the stock price from stock fundamentals, but equity value will eventually back to this fundamentals. Therefore, investor sentiment has a negative relation with future stock return.

Baker and Wurgler (2006) propose a composite index of sentiment which is based on the common variation in six proxies for sentiment: the closed-end fund discount, NYSE share turnover, the number of IPO, average first-day return on IPOs, the equity share in new issues and the dividend premium. They find that investor sentiment significantly affects the cross-section stock returns. When sentiment proxies are low, subsequent returns are high. Meanwhile, Cho, Chang and Lin (2007) also find that market turnover as a sentiment proxy could explain stock returns.

Regarding to the sentiment impact, Chan and Fong (2004) suggest sentiment would affect short-term decision. In the long term, the impact of sentiment on decision making would go down and thus the transaction behavior driven by sentiment only has temporary influence. In addition, researchers find that sentiment may increase the possibility of stock market crisis and has high association with stock return before/after market crash (Siegel 1992; Zouaoui, Nouyrigat and Beer, 2010). In summary, investor sentiment plays an important role because it is significantly related to short-term decision and even might cause a financial disaster.

3. RESEARCH METHODOLOGY

3.1 Research periods and data resource

The Security Exchange and Future Committees have changed the information disclosure frequency of mutual fund contents and proportion since July 2002. The frequency changes from monthly to quarterly base. To be consistent with the same disclosure frequency for all research data, this study covers 9 full years, totally 36 quarters, from January 2003 to December 2011. Research objectives all belongs to local open-end equity funds. The data also includes liquidation funds in order not to generate survivorship bias. In addition, it excludes those funds started after January 2003 to keep all collected data the same research periods. Therefore, the related data includes 126 equity funds and comes from those data banks of securities investment trust and consulting association of the R.O.C. (SITCA), Taiwan Economic Journal (TEJ) and Financial Statistic Monthly Reports.

3.2 Research Methodology

(1) Measure of fund manager behavior

This study adopts and modifies the model developed by Kacperczyk et al. (2008) to measure fund manager behavior. We construct a hypothetical buy-and-hold portfolio that invests in the previously disclosed fund holding and compute its return on the assumption of holding till next disclosure period. Then the difference (gap) between the net investor return and the net holdings return is regarded as the interim trading behavior of fund manager.

At first, we define the return of the fund's holdings (*RH*) as the total return of a hypothetical buy-and-hold portfolio that invests in the most recently disclosed stock positions. And we assume that the fund's holdings continue to next disclosure period.

$$RH_{i,t} = \sum_{j=1}^{N} \tilde{w}_{i,j,t-1} R_{j,t} + \tilde{w}_{i,t-1}^{s} R_{t}^{s} \tag{1}$$

Where $RH_{i,t}$ is the net return of fund's holdings from time t-1 to time t. $R_{j,t}$

denotes the return of stock j at time t. *s* denote fund short-term investment. R_{t}^{s} denotes the short-term return of fund at time t. $\tilde{w}_{i,t-1}^{s}$ is the weight of short-term investment for fund i at time t-1. $\tilde{w}_{i,j,t-1}$ is the weight of individual stock j held by fund i at time t-1. The computation is as following.

$$\tilde{w}_{i,j,t-1} = \frac{N_{i,j,t-1} P_{j,t-1}}{\sum_{j}^{N} N_{i,j,t-1} P_{j,t-1}} \tag{2}$$

In equation (2), $N_{i,j,t-1}$ is the number of shares for stock j held by the fund i at the most recent disclosure date at time *t-1*. $P_{j,t-1}$ present the price of stock j at the time of t-1. If the disclosed share continue to hold above one month, the weight computation is indicated as equation (3).

$$\tilde{w}_{i,j,t-1} = \frac{N_{i,j,t-\tau} P_{j,t-\tau} \prod_{k=1}^{\tau-1} (1 + R_{j,t-k})}{\sum_{j=1}^{N} N_{i,j,t-\tau} P_{j,t-\tau} \prod_{k=1}^{\tau-1} (1 + R_{j,t-k})} \tag{3}$$

According to above statement, equation (4) defines the return gap (*RG*) as the difference between the net investor return and the net holdings return.

$$RG_{i,t} = R_{i,t} - (RH_{i,t} - EXP_{i,t}) \tag{4}$$

$R_{i,t}$ denotes the return of net asset value for fund *i* at time t. EXP stands for various accounting expenses, which include management fee, maintenance fee and guarantee expenses. When the return gap is positive, it implies that manager behavior is efficient for the interim trades and will create value. On the other hand, negative return gap reflects the inefficient trading behavior of fund manager.

(2) Measure of investor sentiment

The measures of investor sentiment could be categorized to direct and indirect methods.

Direct sentiment measures are formed by market survey of reporting institutions, such as American Association of Individual Investors (AAII) survey, Investors Intelligence survey, Merrill Lynch survey and Bullish Sentiment Index. Indirect sentiment measures are composed of economical or financial variables for proxies. For example, closed-end discounted fund (Neal and Wheatley, 1998), Treasury-Eurodollar (TED) spread (Lashgari, 2000), volatility index (VIX), put/call ratio (Dennis and Mayhew, 2002), market turnover (Baker and Stain, 2004), consumer confidence index (CCI) and economic sentiment indicator (ESI) (Grigaliūnienė and Cibulskienė, 2010) are all these kind of sentiment indicators.

Due to the abundant studies about the relationship between fund manager and fund investor, the purpose of this paper is to investigate the impact of individual investor sentiment on fund manager behavior. In Taiwan, 70 percent of investors in stock market belong to retail investors whose investment influence is of importance. Thus, the selection of sentiment indicators should be more rigorous. Among the foreign and domestic literature, this study employs three indicators, margin trading ratio, market turnover and new equity issues, which are suitable for Taiwanese stock market (Cho, Chang and Lin, 2007).

Specifically, in order to obtain more uncontroversial proxies for investor sentiment, we refer to the methodology utilized by Charoenrook (2003), Baker and Wurgler (2006) and Li, Lo and Su(2006) and take the residual based on three sentiment proxies that have been orthogonalized to macroeconomic variables to proceed a robust test. We discuss the investor sentiment proxies as follows.

(a) Margin trading ratio

This study mainly focuses on individual investors instead of professional investors who are prohibited to trade on credit. Thus we capture individual investor sentiment by using the ratio of margin borrowing balance to selling short balance as a proxy. The computation is as following：

$$MS_t = \frac{m \arg in\_borrowing_t}{selling\_short_t} \qquad (5)$$

(b) New equity issue

New equity issuance is related to market liquidity. Managers would evaluate the feasibility of new equity issue based on market sentiment. High value of sentiment might raise stock price, turning in a good timing to issue new equity. The ratio of new equity issue is defined as gross equity issuance plus cash increase of paid-in capital divided by gross equity issuance plus gross debt issuance.

$$NEI_t = \frac{gross\ equity\ issuance_t + cash\ increase\ of\ paid\text{-}in\ capital_t}{gross\ equity\ issuance_t + gross\ debt\ issuance_t} \qquad (6)$$

(c) Market turnover

Market turnover is viewed as the ratio of reported share trading volume to average outstanding shares of listed stocks or the ratio of reported share trading amount to total market price of listed shares. High turnover implies that high frequency of share trading among investors or high volume of speculative trading. Therefore, we deduct the trading volume caused by three large institutional investors to reduce the likelihood of speculative investment.

$$TRN_t = \frac{listed\ stock\ trading\ volume_t - trading\ volume\ of\ institutional\ investors_t}{average\ outstanding\ shares\ of\ listed\ stocks_t} \quad (7)$$

(3) The model of relationship between fund managers' behavior and investor sentiment

In order to investigate the relationship between fund manager behavior and investor sentiment, this study considers both cross-sectional and time-series panel data. It employs fixed effect model to estimate the coefficient of regression formula and reduce estimation bias. In addition, there are other variables, such as fund characteristics, which might affect fund manger behavior to be included in equation (8) for control purpose.

$$RG_{i,t} = \beta_0 + \beta_1 SENTIMENT_{t-1} + \beta_2 FUNDFLOW_{i,t-1} + \beta_3 HIGHRANK_{i,t-1}$$
$$+ \beta_4 LOWRANK_{i,t-1} + \beta_5 TURNOVER_{i,t-1} + \beta_6 STD_{i,t-1} + \beta_7 LOGTNA_{i,t-1} + \varepsilon_{i,t} \quad (8)$$

where *SENTIMENT* indexes different sentiment indicators: *MS*, *NEI* and *TRN*. Control variables include mutual fund flow (*FUNDFLOW*), fund performance ranking (*HIGHRANK* and *LOWRANK*), turnover rate (*TURNOVER*), net worth volatility (*STD*) and total net assets(*LOGTNA*) to avoid disturbance of relationship between investors sentiment and fund manager behavior.

4. EMPIRICAL RESULTS AND ANALYSIS

4.1 The indicator of fund manager behavior

Taiwanese fund firms enter into highly competitive periods in recent years, thus the self-interest risk adjusted behavior of fund managers become obvious. Individual investors cannot observe the stock-picking process and motivation of fund manager subject to the asymmetric information. Prior studies measured the fund performance by comparing the current and last quarterly fund holdings, which ignore the interim trade during two information disclosure periods and result in the measurement bias.

Therefore, this model mainly focuses on the measurement of un-observed behavior of fund manager during the fund holding interim of information disclosure. The positive average of quarterly return gap in Table 1, 2.561%, implies that the return of interim trades by fund managers before the disclosure of next-quarterly holdings information is significantly greater than that of a hypothetical buy-and-hold portfolio based on the just disclosed holdings information. It also indicates that the free riders who copied the just disclosed holdings information may not obtain better returns than professional fund managers.

4.2 The indicator of individual investor sentiment

Based on the domestic literature (Cho, Chang and Lin, 2007), this study employs three sentiment indicators suitable for Taiwanese stock market, ratio of margin buying/short selling, market turnover and new equity issues. Table 1 shows that the smallest standard deviation among these indicators is the margin trading ratio and the biggest is the new equity issues. Furthermore, we break down the quarterly changes of investor sentiment indicators in Figure 1 and find that the second quarterly ratio of year 2008, 2010 and 2011 for margin trading ratio ranks the top 3 among all quarterly ratios. This phenomenon may be related to the hot season frequently happened in the third quarter of ex-right periods for electronics industry. In addition, the ratios of new equity issues are mostly maintained between 30% and 80% except the lower ratios appeared in year 2003 and 2004.

As to the market turnover, the mean is 48.604 percent shown on Table 1 and the maximum value even reaches to 88.153 percent, which indicates the unique feature and the importance of individual investors for Taiwan stock market. Noticeably, the market turnover of individual

Table 1. Descriptive Statistics

This table provides summary statistics for the fund managers' behavior and fund characteristics. The sample consists of 2,088 fund-quarter observations between 2003 and 2011. Table displays summary statistics for the quarterly return gap (*RG*) in percentage, three investor sentiment indices (*MAR, NEI, TRN*) in percentage, respectively. Control variables include the percentage of fund flow (*FUNDFLOW*), the percentage of turnover ratio (*TURNOVER*), the standard deviation (*STD*) and the log of total net asset value (*LOGTNA*).

Variable	Mean	Std. Dev.	Min	Max	Quartile		
					0.25	0.5	0.75
RG	2.561	11.971	-27.617	37.818	-6.331	3.605	11.260
MAR	25.521	7.945	12.647	50.296	18.931	24.658	28.757
NEI	43.505	20.851	5.200	84.615	30.535	44.375	57.295
TRN	48.604	12.202	32.530	88.153	39.956	46.45	51.711
FUNDFLOW	-2.144	10.953	-35.640	29.498	-9.655	-2.393	4.365
TURNOVER	23.953	20.841	0.180	250.091	11.748	22.34	35.055
STD	0.106	0.182	-0.372	0.655	-0.017	0.106	0.242
LOGTNA	13.079	3.405	10.143	16.923	13.114	13.726	14.443

investors goes down in recent years and whether the 40 % is normal or not needs to be watched for more years.

4.3 Fund manager behavior and individual investor sentiment

Black (1986) believes that stock price reflects both the information that information traders trade on and the noise that noise traders trade on. Foucalut, Sraer and Thesmar (2011) also find that individual investor may be regarded as noise trader and his behavior is positively related to volatility of stock price. However, both individual investor and fund manager are market participants. Is there any relationship between these two subjects?

This study firstly considers three sentiment indicators (margin trading ratio, market turnover and new equity issues) to investigate the relationship with fund manager behavior. In addition, fund manager behavior may be influenced by his stock-picking ability and those

factors of mutual fund characteristics and so on. We, therefore, add fund flow, fund ranking, turnover rate, net wealth standard deviation and total net assets value as control variables to avoid their disturbance to fund manager behavior.

Figure. 1 The Proxy for Investor Sentiment Index

The different panels of figure exhibit the proxy for investor sentiment index. Panel A shows the margin trading ratio, Panel B presents market turnover, and Panel C presents new equity issues. The sample period is the first quarter of 2003 through the fourth quarter of 2011. The vertical axis of each graph is represented in percentage.

Panel A. Margin Trading Ratio
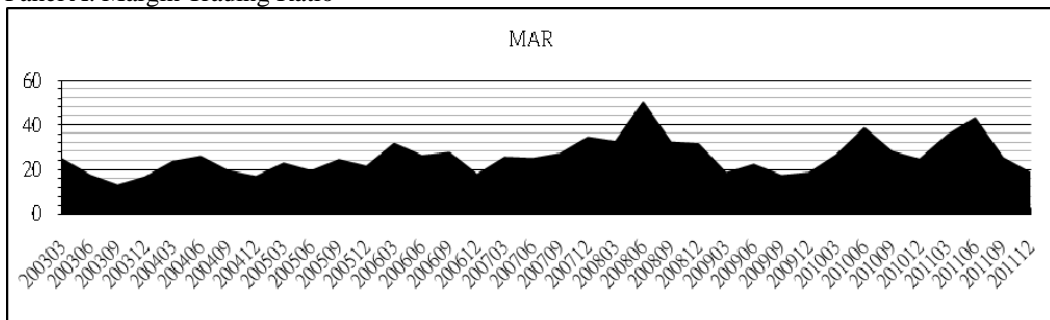
Panel B. Market Turnover
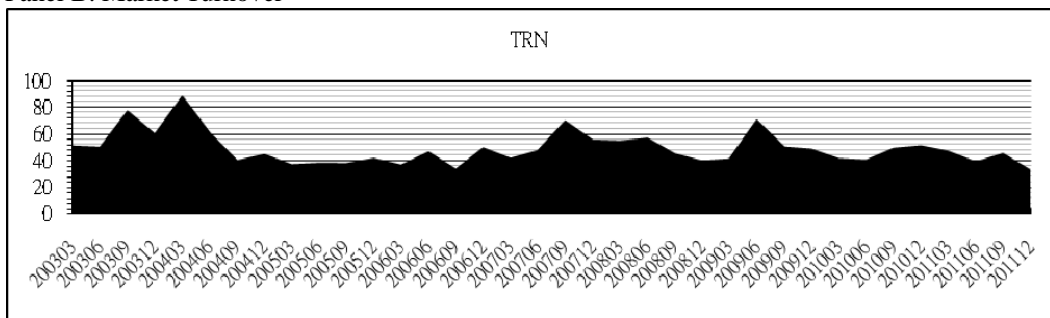
Panel C. New Equity Issue
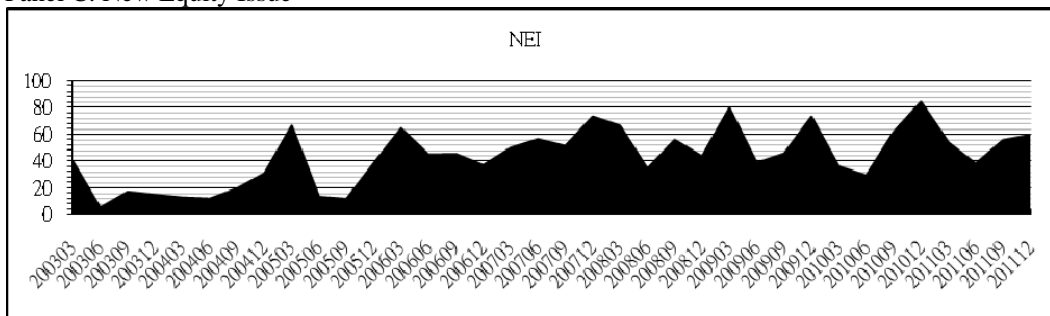
Table 2 displays 5 regression models to analyze the effect of individual investor sentiment on fund manager behavior under different control factors. Model (1) shows the significantly positive relationship between margin trading ratio and fund manager behavior without adding in any control variable. It implies that individual sentiment would influence interim trading behavior of fund managers. When we consider the impact of fund flow, Model (2) exhibits that both fund flow and margin trading ratio affect fund manger behavior, and the economical magnitude (-22.743 for coefficient) of fund flow is larger than that (0.131 for coefficient) of individual sentiment. However, fund rankings (*HIGHRANK* and *LOWRANK*) do not play a role in Model (3). Considering fund characteristics, we propose that turnover rate and net asset value are negatively related to fund manager behavior. The disturbance phenomenon of individual investor sentiment on fund manager behavior exists when we control the factors of fund

characteristics in Model (4). Finally, we add in all above-mentioned control variables. The empirical results in Model (5) show that the main variable, margin trading ratio, would still disturb trading behavior of fund managers during the disclosure interim under the control of other relevant variables.

Following the prior steps, we also utilize the ratio of market turnover as a sentiment proxy and obtain the similar results as above. However, the third sentiment proxy, ratio of new equity issues, does not appear any significant relation with fund manager behavior.

Table 2. Regressions of Investor Sentiment on Fund Managers' Behavior

This table presents the panel regressions results of the effect of the individual investor sentiment on fund manager's behavior. The dependent variable is the return gap (*RG*) as proxy for fund managers' behavior measure and independent variables include the margin trading ratio (*MAR*), the percentage of fund flow (*FUNDFLOW*), the percentage of turnover ratio (*TURNOVER*), the standard deviation (*STD*) and the log of total net asset value (*LOGTNA*). All regressions have 36 calendar quarter observations. ***, **, * stand for statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)
INTERCEPT	10.522***	19.073***	14.035***	26.071***	26.198***
	(0.200)	(0.889)	(0.250)	(4.687)	(4.702)
MAR	0.124***	0.131***	0.133***	0.201***	0.229***
	(0.018)	(0.011)	(0.044)	(0.058)	(0.045)
FUNDFLOW		-22.743***			-19.779***
		(3.501)			(3.488)
HIGHRANK			0.542		0.762*
			(0.408)		(0.395)
LOWRANK			-0.323		-0.329
			(0.412)		(0.388)
TURNOVER				-0.011***	-0.008***
				(0.003)	(0.002)
STD				1.320	0.878
				(1.968)	(1.949)
LOGTNA				-2.959***	-2.758***
				(0.325)	(0.311)
F-statistic	9.005***	9.213***	8.908***	9.835***	9.922***
Adjusted R^2	0.310	0.352	0.302	0.386	0.388
Observations	2088	2088	2088	2088	2088

5. CONCLUSION

Institutional investors are often defined as rational investors but their limitations by law and regulations are much higher than those of individual investors, especially in the market of open-end equity mutual fund. Therefore, mutual fund retail investors would generate sentiment response following the sentiment changes of individual investors. These reactions from individual investors would influence fund manager behavior, resulting in irrational behavior of fund manager.

This study examines the effect of individual investors on fund manager behavior and finds that the trading behavior of fund manager can be well interpreted by individual investor sentiment. As a result, individual investors behave as noise traders. When fund managers excise stock-picking practice, they need to consider the sentiment changes of individual investor beyond the stock fundamentals in order to create well-performed mutual fund value.

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Reversal Fear, Disposition effect and Momentum:

Evidence from the China market

ABSTRACT

This paper examines the influence of reversal fear and disposition effect on momentum returns. We find that reversal fear and disposition effect do have significant influence on momentum and contrarian returns. Under different momentum states, these two forces will either augment or offset each other, making momentum and contrarian returns that are significant become no more significant or those that have been significant become even more significant. In addition, we find that portfolios with inconsistent between psychological and behavioral reaction generate lower future returns than those with consistent between psychological and behavioral reaction.

Keywords: reversal fear; disposition; momentum

INTRODUCTION

Since Kahneman and Tversky (1979) developed and presented the prospect theory as

a descriptive model of decision making under risk, the analysis of trading behavior of

investors from the perspective of their psychology or behavior has garnered much

attention of researchers. Shefrin and Statman (1985) explain the tendency of investors

to sell winners too early and ride losers too long from the aspects of investor behavior

and label it the "Disposition Effect". Meanwhile, many studies have also found fear

can have different effects on judgment and choice (Lerner and Keltner, 2001;

Westerhoff, 2004; Lo et al., 2005; Kar, 2008). In recent years, economists have

confirmed either investor psychology or behavior can cause momentum in stock

prices (Grinblatt and Han, 2005; Shumway and Wu, 2006; Frazzini, A., 2006 ; Wang,

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2008; Abbes et al., 2009 ; Li and Yeh, 2011). As the internal psychological process and the external behavior often affect each other, the momentum effect should not be measured just from the psychological or behavioral perspective. How investor psychology and behavior act together to influence the momentum effect is an important issue that requires further clarification.

Based on the Mean Reversion Philosophy, Wang (2008) observes that investors become worried that the price level is not sustainable and fear that the price is about to reverse or fall. Reversal fear changes if stocks rise when the index is up or rise when the index is down. The reversal fear will become stronger and investors become more willing to sell stocks as there is downward pressure on the market; if stocks fall when the index is down or fall when the index is up, the reversal fear will become weaker and investors become more willing to buy stocks as there is upward pressure on the market.

Odean (1998), Grinblatt and Keloharju (2001), Dhar and Zhou (2006), and Brown et al. (2006) also confirm disposition effect by using the accounts of individual investors. However, we should not just determine whether there is disposition effect or not, there could be also a question about magnitude. Individual disposition may be offset against each other or contrary to each other. Even individual investors have the tendency to sell winners too early and hold on to losers too long, the overall market

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may not exhibit the same tendency. Therefore, studies of investor behavior using the accounts of individual investors have been switched to those of disposition effect using market data (Hur et al., 2010；Zhou and Lei, 2010). The magnitude of disposition effect is the best comprehensive description we can give of the investor tendency. Thus, if we could clearly see the overall disposition effect of investors, we will be able to get to know more delicately correlation between the disposition effect and momentum returns.

Meanwhile, reversal fear reflects the level of investor fear and is a psychological variable, while the disposition effect casts back the investor behavior of quick selling winners and riding losers and is a behavioral variable. There may not be a consistency between psychological reactions and behavioral decisions. When they are consistent, these two forces will be augmented to show a significant price trend and result in more significant momentum returns; when they are not consistent, they will offset each other to disperse and result in insignificant momentum returns. To make it short, the impact of investor psychology and behavior on momentum returns may either augment or offset each other.

We follow the reversal measure proposed by Wang (2008) and combine the concepts of Shumway and Wu (2006) and Zhou and Lei (2010) to determine the magnitude of disposition effect. We find that the Reversal fear and disposition effect

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will augment each other and generate strong momentum effect when winners are retreating and investors in low reversal fear, losers are rebounding and investors in high reversal fear, and in portfolios with stronger disposition effect. The Reversal fear and disposition effect will augment each other and cause price reversal when winners are rising and investors in high reversal fear, losers are falling and investors in low reversal fear, in portfolios with stronger disposition effect.

The rest of the paper is organized as follows. Section 2 explains investor **r**eversal fear and disposition effect variance measures. Section 3 presents the empirical results. Finally, section 4 concludes this study.

REVERSAL AND DISPOSITION EFFECT MEASURES

Wang (2008) documents a reversal fear in momentum investing.. The study follows the variables of Wang (2008) in the calculation of reversal fear as follows:

$$p_{i,t} = a_i + b_i p_{m,t} + u_{i,t} \tag{1}$$

Where the market index $p_{m.t} \equiv \ln(P_{m,t})$ is an independent variable, and the individual stock price $p_{i,t} \equiv \ln(P_{i,t})$ is a dependent variable. The regression analysis shows a relationship between these two variables and output of a_i and b_i for the equation of reversal fear as follows:

$$\pi_{i,t_h} = \Phi\left(\frac{p_{i,t_h} - a_i - b_i p_{m,t_h}}{\sigma_{u_i}}\right) \tag{2}$$

Where Φ (·) is the cumulative distribution function for the standard normal

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distribution. Substract the estimated value from the actual value of individual stock price in (1), then divided the difference by the residual standard deviation. Compare the answer with the cumulative distribution table for the standard normal distribution to find the p-value (i.e reversal fear). When the reversal fear is between 0 and 1, and the estimated value from the regression analysis equals to the actual value, $\pi = 0.5$, indicating the stock price is at a reasonable level and there is no reversal fear. When π has a value smaller than 0.5, it indicates the individual stock will fall, and the smaller the π is, the more the individual stocks fall, and investors become more worried that the price level is not sustainable and fear that the price is about to reverse and rise. When π has a value greater than 0.5, it indicates the individual stock will rise, and the greater the π is, the more the individual stocks rise, and investors becomes more worried that the price level is not sustainable and fear that the price is about to reverse and fall.

Grinblatt and Han (2005) assume that reference prices are the volume-weighted average of their purchase prices. Zhou and Lei (2010) suggest the utility indifference price is the investor's reference price. Relative gains occur when the purchase price is below the reference price, while relative losses occur when the purchase price is above the reference price. They use four statistical measures, such as the mean, variance, skewness and kurtosis of the reference price distribution to interpret their

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findings as supporting the disposition effect and find that reference price distribution can predict the variations in cross-sectional stock returns.

The calculation of ARC and SRC of Zhou and Lei (2010) is as below:

$$RC_n = \frac{AC_N - AC_n}{AC_N} \tag{3}$$

Where N is the number of days that the cumulative turnover rate of the individual stock takes to reach 100 %; n is the date of purchase, $1 \leq n \leq N$; RC_n is the relative capital gains/losses after the date of purchase (n). AC_n is the closing price of the stock on the date of purchase. If the investor purchases at the date of n, and the price becomes lower than the closing price at the date of N, then there are capital gains. That is, when $AC_n < AC_N$, there are capital gains; on the contrary, there will be capital losses.

$$ARC_N = \frac{\sum_{n=1}^{N} VOL_n RC_n}{\sum_{n=1}^{N} VOL_n} \tag{4}$$

$$SRC_N = \frac{\sum_{n=1}^{N} VOL_n (RC_n - ARC_N)^3}{N \cdot VRC_N^{3/2}} \tag{5}$$

Where ARC_N is the mean of relative capital gains or losses based on weighted trading volume. When $ARC_N > 0$, it indicates there are relative capital gains for most investors on the date of N. SRC_N are skewness of relative capital gains on the date of N.

Shumway and Wu (2006) find that stocks will continue to rise if the reduced amount of unrealized gains over the early period of price increase is the result of disposition effect; stocks will continue to fall if the increased amount of unrealized losses over the early period of price decrease is the result of disposition effect. Thus, unrealized capital gains or losses can be used to predict the future price of stocks.

We combine the concepts of Shumway and Wu (2006) and Zhou and Lei (2010) to determine the magnitude of disposition effect of individual investors. We use two procedures to determine if there is disposition effect based on the relative increase/decrease of unrealized capital gains/losses on a date. We divide the ARC by SRC to see if the product or quotient is positive or negative. When the quotient is positive and both the ARC and SRC are greater than 0, it indicates most unrealized capital gains are above average. When most relative capital gains on the date of N are reduced, it indicates that there is disposition effect. When the quotient is positive and both the ARC and SRC are smaller than 0, it indicates most unrealized capital losses are above average. When most relative capital losses on the date of N are increased, it indicates that there is disposition effect. In other words, the positive quotient indicates that the individual investors exhibit disposition effect on the date. Let the index (D) of the disposition effect be 1, and the others be 0. The negative quotient indicates that the individual investors do not exhibit disposition effect on the date as shown in

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Equation (6). The study uses weekly frequency data by transferring the day of N to the last trading day of the week (w).

$$\frac{ARC_W}{SRC_W} > 0 \qquad \text{, then} \qquad D_{i,n} = 1$$

$$\text{, else} \qquad D_{i,n} = 0 \tag{6}$$

Then, we determine the magnitude of disposition effect of investors based on the cumulative disposition effect over a given period. To study the magnitude of the disposition effect, we define the index over the formation period to be 1, select those that appear the most times in a row, arrange them in descending order, and divide them into four groups with investors in Group of D_4 having the strongest disposition effect and Group D_1 with the weakest disposition effect.

As to the volatility, stocks that rose in the past and with ARC>0 are considered rising stocks; stocks that rose in the past and with ARC<0 are considered retreating stocks; stocks that fell in the past and with ARC>0 are considered rebounding stocks; stocks that fell in the past and with ARC<0 are falling stocks. After the determination the magnitude of disposition effect and volatility, we observe the relevancy between disposition effect and momentum returns.

EMPIRICAL RESULTS

China Stock Market has imposed a 10% price limit since 1997. To avoid the influence of small sample size and government policies on study findings, the study chose the

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period of January 1998 to December 2010 and adopted the weekly trading data on A

shares of publicly listed companies traded at the Shanghai Stock Exchange.

Companies that have been delisted or issued a temporary cease trade order are

excluded in the portfolio to avoid the influence on the calculation of returns of

formation periods and holding periods. At the beginning, 270 companies are included

in the sample and the number is increased to 823 at the end of the study period. Data

are collected from Taiwan Economic Journal (TEJ) Mainland China Database.

Kang et al.(2002), Li and Yeh (2011) employ the approach of Jegadeesh and Titman

(1993) to examine the momentum effect present in China Stock Market and find there

are short-term price reversal and medium term price momentum present in China

Stock Market. We test our hypotheses on the following [ranking period, holding

period] momentum strategy: [24, 24].

What is the relationship between magnitude of disposition effect and momentum?

We employ the three-way sorting procedure to sort stocks into four portfolios based

on the cumulative rate of return over the past 24 weeks. Each of the winner/loser

portfolios is divided into portfolios of capital gains and losses, and then further

categorized into four portfolios based on the magnitude of the disposition effect over

the past 24 weeks to construct a total number of 4*2*4 portfolios. Four momentum

strategies are established based on cumulative rate of return and relative average

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capital gains/losses.We find that, among momentum strategies, when winners with a high proportion of retreating stocks and losers with a high proportion of rebounding stocks and in portfolios with stronger disposition effect generate positive momentum returns. Winners with a high proportion of rising stocks and losers with a high proportion of falling stocks and in portfolios with stronger disposition effect generate negative momentum returns.

Table 1: Disposition effect and momentum

Strategy	Average Capital Gains (Losses)	D1	D2	D3	D4
Panel A : buy winners with ARC>0 (rising), sell losers with ARC>0 (rebounding)					
R4(W)	ARC>0	1.88	0.82	1.25	2.60
		(-1.41)	(0.60)	(0.83)	(1.53)
R1(L)	ARC>0	3.87	-0.42	0.46	0.71
		(2.00)	(-0.29)	(0.30)	(1.28)
R4-R1		-1.99**	1.24	0.80	1.89*
		(-1.98)	(0.63)	(0.37)	(1.74)
Panel B: buy winners with ARC<0 (retreating), sell losers with ARC<0 (falling)					
R4(W)	ARC<0	6.94	6.65	5.38	6.06
		(4.11)	(3.55)	(2.96)	(3.31)
R1(L)	ARC<0	6.08	9.08	8.02	7.52
		(2.36)	(4.24)	(3.75)	(5.31)
R4-R1		0.86	-2.43	-2.64	-1.46
		(1.15)	(-0.93)	(-1.05)	(-0.56)
Panel C: buy winners with ARC<0 (retreating), sell losers with ARC>0 (rebounding)					
R4(W)	ARC<0	6.94	5.38	6.65	6.06
		(4.11)	(2.96)	(3.55)	(3.31)
R1(L)	ARC>0	3.87	0.46	-0.42	0.71
		(2.00)	(0.30)	(-0.29)	(1.28)
R4-R1		3.07	4.92**	7.07***	5.35**
		(1.39)	(2.12)	(3.26)	(1.98)
Panel D: buy winners with ARC>0 (rising), sell losers with ARC<0 (falling)					
R4(W)	ARC>0	1.88	0.82	1.25	2.60
		(1.41)	(0.60)	(0.83)	(1.53)
R1(L)	ARC<0	6.08	9.08	8.02	7.52

	(2.36)	(4.24)	(3.75)	(5.31)
R4-R1	-4.20	-8.26***	-6.77***	-4.92**
	(1.55)	(3.47)	(2.76)	(1.97)

Note: In this table, we first sort stocks into four portfolios based on the cumulative rate of return over the past 24 weeks. Each of the winner/loser portfolios is sorted into portfolios of capital gains and losses, and then further categorized into four portfolios based on the magnitude of the disposition effect over the past 24 weeks to construct a total number of 4*2*4 portfolios. Four momentum strategies with different disposition effects are created based on the correlation between winners/losers and gains/losses. The cumulative returns are calculated with equal weights and holding periods of 24 weeks. *, **, and *** denote the statistical significance of coefficients at the 10%,5%,and 1% level respectively.

We employ the two-way sorting procedure on the cumulative rate of return and reversal fear. Then, buying winners and selling losers in each of the portfolio to create 5*5 momentum strategies. On the implementation of momentum strategies, the empirical findings indicate (1) no matter which portfolio of reversal fear the winners are in, the negative abnormal returns are particularly strong; (2) Winners in the portfolio of high reversal fear(F5R5) and losers in the portfolio of low reversal fear (F1R1) can act in concert with each other to maximize the abnormal returns with the most significant price reversal; (3) when winners in the portfolio of low reversal fear(F1R5) and losers in the portfolio of high reversal fear (F1R1) act in concert with each other, there are no negative returns, but positive abnormal returns instead. The momentum effect is significant. We find it is a positive driving force to result in momentum effect when winners in the portfolio of low reversal fear and losers in the portfolio of high reversal fear act in concert with each other, while it is a negative driving force to result in reversal effect when winners in the portfolio of high reversal fear and losers in the portfolio of low reversal fear act in concert with each other.

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Table 2: Reversal fear and momentum

Fear	R1(L)	R5(W)	R5Fi-R1F1	R5Fi-R1F2	R5Fi-R1F3	R5Fi-R1F4	R5Fi-R1F5
F1(L)	11.29	8.50	-2.79 **	1.75	3.98 ***	5.88 ***	8.12 ***
	(9.91)	(8.49)	(-1.97)	(1.21)	(2.79)	(4.19)	(5.92)
F2	6.75	3.70	-7.59 ***	-3.05 **	-0.82	1.08	3.32 ***
	(6.17)	(4.00)	(-5.28)	(-2.14)	(-0.58)	(0.78)	(2.47)
F3	4.51	2.04	-9.25 ***	-4.70 ***	-2.47	-0.58	1.66
	(4.36)	(2.39)	(-6.55)	(-3.36)	(-1.79)	(-0.43)	(1.65)
F4	2.62	0.51	-10.78 ***	-6.24 ***	-4.01 ***	-2.11	0.13
	(2.71)	(0.65)	(-7.77)	(-4.55)	(-2.96)	(-1.59)	(0.10)
F5(H)	0.38	-1.09	-12.38 ***	-7.84 ***	-5.61 ***	-3.71 ***	-1.47
	(0.43)	(-1.46)	(-9.02)	(-5.78)	(-4.20)	(-2.83)	(-1.15)

Note: We first sort stocks into five portfolios based on the cumulative rate of return over the past 24 weeks. Each of these five portfolios is further sorted based on the reversal fear of the previous week to create a total number of 5*5 portfolios. Then, buying winners and selling losers in each of the portfolio to create 5*5 momentum strategies. *, **, and *** denote the statistical significance of coefficients at the 10%,5%,and 1% level respectively.

We then observe if the consistency between psychological reactions and behavioral decisions have an effect on future returns. We examine average portfolio returns to 2*5*5 portfolios formed on capital gains (losses), reversal fear, and disposition effect.

Panel A of Table 3 are portfolios that have relative average capital gains. Based on the difference between psychological reactions and behavioral decisions, four states can be categorized: (1) Strong disposition effect (D5) (quick sell of winners) and high reversal fear (F5) (fear that the price is about to reverse). The supply is increased to cause negative returns (F5D5 = -3.84%); (2) Strong disposition effect and low reversal fear (F1) (no fear about price reversal). The quantity for sale is suppressed to generate significant positive returns (F1D5 = 6.35%); (3) Weak disposition effect

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(D1) (No sell of winners) and low reversal fear. The supply is limited to generate

positive returns (F1D1 = 9.25%); (4) Weak disposition effect and high reversal fear.

Investors would not sell stocks. There are no significant returns for such portfolios.

On the other hand, Panel B of Table 3 represents portfolios that have relative

average capital losses. Based on the difference between psychological reactions and

behavioral decisions, four states can be categorized: (1) Strong disposition effect (to

ride losers) and low reversal fear (fear that the price is about to reverse). Investors

would ride the losers and there will be significant positive returns (F1D5 =16.82 %);

(2) Strong disposition effect and high reversal fear (no fear about price reversal).

Investors would not ride the losers and there will be no significant returns; (3) Weak

disposition effect (Not to ride losers) and low reversal fear (fear that the price is about

to reverse). Investors would not ride the losers and there will be significant returns

(F1D1 = 10.94%); (4) Weak disposition effect and high reversal fear. Investors would

not ride the losers and there will be positive returns (F5D1 = 2.99 %).

(1) and (3) of Panel A and (1) and (4) of Panel B in Table 3 indicate that the

psychological reactions of investors are consistent with behavioral decisions; (2) and

(4) of Panel A and (2) and (3) of Panel B in Table 3 indicate that the psychological

reactions of investors are inconsistent with behavioral decisions. Upon careful

observation, we notice that when there are unrealized capital gains, portfolios with

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inconsistent between psychological and behavioral reaction generate lower future returns than those with consistent between psychological and behavioral reaction. Please see Panel A in Table 3, F1D5 – F1D1 = - 2.9%.When there are unrealized capital losses, portfolios with consistent between psychological and behavioral reaction generate higher future returns than those with inconsistent between psychological and behavioral reaction. Please see Panel B in Table, F1D5 – F1D1 = 5.88%. Obviously, when the decisions made psychologically are consistent with those made behaviorally in low reverse fear, it indicates a thoughtful decision-making that is most likely more accurate to lead to better overall results.

Table 3 : Reversal fear and disposition effect

Portfolio	D1	D2	D3	D4	D5	D5-D1
Panel A: cumulative returns generated by the relative average capital gains						
F1(L)	9.25	5.13	1.06	4.56	6.35	-2.9*
	(2.35)	(3.52)	(0.74)	(2.85)	(3.83)	(-1.78)
F2	3.06	2.03	1.60	2.75	3.96	0.90
	(1.96)	(1.70)	(1.30)	(1.63)	(2.77)	(1.23)
F3	2.20	4.43	4.21	2.86	4.07	1.87
	(1.66)	(3.20)	(2.73)	(2.13)	(3.03)	(0.99)
F4	-0.21	-0.27	-0.02	-0.75	1.34	1.54
	(-0.16)	(-0.22)	(-0.01)	(-0.56)	(1.73)	(0.84)
F5(H)	-0.98	-0.26	-1.19	-2.10	-3.84	-2.86
	(-1.34)	(-0.18)	(-0.83)	(-1.54)	(-3.96)	(1.03)
Panel B: cumulative returns generated by the relative average capital losses						
F1(L)	10.94	14.16	12.44	14.77	16.82	5.88**
	(5.60)	(6.56)	(5.56)	(6.30)	(5.84)	(1.99)
F2	7.83	9.92	9.61	10.30	6.80	-1.03
	(3.82)	(5.44)	(5.53)	(5.44)	(4.12)	(-0.39)
F3	6.39	6.38	6.70	4.97	3.83	-2.56
	(4.50)	(4.83)	(4.39)	(3.51)	(2.70)	(-1.27)
F4	5.35	5.77	5.15	3.97	2.57	-2.78
	(3.53)	(3.76)	(3.29)	(2.48)	(1.68)	(-1.29)
F5(H)	2.99	5.97	2.27	2.15	2.77	-0.22
	(1.79)	(3.15)	(1.53)	(1.27)	(1.71)	(-0.1)

Note: In this table, we first sort stocks into two portfolios based on their means of relative capital gains and losses in the formation period (24 weeks), then sort each of these two portfolios into five subportfolios based on their reversal fear from the prior week, and each of these subportfolios is

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We found both disposition effect and reversal fear have a significant impact on momentum returns. Does their influence on momentum returns interact to augment or offset the power they originally have? Does it augment or weaken the existing momentum returns? We examine this question by using three-ways. We establish four momentum strategies for the portfolio of disposition effect based on relative average capital gains/losses, winners/losers, high/low reversal fear to create a total number of 4*2*2*4 portfolios.

In Panel A of Table 4, buy winners with both ARC<0 and investors in high reversal fear, sell losers with both ARC>0 and investors in low reversal fear; In Panel B, buy winners with both ARC<0 and investors in low reversal fear, sell losers with both ARC>0 and investors in high reversal fear; In Panel C, buy winners with both ARC>0 and investors in high reversal fear, sell losers with both ARC<0 and investors in low reversal fear; In Panel D, buy winners with both ARC>0 and investors in low reversal fear, sell losers with both ARC<0 and investors in high reversal fear.

By combining the influence of psychological reactions and behavioral decisions on momentum returns, we find the momentum strategies in Panel A and D of Table 4 no longer generate any significant momentum profits, indicating the reversal fear has an

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effect on momentum returns and the influence by the disposition effect has been offset.

There is no momentum effect; the momentum strategies in Panel B and C of Table 4

still generate significant returns, indicating reversal fear and disposition effect work

together to make more significant returns. In a word, the Reversal fear and disposition

effect will augment each other and generate strong momentum effect when winners

are retreating and investors in low reversal fear, losers are rebounding and investors in

high reversal fear. The Reversal fear and disposition effect will augment each other

and cause price reversal when winners are rising and investors in high reversal fear,

losers are falling and investors in low reversal fear.

Table 4 : Relationship among momentum, fear and disposition

Strategy	Average Capital Gains (Losses)	Fear	D1	D2	D3	D4
Panel A: buy winners with both ARC<0 (retreating)and high reversal fear, sell losers with both ARC>0 (rebounding) and low reversal fear						
R4	ARC<0	F2(H)	0.00	0.68	2.69	1.62
R1	ARC>0	F1(L)	2.20	0.68	1.92	0.67
R4-R1			-2.20	0.00	0.76	0.95
			(-1.39)	(0.00)	(0.52)	(0.76)
Panel B: buy winners with both ARC<0 (retreating) and low reversal fear, sell losers with both ARC>0 (rebounding) and high reversal fear						
R4	ARC<0	F1(L)	5.62	7.60	7.33	5.85
R1	ARC>0	F2(H)	1.66	0.11	-0.44	0.16
R4-R1			3.97**	7.50***	7.77***	5.69***
			(2.01)	(3.47)	(4.01)	(3.32)
Panel C: buy winners with both ARC>0 (rising) and high reversal fear, sell losers with both ARC<0 (falling) and low reversal fear						
R4	ARC>0	F2(H)	3.25	-0.30	-0.25	-0.91
R1	ARC<0	F1(L)	1.69	3.97	5.57	4.47
R4-R1			1.56	-4.27*	-5.83***	-5.38***
			(0.43)	(-1.87)	(-3.11)	(-2.78)
Panel D: buy winners with both ARC>0 (rising) and low reversal fear, sell losers with both ARC<0 (falling) and high reversal fear						
R4	ARC>0	F1(L)	3.15	0.48	0.68	0.70

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R1	ARC<0	F2(H)	-0.53	2.71	-1.55	1.98
R4-R1			3.68	-2.23	2.23	-1.28
			(1.26)	(-0.95)	(1.61)	(-0.67)

CONCLUSIONS

We attempt to combine behavioral and psychological theories to explain the momentum phenomenon and evaluate the influence of psychology and behavior on momentum returns based on volatility, reversal fear and magnitude of disposition effect. We find that reversal fear and disposition effect do have significant influence on momentum positive/negative returns. The Reversal fear and disposition effect will augment each other and generate strong momentum effect when winners are retreating and investors in low reversal fear, losers are rebounding and investors in high reversal fear, and in portfolios with stronger disposition effect. The Reversal fear and disposition effect will augment each other and cause price reversal when winners are rising and investors in high reversal fear, losers are falling and investors in low reversal fear, in portfolios with stronger disposition effect.

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FEAR, GREED, AND TRADING ACTIVITIES

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ABSTRACT

This study uses the VIX debuted in 1993 to construct fear and greed indices for financial markets and to examine the effects of fear and greed on trading activities in Taiwan. We find that fear is negatively associated with and that greed is positively associated with trading activities. In high trading activity quantiles, greed exerts more influence than fear. In contrast, empirical results suggest that fear dominates greed in low trading activity quantiles. Finally, greed has a greater influence than fear on stocks with low prices, low market capitalization, high returns, and high turnover.

Keywords: Fear, Greed, Implied volatility

1. INTRODUCTION

Financial crises have recently burst out everywhere, and their effects often last for several years. Many observers attribute these crises to the decisive role played by greed ([21]). The Internet boom of 2000 is a perfect example of greed. During the greed-caused financial crisis of 2008 ([23]), financial assets experienced significant drops, the correlation between asset classes increased significantly, and the fear index (VIX) reached its highest level in October 2008 ([16]). Numerous academics and market participants are extensively concerned with fear and greed, which coexist in the market and have mutual implications. Both forces contribute immensely to market volatility. The VIX method, which functions as a barometer of risk for financial assets, is a weighted index that comprises the implied volatility of put and call options. This study uses the VIX method to compute the implied volatility of put and call, which respectively serve as proxies for fear and greed. We use the aggregate trading activities-trading value, trading shares, and turnover as proxies for investors' trading activity. If investors are concerned about fear and greed, the differential effects of fear and greed should be apparent in their trading activities.

The Chicago Board Options Exchange (CBOE) originally constructed an implied volatility index (VIX), based on eight near-the-money, nearby, and second-nearby call and put options of the S&P 100 index. This CBOE index is said to be the "investors' fear gauge," where the term "fear" is used because investors are risk averse and fearful of uncertainty. When investors suffer large losses, they become more fearful of further losses. To stem their losses, investors quickly sell portfolios in search of less risky assets such as money market securities and principal-protected funds, which are low-risk, low-return securities. When traders fear losses, they start selling stocks. These sales drag down stock prices heavily, causing financial markets to crash irrationally.

The financial market is driven by two prominent emotions: fear and greed. The interplay of

fear and greed often appears in financial markets. Financial markets generally move upward, but downturn periods cause investors to retreat. Fear is temporary, yet greed is permanent. Greed takes over when investors see others making money and want to game before opportunities fade. When people approach the stock market with greed, stock prices start rising sharply because of heavy purchasing based on speculations about a possible uptrend of prices.

[15] argued that the VIX method is the best aggregate fear gauge for sophisticated and well-informed investors in the nearby index option market. However, he also showed that implied volatility has weak power in predicting future returns. [3] showed that when both individual and institutional sentiments decrease and the fear gauge increases, investors reduce their net purchasing volume and market liquidity. [6] applied a survey sentiment [Financial and Economic Attitudes by Research survey (FEARS)] to show that FEARS triggers excess volatility and daily mutual flow. Their evidence suggests that one standard deviation increase in FEARS is associated with approximately 40% outflow of the daily average mutual fund.

Investors differ greatly in their characteristics. Some investors are more optimistic about a potential rise in the stock market in the future, and purchase more call options. Conversely, some investors are more pessimistic about a potential drop in the stock market, and therefore, purchase more put options to hedge their positions. The VIX method is a weighted measure of the implied volatility of four put and four call options on the S&P 100. Therefore, VIX is a measure of perceived market volatility in either direction over the next 30 days, including the upside and downside. A high VIX index suggests that investors see significant risk that the market will move sharply, whether downward or upward. [15] suggested that increases in the VIX index are associated with option prices. When a large shock that affects the market leads to a greater change in the magnitude of one type of option relative to the others, the VIX moves along the direction of the net change. If a positive shock causes investors to believe that the market is moving upward, the result could raise the price of call options and reduce the price of put options. When the magnitude of changes in call options exceeds that of put options, the net differential effects of these two options increases the VIX index. Conversely, a negative shock increases the price of put options and reduces the price of call options. If the magnitude of a price increase of put options exceeds the decrease in the price of call options, the VIX rises.

The VIX index represents both the fear and exuberance of sophisticated and informed investors. A high VIX index suggests that the market will move either upward or downward. In this case, it is appropriate to partition the VIX into implied volatility of put, a proxy of fear, and implied volatility of call, a proxy of greed. We partition VIX into perceived volatility of put and call to investigate whether fear and greed are related to the trading activities of investors.

This study uses the VIX method proposed in 1993 to compute the fear and greed index and examine their effects on trading activities. Results show that fear and greed are negatively and positively associated, respectively, with trading activities. However, greed also exerts a greater influence than fear during high trading activities. Conversely, fear dominates greed during low trading activities. We also show that greed has a greater influence than fear on stocks with low prices, low market capitalization, high returns, and high turnover.

The remainder of this paper is structured as follows. Section 2 introduces the literature review and hypothesis development. Section 3 presents the data and empirical model. Section 4 provides the empirical results, and Section 5 offers a conclusion.

2. LITERATURE REVIEW AND HYPOTHESIS

[18] showed that fear and greed both trigger investors' trading behaviors in financial markets. Although fear plays an essential role in financial markets, most investors react less to greed. Fear and greed are polar opposites, with fear being a negative emotion and greed being a positive emotion. Fear drives investors to bid up put prices and reduce or hedge risk. Greed causes investors to look for ways to profit from the trading activity itself and bid up call prices. The perceptions of option traders are the dominant factors in determining the VIX ([11]). We use the implied volatility of a put option as a proxy for fear, and use the implied volatility of a call option to represent greed. If investors are optimistic about the spot market, they purchase securities, which in turn drive prices up and increase trading activity. The call option value increases when implied volatility increases after entering the long call. Conversely, if investors are pessimistic about the spot market, they either reduce the trading activities in the spot market or they long a put option in the futures market. If investors enter a put option, this results in an increase in the implied volatility of the put option, along with its value. We postulate that fear and greed influence trader' behaviors such that the fear of additional loss decreases trading activities and the greed for potential profit promotes the trading activities. We present the first hypothesis as follows:

$H1_0$: Fear (greed) has a negative (positive) effect on trading activity in the spot market.

[11] provided evidence confirming that the return-implied volatility relationship is strongly associated with extreme returns. Investors in financial markets swing between the extremes of fear and greed. If fear and greed affect each other in the financial market, we should be able to find the relative effects of fear and greed on differential trading activities. When greed is greater than fear, investors purchase aggressively, increasing the aggregate trading activity. Specifically, greed dominates fear during a high trading activity. Conversely, when fear is greater than greed, investors are loath to trade and retreat from the market, decreasing the trading activity; that is, fear dominates greed during low trading activity. Thus, we present the second hypothesis as follows:

$H2_0$: The effect of greed (fear) is relatively greater than that of fear (greed) during high (low) trading activity.

[9] showed that the relationship between stock returns and implied volatility is asymmetric because negative stock index returns produce greater changes in VIX than do positive returns. Fear and greed are both sentiments, and whether they exert asymmetric effects on the trading activity of low and high portfolios within certain stock characteristics remains unclear. [12] suggested that stocks with low prices, high idiosyncratic skewness, and greater idiosyncratic volatility are more likely to be perceived as lotteries. [8] showed that when the jackpot exceeds NT$500 million, the number of shares traded by individual investors significantly decreases among stocks with low market capitalization, high past returns, and a high past turnover. This indicates that lottery tickets function as a substitute investment to stocks with low market capitalization, high past returns, and a high past turnover. Greed is an important

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reason for purchasing lottery tickets and gambling. We presume that trading activities among stocks with a low stock price, low market capitalization, high return, and high turnover are more likely to be affected by greed than by fear. Among stocks with a high price, high market capitalization, low return, and low turnover, investors move their money from the stock market to low-risk and low-return securities to stem their losses during a financial crisis. Thus, we present the third hypothesis as follows:

$H3_0$: The effect of greed on trading activities is greater (smaller) than that of fear within a low (high) stock price, low market capitalization, high return, and high turnover portfolios.

3. DATA AND METHODOLOGY

3.1 Construction of the fear and greed index
Implied volatility (VIX), which is a measure of the fear of uncertainty, is also a measure of investor sentiments. This index was originally introduced in 1993 and computed from the implied volatility of eight put and call option series near-the-money, nearby, and second-nearby option series, and was weighted to reflect the implied volatility of a 30 calendar-day at-the-money option. We partitioned the VIX into implied volatility of the put and volatility of call options. Our weighted implied volatility of the put (call) option was computed by referring to the CBOE construction.

The greed index was computed based on a series of implied volatility for call options, and referred to the construction of fear index. Thus, this study uses separate fear and greed indices. Fear and greed are the two driving forces in financial markets. Greed drives up prices and has many traders follow suit and purchase the securities. Greed also drives up prices to a level where they are no longer sustainable, forming a bubble. In times of bull market rallies, greed captures traders completely and eclipses fear. As traders watch the stock market move strongly upward, they might be persuaded to purchase a call option even if they do not have such trading experience. Conversely, fear increases traders' pessimistic expectations for short-term returns about underlying assets in the spot market, leading to a decrease in the trading volume of underlying assets and an increase in the demand for a put option to hedge long positions. Put and call options, such as greed and fear, work in tandem and complement each other perfectly.

3.2 Trading activities of subgroups with certain characteristic
Financial markets are simultaneously driven by the emotions of optimistic and pessimistic investors. Investors are not homogenous with respect to fear and greed, and we presume that some stocks associated with certain characteristic response to fear/greed are more stronger than the other. For example, Shleifer and Thaler (1991) showed that returns with small market capitalization and lower institutional holdings are corrected with changes in closed-end fund discounts. This study investigates the relationship between fear and greed and the trading activities of stocks with certain characteristics. To build on this theme, we constructed three subgroups of stocks with certain stock characteristics, and tested how the trading activities influenced by fear and greed. The trading activities of stocks with certain characteristics are classified equally into three subgroups based on their characteristics at the end of the previous season. We then averaged the trading activities across all stocks in each of the three subgroups.

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The implied volatility of a put option implies uncertainty and fear for the future. Thus, the sign of the coefficient for fear (implied volatility of put) in the following regression model should be negative. The buyer of a call option purchases it in the hope that the price of the underlying instrument will rise in the future. A high implied volatility of a call option is an indicator that mirrors the optimism about underlying assets in the future. Thus, the sign of coefficients for greed (implied volatility of call) should be positive. To examine the effects of fear and greed on trading activities in low, medium, and high group with certain characteristic, this study presents the following empirical systemic regressions based on the works by [8] and [19]:

$$TV_{l,t} = \alpha_{l,0} + \alpha_{l,1}TV_{l,t-1} + \alpha_{l,2}VIX_{p,t} + \alpha_{l,3}VIX_{c,t} + control + \varepsilon_{l,t}$$

$$TV_{m,t} = \alpha_{m,0} + \alpha_{m,1}TV_{m,t-1} + \alpha_{m,2}VIX_{p,t} + \alpha_{m,3}VIX_{c,t} + control + \varepsilon_{m,t}$$

$$TV_{h,t} = \alpha_{h,0} + \alpha_{h,1}TV_{h,t-1} + \alpha_{h,2}VIX_{p,t} + \alpha_{h,3}VIX_{c,t} + control + \varepsilon_{h,t}$$

where $TV_{l,t}$, $TV_{m,t}$, and $TV_{h,t}$ are the trading activities for all stocks with a certain characteristic in a portfolio in the low, medium, and high group, respectively. We added the lagged term of the dependent variable to control the endogeneity and the persistence in the trading activities. The term VIX_p (VIX_c) denotes the fear (greed) index. The systemic regressions in this study augment a set of control variables, including lagged market returns, term spread ([14] [1] [22]), and dummies for weekdays ([7] [4]). Term spread is the difference between the yield on a 10-year treasury bond and 90-day commercial paper rate. All variables examined in this paper were obtained from the *Taiwan Economic Journal* (TEJ). To compare the effects of fear and greed on trading activities within a subgroup of stocks, we estimated three regression equations simultaneously. Because the error terms are assumed to be correlated across the equations, we performed seemingly unrelated regression (SUR) to examine the effects of fear and greed on the trading activities of high and low subgroups with certain characteristic.

[13] showed that sentiment affects the trading behavior of small-cap return, particularly among stocks with lower stock prices, low institutional ownership, and higher B/M ratios, especially if these stocks are also costly to arbitrate. [5] used implied volatility as an indicator of timing strategies, showing that changes in the VIX are associated with future return differences between value versus growth and large cap versus small cap portfolios. However, this study focuses on the relationship between fear and greed and the trading activities of investors without investigating sentiment-return relationships. This study classifies the trading activities of all stocks into three subgroups based on the value stock prices, market capitalization, turnover, and stock returns at the end of the last season.

4. EMPIRICAL RESULTS

4.1 Descriptive statistics
The options of the Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) debuted on January 2, 2002. To ward off the effects of low trading activity of options on the fear and greed indices, we dropped data for the first 2 years after this debut. The sample period spans from January 2, 2004 to June 29, 2012, and includes 2111 daily observations. The implied volatility provides additional information as the trading volume increases. Panel A in Table 1 presents descriptive statistics for the daily variables of market returns, term

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spread, fear, greed, and three trading activities: trading value, trading shares, and turnover. The mean daily trading value amounts to NT$106 billion. On average, 4.09 billion shares were traded each day for a yield daily turnover of 0.595. Fear and greed are proxied by the implied volatility of the put and call options respectively, and the fear index is greater and more volatile than that of greed. The maximum (minimum) market returns approximated to daily price limits of 7% set by the Taiwan Stock Exchange Corporation. The Pearson correlation coefficients in Panel B of Table 1 suggest that the fear index is significantly negative to aggregate trading value and market returns, and not significantly associated with aggregate trading shares and turnover. Consistent with previous research ([9]), the Pearson correlation coefficients in this study support a contemporary negative relationship between the fear index and the returns of underlying assets. The greed index is positively related to trading value, shares, turnover, and market returns. According to the Pearson correlation coefficients, fear and greed both have a positive relationship.

Tabel 1 Descriptive statistics

Panel A of Table 1 presents descriptive statistics for the daily variables of market returns (M-return), term spread (TS), fear (VIX_p), greed (VIX_c), and three trading activities: trading value (value), trading shares (volume), and turnover (turnover). The term spread is the difference between the yield on a 10-year treasury bond and the 90-day commercial paper rate. Pearson correlation coefficients are reported in Panel B. * denotes significance at the level of 5%.

Panel A							
Variable	Value	Volume	Turnover	VIX_p	VIX_c	Mreturn	TS
Mean	106000000	4096654	0.5946	0.2586	0.2104	0.0101	0.5046
Std.	38800000	1381560	0.2563	0.1145	0.0831	1.3856	0.4985
Min	23800000	1396733	0.1890	0.1090	0.0504	-6.9123	-0.7991
Max	322000000	11600000	2.2312	1.3159	0.7890	6.5246	1.9684
Panel B							
volume	0.9176*	1.0000					
	0.0000						
turnover	0.7628*	0.9139*	1.0000				
	0.0000	0.0000					
VIX_p	-0.0997*	0.0048	-0.0156	1.0000			
	0.0000	0.8253	0.4747				
VIX_c	0.1143*	0.2526*	0.2453*	0.7198*	1.0000		
	0.0000	0.0000	0.0000	0.0000			
Mreturn	0.0818*	0.0785*	0.0916*	-0.1926*	-0.0091	1.0000	
	0.0002	0.0003	0.0000	0.0000	0.6770		
TS	-0.0743*	0.0552*	0.3317*	-0.1469*	-0.0635*	0.0331	1.0000
	0.0006	0.0112	0.0000	0.0000	0.0035	0.1290	

We standardized the fear index and trading activity to identify their mutual interaction on the same figure. Figure 1 shows the standardized daily levels of the fear index and the aggregate trading value of all stocks listed on the Taiwan Stock Exchange Corporation from January 2, 2004 to June 29, 2012. The most interesting phenomenon in the graph is the considerable variation in the fear gauge since September 2007. This value jumps to its highest level on

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October 27, 2008, during a global financial crisis. On the same day, the implied volatility for Taiwan index options (TVIX) reaches its highest level of 83.54. The trading value of the Taiwanese stock market fell to its lowest level in October 2008. Following the global financial crisis of 2008, the Euro financial crisis emerged in 2010, striking fear in investors again. Unlike the fear index, which fluctuates over time, the standardized trading values hover between -2 and 6, equaling NT$23.8 to NT$322 billion.

Figure 1: Daily level of VIX gauge and aggregate trading shares
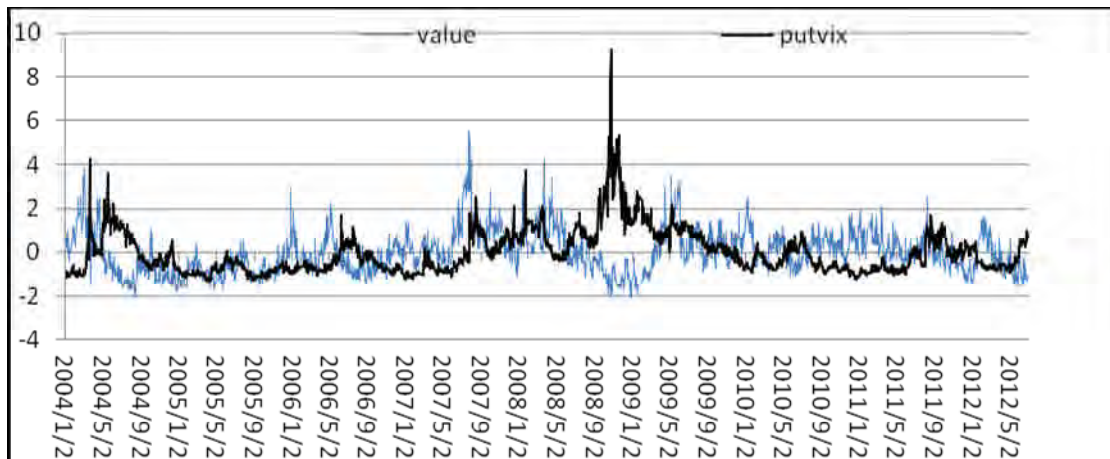
Figure 2 shows the standardized daily levels of the greed index in addition to the aggregate trading value. There has been a magnificent variation in the greed index since 2007, and it peaked to its highest level on May 4, 2009. Figures 1 and 2 show that fear and greed exhibit similar patterns, whereas Panel B in Table 1 shows that both have a Pearson correlation coefficient of 0.7198. This interplay between fear and greed seems like the motto of Warren Buffett: "We simply attempt to be fearful when others are greedy and to be greedy only when others are fearful."

Figure 2: Daily level of VIX gauge and aggregate trading shares
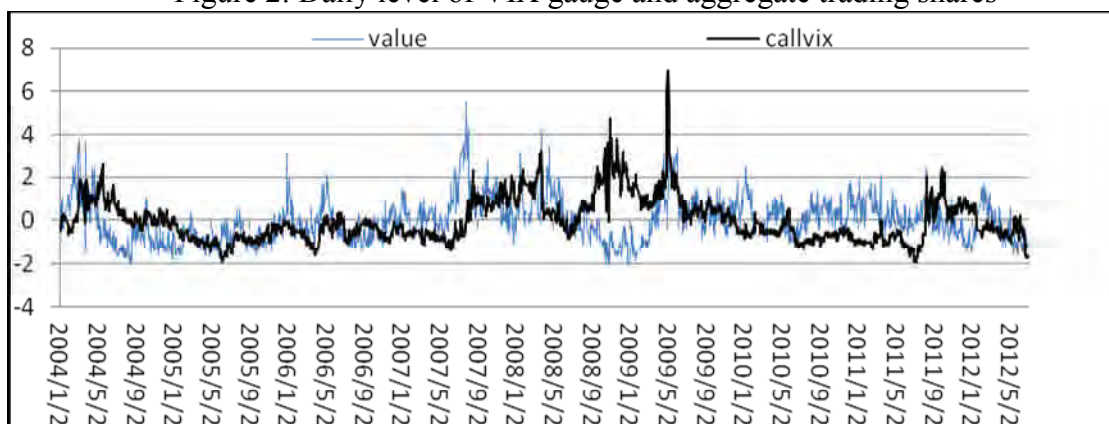
We standardized the fear index and aggregate trading value to identify their mutual implication on the same figure. Figure 1 shows the standardized daily levels of the fear index and the aggregate trading value of all stocks listed by the Taiwan Stock Exchange Corporation from January 2, 2004 to June 29, 2012. Figure 2 shows the standardized daily levels of the greed index, in addition to the aggregate trading value.

4.2 Effects of fear and greed index on aggregate trading activities

Fear and greed are intriguing psychological concepts in financial markets. Greed causes traders to purchase stocks in the expectation that the stock price will rise in the future. Fear causes traders to sell stocks or paralyzes them into inactivity. To obtain an overall grasp of the effects of fear and greed index on aggregate trading activities, we first regressed aggregate trading value, a proxy of investors' trading activities, on fear and greed gauges and control variables. For simplicity, we dropped the results for the dummy variables of weekday. The results presented in Table 2 show that the coefficient of the fear gauge is negative and significantly different from zero, implying that fear threatens the trading activity of investors. Conversely, the coefficient of greed is positive and significantly different from zero. A comparison of these two coefficients shows that the magnitude of the greed effect is greater than that of fear in the trading activities of investors. [3] showed that bearish and fear (VIX) sentiments induce more sell orders and reduce market liquidity. When partitioning VIX into fear and greed, we observed that the effect of greed on trading activities is much stronger than that of fear. Although stock markets move up over time, there are short periods of fear and doubt that cause investors to retreat. Fear may be a strong emotion, but the greed for potential gain is much greater.

Table 2 Effects of fear and greed index on aggregate trading activity

This table shows the results of OLS of trading activities on fear, greed, and control variables. $TV_{l,t} = \alpha_{l,0} + \alpha_{l,1}TV_{l,t-1} + \alpha_{l,2}VIX_{p,t} + \alpha_{l,3}VIX_{c,t} + control + \varepsilon_{l,t}$. The term TV is the aggregate trading activity for all stocks. The term TV_{t-1} is the lagged term of the dependent variable (D.var(-1)), and VIX_p (VIX_c) denotes the fear (greed) index. Other control variables include lagged market returns (Mretrun(-1)), lagged term spread (TS(-1)), and weekday dummy. The term spread is the difference between the yield on a 10-year treasury bond and the 90-day commercial paper rate. The last row presents the Wald-test results for fear and greed. ***, **, and * denote the level of significance at 1%, 5%, and 10%, respectively.

	Value	Volume	Turnover
Constant	3.195***	2.887***	0.052***
	14.607	15.428	4.912
D.var(-1)	0.827***	0.807***	0.829***
	70.191	65.186	71.179
VIXp	-0.343***	-0.256***	-0.169***
	-6.319	-5.311	-4.912
VIXc	0.429***	0.470***	0.343***
	5.893	6.999	7.069
Mreturn(-1)	0.009***	0.011***	0.010***
	2.939	3.914	5.439
TS(-1)	-0.023***	-0.006	0.024***
	-2.689	-0.837	4.235
fear=greed	42.339	45.430	43.763

Again, we used the aggregate turnover as a proxy of investors' trading activity, and the results hold. Finally, instead of aggregate turnover with aggregate trading shares, this study shows that greed is stronger than fear in its effects on the trading activities of investors. We partitioned VIX into the implied volatility of put and call options, representing fear and greed, respectively, to observe their effects on trading activities. The results of this study partially

support the effects of the interplay between fear and greed on the trading behaviors of investors. Finally, regression analysis suggests that fear is negatively and significantly associated with trading activity and that greed is positively and significantly associated with trading activity for all three trading activities. Fear is the opposite of greed. These results support $H1_0$: Fear (greed) has a negative (positive) effect on trading activity in the spot market. To obtain the subtle and distinctive effects of the fear and greed indices on the trading activity of investors, we further examined whether fear and greed have differential effects on the trading activity of stocks with certain characteristics.

4.3 How do fear and greed influence the trading activity of stocks with certain characteristics?

Fear accompanied with greed, but they may have different influences on investors' behaviors because investors are not homogenous and are preferred to stocks with some characteristic. For example, retail investors exhibit a preference for value stocks and small stocks ([2]), whereas institutional investors tend to prefer large stocks with more liquidity ([10]). [8] showed that on large jackpot drawing days, the number of shares traded by individual investors significantly decreases among stocks with low market capitalization, high past returns, and a high past turnover. Greed is the primary motivator for purchasing lottery tickets and gambling. When investors trade in the stock market with greed, those stocks among low stock price, low market capitalization, high return, and high turnover start rising because of heavy purchasing based on speculation about a possible uptrend of prices.

We extracted the variables of characteristics for stocks from the TEJ database, and then equally sorted all stocks into three subgroups based on the value of each characteristic at the end of last season, forming low, medium, and high portfolios. After sorting, we averaged all daily trading activities of the stocks in each portfolio to establish a time series of trading activities for each subgroup. Fear and greed might have different influences on the trading activity of each portfolio characterized by market capitalization, stock price, turnover, and returns. To address these concerns, we conducted SUR to examine the differential magnitude of the effects of fear and greed on the trading activities of low, medium, and high subgroups.

4.3.1 Stock subgroups sorted by market capitalization
For brevity, we dropped the empirical results for the weekday dummy variables, and used the trading values to represent trading activity. Table 3 presents the SUR results. We sorted the market capitalization of stocks, based on the value at the end of the previous season, into three subgroups, and regressed their trading values on independent variables. The results show that greed (fear) has a positive (negative) effect on the trading values among three low, median, and high subgroups. For those stocks with low market capitalization, the coefficient of greed is greater than that of fear on the trading value. This implies that the effects of greed are stronger than the effects of fear. If people prefer stocks with low capitalization ([13]) and lottery tickets ([8]), the trading activities of low capitalization are likely driven by greed. Conversely, the effect of fear is greater than that of greed for high market capitalization. Stocks with large market capitalizations are always traded by institutions that tend to trade by discipline and have stop loss limits. Thus, trading activities with large market capitalization are more likely affected by fear than greed.

4.3.2 Stock subgroups sorted by stock Price

Table 3 shows the same picture when stock subgroups are sorted by stock price based on the value at the end of the last season. In the low-priced stocks, the coefficient of greed is greater than that of fear, implying that their trading activities are driven by fear more than by greed. This result is similar to that by [8]. For stocks with a past high stock price, the fear index has a greater influence on trading values than on greed. Investors of high stock prices are fearful of potential losses because the losses for stocks with high prices are greater than those for stocks with low prices. Thus, their trading activities are more vulnerable to fear than to greed.

Table 3 Effects of fear gauge on trading volume classified by stock characteristics

This table presents the results of seemingly unrelated regression (SUR) for trading activities on fear, greed, and control variables.

$$TV_{l,t} = \alpha_{l,0} + \alpha_{l,1}TV_{l,t-1} + \alpha_{l,2}VIX_{p,t} + \alpha_{l,3}VIX_{c,t} + control + \varepsilon_{l,t}.$$ TV_t is the aggregate trading activity all stocks. The term TV_{t-1} is the lagged term of the dependent variable (D.var(-1)), and VIX_p (VIX_c) denotes the fear (greed) index. Other control variables include lagged market returns (Mretrun(-1)), term spread (TS(-1)), and weekday dummy. The term spread is the difference between the yield on a 10-year treasury bond and the 90-day commercial paper rate. The last row presents the Wald-test results for fear and greed. ***, **, and * denote the level of significance at 1%, 5%, and 10%, respectively.

	Stock price	Market	Stock return	Turnover
Low group				
Constant	2.695***	0.326***	0.334***	0.096
	(25.659)	(3.924)	(8.620)	(1.296)
D.var(-1)	0.755***	0.936***	0.964***	0.879***
	(69.888)	(110.399)	(256.787)	(116.845)
VIXp	-0.456***	-0.733***	-0.216***	-1.03***
	(-4.001)	(-7.678)	(-3.549)	(-12.010)
VIXc	1.022***	1.851***	0.199***	0.629***
	(6.719)	(14.495)	(2.429)	(5.482)
Mreturn(-1)	0.02***	0.017***	0.003)	0.01***
	(3.150)	(3.222)	(0.783)	(2.121)
TS(-1)	0.125***	0.249***	-0.010	0.274***
	(6.998)	(16.609)	(-1.074)	(20.328)
Adj R2	0.696	0.837	0.924	0.861
Medium group				
Constant	0.746***	0.994***	0.451***	1.492***
	(13.683)	(16.727)	(10.153)	(23.257)
D.var(-1)	0.924***	0.902***	0.955***	0.855***
	(178.669)	(161.914)	(241.851)	(142.660)
VIXp	-0.312***	-0.37***	-0.269***	-0.51***
	(-4.816)	(-5.794)	(-4.173)	(-7.843)
VIXc	0.318***	0.306***	0.289***	0.398***
	(3.663)	(3.589)	(3.345)	(4.613)
Mreturn(-1)	0.007**	0.009***	0.007*	0.01***
	(1.999)	(2.407)	(1.852)	(2.872)
TS(-1)	-0.001	0.002	-0.004	-0.008
	(-0.121)	(0.185)	(-0.438)	(-0.773)
Adj R2	0.887	0.880	0.892	0.881

High group

Constant	0.861[***]	1.412[***]	0.695[***]	2.303[***]
	(14.255)	(17.225)	(11.068)	(23.038)
D.var(-1)	0.919[***]	0.873[***]	0.935[***]	0.802[***]
	(169.522)	(121.347)	(169.025)	(95.612)
VIXp	-0.364[***]	-0.392[***]	-0.287[***]	-0.44[***]
	(-5.668)	(-6.668)	(-4.515)	(-7.063)
VIXc	0.301[***]	0.306[***]	0.369[***]	0.591[***]
	(3.535)	(3.947)	(4.305)	(7.011)
Mreturn(-1)	0.004	0.003	0.01[***]	0.008[***]
	(1.110)	(0.853)	(2.851)	(2.238)
TS(-1)	-0.004	-0.02[***]	0.001	-0.013
	(-0.442)	(-2.147)	(0.055)	(-1.346)
Adj R2	0.885	0.815	0.825	0.772

4.3.3 Stock subgroups sorted by stock return

Stocks within the high group are those stocks with returns that at the end of the previous season fall in the top one-third percentile. As Table 3 shows, for those stocks among the past high returns category, greed has a greater influence on their trading values than does fear. [8] showed that lottery tickets are a substitute for high return stocks for people. In contrast, for stocks with a low past return, the coefficient of fear is greater than that of greed. When all stocks are sorted into three subgroups based on past stock return, fear and greed have differential effects on the trading value among high and low stock return portfolios.

4.3.4 Stocks sorted by stocks turnover

The SUR results shown in Table 3 indicate that the trading values of stocks in the high turnover portfolio increase as greed rises and decrease when fear rises. The trading value of stocks with a high turnover reacts more positively to greed than it reacts negatively to fear. In the low stock turnover group, trading values tend to be influenced more by fear than by greed.

In summary, these results suggest that trading activities react to fear and greed asymmetrically. Among the subgroup with low market capitalization, low stocks price, high stock returns, and high turnover, trading values react more positively to an increase in greed than they react negatively to an increase in fear. Greed is the primary motive in purchasing lottery tickets at the cost of a small loss. These results are consistent to a degree with the findings by [8], who showed that on the large jackpot drawing days, the number of shares traded by individual investors significantly decreases among stocks with low market capitalization, high past returns, and high past turnover. In contrast, fear has a more powerful effect than greed among stocks with high market capitalization, high stocks price, low stock returns, and low turnover. Perhaps the potential losses of wealth for these stocks are more important to investors; therefore, their trading activities are more influenced by fear than by greed. Thus, the SUR results support $H3_0$.

4.4 Asymmetric effects of fear and greed on differential trading activity

These results confirm the differential effects of fear and greed on the trading values of stock portfolios with certain characteristics. [24] showed that the relationship between the rates of

changes in the fear gauge and the returns of underlying asset is asymmetric, and that the fear gauge better fits investors' fear of the downside than it serves as a barometer of investors' excitement in a market rally. In addition to exploring the effects of VIX on trading activities, this section examines the differential effects of fear and greed on trading activities. We performed quantile regression to examine this topic and regressed aggregate trading values on fear, greed, lagged trading values, lagged market returns, lagged term spread, and dummy of weekday.

Table 4 Asymmetric effects of fear and greed on differential trading activities

This table reports results of the quantile regression of trading activity on fear, greed, and control variables. $TV_{l,t} = \alpha_{l,0} + \alpha_{l,1}TV_{l,t-1} + \alpha_{l,2}VIX_{p,t} + \alpha_{l,3}VIX_{c,t} + control + \varepsilon_{l,t}$. The term TV_t is the aggregate trading activities for all stocks. The term TV_{t-1} is the lagged term of the dependent variable (D.var_lag), and VIX_p (VIX_c) denotes the fear (greed) index. Other control variables include lagged market returns (Mretrun(-1)), term spread (TS(-1)), and weekday dummy. The term spread is the difference between the yield on a 10-year treasury bond and the 90-day commercial paper rate. The last row presents Wald-test results for fear and greed. ***, **, and * denote the level of significance at 1%, 5%, and 10%, respectively.

| quantile	D.var(-1)	VIXp	VIXc	Mreturn(-1)	TS(-1)	constant	Adj R2
0.01	0.863***	**-0.758*****	0.611**	0.002***	-0.115***	2.217***	0.572
	(26.78)	(-3.04)	(2.00)	(0.27)	(-4.51)	(3.71)	
0.05	0.874***	**-0.661*****	0.441**	0.003	-0.080***	2.115***	0.534
	(36.44)	(-3.75)	(2.09)	(0.63)	(-4.04)	(4.79)	
0.1	0.862***	**-0.328****	0.138	0.011***	-0.064***	2.377***	0.527
	(37.82)	(-1.85)	(0.66)	(2.22)	(-3.36)	(5.63)	
0.2	0.896***	**-0.206*****	0.164	0.014***	-0.037***	1.772***	0.528
	(51.12)	(-2.25)	(1.3)	(3.7)	(-2.62)	(5.38)	
0.3	0.880***	-0.301***	**0.345*****	0.012***	-0.029***	2.123***	0.521
	(55.76)	(-3.46)	(2.63)	(3.03)	(-2.44)	(7.22)	
0.4	0.862***	-0.259***	**0.400*****	0.014***	-0.019	2.481***	0.514
	(59.28)	(-2.98)	(3.99)	(3.19)	(-1.43)	(9.31)	
0.5	0.847***	-0.254***	**0.406*****	0.015***	-0.017	2.799***	0.508
	(58.02)	(-4.08)	(5.63)	(3.72)	(-1.6)	(10.25)	
0.6	0.838***	-0.239***	**0.365*****	0.015***	-0.006	3.012***	0.5
	(61.3)	(-4.11)	(5.16)	(4.41)	(-0.54)	(11.92)	
0.7	0.816***	-0.265***	**0.367 *****	0.013***	-0.001	3.473***	0.489
	(53.49)	(-3.49)	(4.02)	(3.29)	(-0.06)	(12.24)	
0.8	0.813***	-0.272***	**0.393*****	0.006	0.005	3.566***	0.475
	(39.97)	(-2.74)	(3.97)	(1.45)	(0.4)	(9.41)	
0.9	0.744***	-0.312***	**0.462*****	0.006	0.000	4.913***	0.456
	(27.81)	(-2.69)	(3.28)	(1.03)	(-0.01)	(9.95)	
0.95	0.705***	-0.365***	**0.637*****	0.01	-0.016	5.685***	0.452
	(28.73)	(-3.2)	(3.69)	(1.28)	(-0.86)	(12.28)	
0.99	0.656***	-0.373*	**0.655*****	0.024	-0.018	6.730***	0.428
	(15.53)	(-1.7)	(1.83)	(0.65)	(-0.5)	(8.63)	

Table 4 presents the coefficients estimated on lag trading values, fear, greed, lag market returns, and lag term spread. For the lower trading value quantiles, the coefficient of fear is

negatively associated with the trading value, whereas that of greed has a positive association. The absolute value of the coefficient of fear is greater than that of greed, implying that the trading value reacts more negatively to fear than it reacts positively to greed. These empirical results imply that investors are reluctant to trade when fear overcomes greed. In contrast, the absolute value of the positive coefficient of greed is greater than that of the negative coefficient of fear for upper trading value quantiles, suggesting that high trading values are driven by greed more than by fear. When investors' greed dominates fear, they pour money into the stock market, producing high trading values. These empirical results support $H2_0$ [i.e., the effect of greed (fear) is relatively greater than that of fear (greed) among high (low) trading activities].

4.5 Effects of change in fear and greed on trading activities

The previous sections presented the investigation of the associations between the level of fear and greed and trading activities. [15] suggested that the association between falling prices and increasing risk is stronger and more sensitive than that between rising prices and diminishing risk. [24] showed that the negative relationship between the stock market return and VIX change is asymmetric because VIX rises at a higher absolute rate for negative returns than for positive returns. This section further investigates the relationship between the changes in fear and greed and trading activities.

Figure 3 Response of aggregate trading activity to fear and greed

Response to Generalized One S.D. Innovations ± 2 S.E.
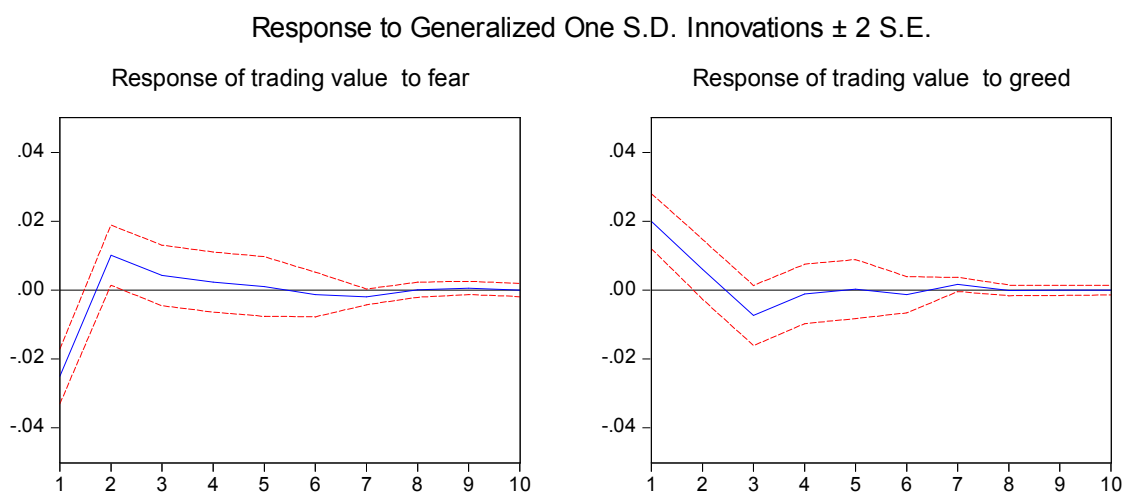
Fear and greed are powerful emotions in the stock market, and these two emotions and trading activities act as a system. We applied the vector autoregression model (VAR) to investigate this postulated relationship. [20] suggested that *t* tests on individual coefficients do not produce reliable results, and cannot strongly support the relationship among the variables in the system. He advocated a focus on the impulse response to random shocks. To avoid the innovations in VAR are sensitive to variables ordering ([17]), we applied a generalized impulses technique to examine the responses of trading activities to changes in fear and greed ([22]). We also used the Schwarz information criterion (SIC) to identify the appropriate lag lengths.

Figures show the impulse responses of trading activities to changes for fear and greed, respectively. Trading activities appear to respond positively and significantly to greed during

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the first day and reverse negatively on the third day, becoming non-significant thereafter. The immediate positive and the subsequent negative effect of greed is consistent with the arguments that if excessive optimism moves trading values up, periods of high trading activities should be followed by low trading values. Although the response of trading activities to fear is negative and significant during the first day, it becomes positive on the second day. Similar to the results of greed, the immediate negative and subsequent positive effect of fear is analogous to arguments that if excessive pessimism moves trading activities down, periods of low trading activities should be followed by high trading activities.

5. CONCLUSION

This study uses the VIX method introduced in 1993 to construct the fear and greed indices and examine the effect of fear and greed on trading activities. Results show that fear and greed are negatively and positively, respectively, associated with trading activities. During high trading activity quantiles, greed has a greater influence than fear, and vice versa for low trading activities quantiles. Finally, this study shows that greed has a greater influence than fear on stocks with low prices, low market capitalization, high returns, and high turnover.

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TORTS GONE WILD!
A BUSINESS LAW CASE BASED ON STEVE WYNN V. JOE FRANCIS LITIGATION

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ABSTRACT

Large defamation awards are not exclusive to well-known individuals, but their news provides a reminder of the loss potential. A history of litigation between Steve Wynn, a casino owner, and Joe Francis, most well-known for *Girls Gone Wild!*, provides a colorful illustration. This business law case explores the risks to which individuals are exposed when they make remarks to media or on the internet. The case raises liability issues relevant to every household and employer, with an unlikely cast of celebrities against a backdrop of Las Vegas excess.

Key words: absolute privilege, civil law, defamation, risk management, tort

INTRODUCTION

Technological advances, particularly social networking sites, enable individuals to defame others faster and to a broader audience than ever before. Smart phones provide access to social networking sites where statements may be intended for a few contacts but can ultimately be disseminated to millions of internet users. Further, the originators of the statements may be mistaken as to the level of privacy that they enjoy with their communications.

Failing to manage this risk exposure can result in costly and lengthy litigation, and court awards can be unpredictable. Large defamation awards are not exclusive to well-known individuals, but their news provides a reminder of the loss potential. A history of litigation between Steve Wynn, a casino owner, and Joe Francis, most well-known for his *Girls Gone Wild!* videos and DVDs, provides a colorful illustration.

Households and businesses must recognize and manage the potential liability exposure arising from family members or employees using the internet or other media to cause harm to others. This business law case illustrates the risk exposure that individuals have when they make remarks to media or on the internet. The case raises liability issues relevant to every household and employer, with an unlikely cast of celebrities against a backdrop of Las Vegas excess.

BACKGROUND

The Wynn/Francis litigation history began in 2008, when a criminal case was opened based on Wynn's claim that Francis had accumulated $2 million in unpaid gambling debt the prior year. The indictment alleged that Francis had intended to defraud the Wynn Las Vegas casino by

signing a $2.5 million marker on a closed bank account (under Nevada law, markers are the equivalent of checks). Francis paid back only $500,000 of the $2.5 million. The criminal case against Francis over his gambling marker was dismissed in September 2011 based on lack of evidence because the casino had taken too long, 16 months, to collect the funds.

In 2008, Wynn Las Vegas casino attempted to recover the debt by filing a civil suit. This suit ended with a summary judgment against Francis for $2 million plus interest. In an October 2011 appeal, the Nevada state Supreme Court upheld that award.

Defamation: Illegal Business Practices

Both in his court defense of the 2008 suit and in public, Francis accused Wynn of using illegal business practices. In August 2008, Wynn sued for $10,000 for defamation related to Francis' statements regarding Wynn's business practices.

In November 2011, after losing the appeal on the civil gambling case, Francis filed three suits against Wynn, seeking unspecified damages for alleged forged documents, fraud, and defamation. This formalized the accusations that Francis had made related to the gambling trials, allegations for which Wynn had already filed suit for defamation.

In the suit, Francis claimed that Wynn deceives high rollers using "alcohol, prostitutes and illegal drugs" to lure big spenders to his casinos and using diversions and creating counterfeit markers to obtain money by "false pretenses." Francis alleged that Wynn "intentionally miscalculates markers and forges the high rollers' signatures in order to change a high rollers' win to a loss." Francis accused Wynn of malicious prosecution, conspiracy, and abuse of process in addition to defamation, which led to ruining his reputation.

In February 2012, a Nevada state judge ordered Francis to pay Wynn $5 million on the Wynn v. Francis defamation case regarding illegal business practices. The court awarded an additional $2.5 million in punitive damages. Francis is expected to appeal.

Defamation: Murder Plot

During the gambling debt civil trial and also to a TMZ reporter in April 2010, Francis stated that he needed a restraining order against the casino tycoon because "Wynn threatened to kill me. He said he would hit me in the back of the head with a shovel and bury me in a hole in the desert."

In response to Francis' murder plot allegations, Wynn sued Francis for slander in 2010. In his response to the court, Francis stated that he had seen email from Wynn plotting to have Francis killed, and repeated that the plan was to bash him with a shovel "in the back of the head with a shovel" and then dig him a sandy grave away from the Las Vegas strip.

In August 2012, Francis repeated the murder plot claims on ABC's "Good Morning America". Francis stated that Wynn had sent ominous, threatening emails about him and that (friend and neighbor) Quincy Jones told him about Wynn's threats. Francis claimed that Jones had showed him a stack of these printed email threats.

In anticipation of the September 2012 defamation trial, Jones was subpoenaed to testify. However, he was excused due to his claim, substantiated by a doctor's note, that the Wynn-Francis dispute caused him "grave fear of his health" and that he suffered "increased anxiety, heart palpitations, and difficulty breathing."

Despite having been excused for medical reasons, Jones chose to testify at the trial. He denied Francis' statements that Jones "flashed a stack of emails" that contained the threats, and denied that he'd heard Wynn threaten Francis. Subsequently, Wynn testified that he doesn't use email and that he never told Jones he wanted Francis dead. Further, Wynn's attorney referred to Francis as a "digital assassin" who had taken advantage of the broad reach of the internet to attack Wynn.

In late 2012, Wynn won this second defamation lawsuit against Francis. Although Wynn had sued for $12 million in damages, the jury awarded $20 million with an additional $20 million in punitive damages. In reaction to the judgment, Francis posted a message on his website saying he was "incredibly disappointed the jury grossly misinterpreted the facts.", and indicated that he plans to appeal.

THE ISSUES

While the cases primarily focus on defamation claims, a variety of business law issues arise from this case history. These issues include:

- Non-payment of debt
    - Criminal prosecution
    - Timely attempt to collect
    - Civil litigation, tort law

- Defamation
    - Absolute privilege
    - Civil litigation, tort law
    - Punitive damages

- Dissemination of defamatory comments
    - Media responsibility
    - Online service provider responsibility

- Risk management
    - Risk exposure
    - Behavioral management

- Related cases
    - Lindsey Lohan
    - Courtney Love (twice)
    - Dr. Phil McGraw

- o Jerry Seinfeld
- o Oprah Winfrey

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BUSINESS ETHICS EDUCATION IN POLAND: AN EMPIRICAL STUDY

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ABSTRACT

In this study, Polish undergraduate business student ethics learning was investigated. One hundred and eighty-six Polish students were asked to provide their moral awareness and moral behavioral intent ratings twice, first at the beginning of the semester and again at the end of the semester. Students read four scenarios, i.e., accounting, management, finance, and human resource management, and then provided their overall moral awareness and moral behavioral intent ratings. We found that ethics learning in terms of pre-post changes were not statistically significant across four scenarios. Implications for business ethics education in Poland were discussed.

Keywords: business ethics, learning outcome assessment, moral awareness, pre-post

INTRODUCTION

Among Eastern European countries that benefited from the economic transformation over the past two decades is Poland. In fact, according to the most recent study conducted by the Intelligence Unit at the Economist, Poland is the only country that experienced positive GDP growth in the European Union post the global financial crisis. In the midst of the economic growth, a lot of challenges remain, one of which is corruption. According to Transparency International, the 2011 and 2010 corruption perception index for Poland is 5.5 and 5.3 respectively on a 10 point scale with lower numbers indicating more corruption as perceived by business people and country analysts [15]. Other empirical research also shows that corruption is an obstacle to grow a business in Poland [18]. Whereas membership in the European Union may force Poland to fight corruption at the national level, evidence remains that there is still distrust among business people in how the government handles the country's economic transition. For example, Valentine and colleagues conducted a survey of small business owners in Poland and reported that being ethical was positively related to facing challenges in growing one's business [17]. It is our belief that unless there is shared consensus at the individual level that being ethical will lead to economic success, any growth experienced in Poland today will be short-lived. Instrumental in this effort is business ethics education at the university level.

According to the Association to Advance Collegiate Schools of Business International (AACSB International), only one university in Poland – Kozminski University, was accredited as of July 2012 [1]. This means that business ethics education in Poland remains fragmented, more so than in the United States. Although AACSB allows business schools to design their own ethics curricula, it is important to establish guidelines as to what should be included in an ethics curriculum. In an effort to standardize ethics teaching in the classroom, various goals for an ethics training program have been identified. Of the four objectives of an ethics curriculum, raising moral awareness among students and helping students understand their core values were considered most important [12].

Raising ethical awareness requires raising students' level of ethical sensitivity. In a recent extensive review of behavioral ethics literature, citing evidence in nursing, dentistry, accounting, marketing, and education, Treviño and colleagues [16] noted that training and experience can enhance ethical sensitivity. Whereas moral values are the foundation upon which principles of right or wrong are formed, business educators have realized that teaching students to uphold certain sets of values after a course may not be successful [3]. Therefore, we think the most realistic goals of an ethics course should be to raise students' moral awareness because awareness is the first step in the moral decision making process [8]; [5]. Lacking moral awareness, it would be futile to teach students to uphold ethical values and/or understand ethical theories and identify levels of ethical judgment because moral behavior is only possible with moral awareness.

The purpose of this study is to examine the effectiveness of including a business ethics course in undergraduate curriculum in Poland. Specifically, we wanted to identify how much of an improvement in moral awareness and moral behavioral intent that can be acquired after a course in which business ethics is introduced in Poland. The use of scenarios to depict moral dilemmas has been utilized in prior research on business ethics education. In this study, we used four scenarios covering a variety of ethically challenging situations ranging from accounting, finance, Human Resource Management, and sales management. We expected that student awareness or sensitivity of moral implications across scenarios would be increased through active participation in in-class discussion measured at the end of the semester. Further, we expected that the increased level of moral awareness would lead to more moral behavioral intent as proposed in Jones (1991) model of issue contingent ethical decision making. At least one study reported that a gain in students' moral sensitivity resulted from in-class ethics exercises.

In this study, we note several definitions. First, an ethical or moral scenario is defined as an issue "where a person's actions, if performed freely, may harm or benefit others" [5]. This definition connotes an interpretation process that the decision maker has to go through in order to choose an alternative that is the least harmful to others. Second, we define an ethical decision or intent as one that is both "legally and morally acceptable to the larger community" [5]. Third, moral awareness is defined as one's ability to recognize the ethical nature of a situation in a professional context based on [11] study. We note that in this study the term "moral" and "ethical" are used interchangeably. Although moral awareness and moral sensitivity are different such that whereas the former refers to an ability to recognize the moral import of an issue; the latter refers to how many one can identify within an already recognized moral dilemma; the term moral awareness and moral sensitivity are used interchangeably in this study.

METHOD

Sample and procedure
A total of two hundred and sixty six undergraduate business students at a large university in Poland participated in this study as part of a larger assessment project. Data were collected at two different points in time: during the first week of the semester and the last week of the semester. Student responses were matched from pre-post data using identification numbers because no names were collected and students were assured of confidentiality. However, we were able to match data from both the beginning of the semester and the end of the semester for one hundred and eighty-six students only. Of these students, one hundred and thirty were female

and fifty six were male with an average age of 26.68 ranging from twenty-two to fifty-seven. In terms of ethnicity, all were Polish or of Polish origin (N = 183 or 98.4%) with the remainder reported as international students but were of Polish origin (N = 3 or 1.6%). The majority of the participants (80.1%) were majoring in management or human resource management with the remainder reporting accounting, finance, and marketing as their major. All participants had not taken a business ethics course prior to this study.

Measures
Scenarios. Four scenarios covering ethical dilemmas in accounting, management, finance, and human resource management situations taken from [9] text used in the Principles of Management course used in prior research. The scenarios were translated to Polish by the second author and back translated into English by the third author. The scenarios are shown in the Appendix.

Moral awareness. Students were asked to provide their agreement to four statements concerning the level of moral implication in the four scenarios. The statements range from 1 being "none of the scenarios have any moral implications" to 4 "they all have moral implications".

Moral intent. Following each scenario is a question asking students to indicate their intent to act based on the dilemma depicted in the scenario. All moral intent items were dichotomous and coded as 1 being "ethical" and zero being "unethical".

Personal value of honesty. We used Scott's (1965) 20 item honesty sub-scale of the Personal Value scale. This scale has been used in prior studies [6] examining applicant faking in staffing research. Each item is a statement referring to a value-laden behavior, e.g., "helping a friend get through an examination"; "being dishonest in harmless ways"; "helping a close friend get by a tight situation, even though one may have to stretch the truth a bit to do it"; "using a false ID to get into restricted places". Participants were asked to describe whether each statement referred to something that they "always admired," "always disliked", or "depends on the situation" whether they admire it or not. Following the original scoring instruction, the neutral response, i.e., "depends on the situation" was collapsed with "always disliked" and scored as zero for positively worded items, whereas "depends on the situation" was collapsed with "always admired" and scored as zero for negatively worded items. "Always admired" was scored as 1 for positively worded items and -1 for negatively worded items. Scale scores were the sum of all the 20 item scores. The internal consistency estimate for this variable in this study was .58 for the pretest and .52 for the posttest. We note that these values are substantially lower than the same values obtained for American samples in prior research [6][10] and caution any interpretation of this variable.

Ethics learning. We defined ethics learning as the positive change from the beginning of the semester measured at the end of the semester. Thus, we computed difference scores for all student participants across four scenarios (accounting, finance, management, and HR) by taking the moral awareness and moral intent ratings from the beginning of the semester and subtracting the respective individual ratings from the end of semester assessment. Difference scores are considered an appropriate measure of change or learning when individual differences in true change exist. Following this procedure, we computed six difference scores for each student, a difference score for moral awareness, four difference scores for moral intent corresponding to

four scenarios, and one difference score for personal honesty. Positive scores reflect that learning did occur as a result of ethics education over the course of a semester whereas negative scores reflect a lack of learning.

Control variables. Data on typical demographic variables such as sex and age were used as control variables. We also included personal honesty as a control variable because honesty as an individual's ethical orientation has been shown to be an antecedent of moral awareness and that ethical orientation was positively related to moral awareness [11][16]. Thus, to remove any potential confound in ethics learning concerning moral awareness, we decided to control for personal value of honesty.

Analysis. We performed all statistical analyses using SPSS version 19.0.

RESULTS

Table 1 shows the descriptive statistics and inter-correlation of variables examined in the study. As shown in Table 1, female students were more aware of the moral implications across four scenarios at the beginning of the semester before they were introduced to business ethics ($r = .21$, $p < .01$). This was consistent with previous research reporting that women were more sensitive to ethical issues compared to males [16]. Age showed some statistically significant relationships to several variables in the study. Specifically, age was positively related to moral intent measured in the accounting scenario both at the beginning of the semester ($r = .18$, $p < .05$) and the end of the semester ($r = .15$, $p < .05$). Age was also positively related to moral intent in the finance scenario measured at the end of the semester ($r = .26$, $p < .01$), but not at the beginning of the semester ($r = .09$, *n.s.*). Similarly, age was positively related to moral intent in the human resource (HR) scenario) measured at the end of the semester ($r = .15$, $p < .05$) but not at the beginning of the semester ($r = .01$, *n.s.*).

Personal honesty measured at the beginning of the semester was positively correlated to moral intent in the accounting scenario at pre-test ($r = .18$, $p < .01$) as well as post-test ($r = .26$, $p < .01$). The same pattern of finding was revealed with personal honesty measured at the end of the semester. Specifically, honesty measured at post-test was positively correlated to both moral intent in the accounting scenario at pre-test ($r = .16$, $p < .05$) and post-test ($r = .21$, $p < .01$). This finding means that more honest students were more likely to form a more moral behavioral intent in the accounting scenario before and after being introduced to a business ethics course. Honesty at pre-test was also positively correlated with moral intent in the management scenarios both at pre-test ($r = .15$, $p < .05$) and post-test ($r = .23$, $p < .01$) as well as the HR scenario measured at post-test ($r = .16$, $p < .05$). Interestingly, honesty was not correlated to moral intent in the finance scenario.

Table 2 shows the difference scores or effect size Cohen's d values for various ethics learning variables. As shown in Table 2, our expectation concerning the potential gain in moral awareness was not supported. Specifically, students displayed some gain in their moral sensitivity ($M = 3.50$ vs. $M = 3.55$) from beginning and end of semester, the gain was not statistically significant ($d = .07$, *n.s.*). None of the moral intent ratings across four scenarios showed any gain at post-test. Although the gain in moral intent in the finance scenario was in the

expected direction, the magnitude of the gain failed to reach statistical significance (d = .16, *n.s.*) Personal value of honesty was revealed to be a reliable measure in this study because the test-retest reliability was quite high (r = .42, see Table 1) and there was no change between pre-test and post-test (d = -.01, see Table 2).

Table 1. Descriptive statistics and correlations of variables in the study (N = 173)

Variable	Mean	Std.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	26.68	6.14	-													
2. Sex	.70	.46	-.02	-												
3. Moral awareness – pre	3.50	.72	-.01	.21	-											
4. Moral awareness – post	3.55	.65	-.07	.15	.34	-										
5. Moral intent – accounting - pre	.77	.42	.18	.23	.05	-.05	-									
6. Moral intent – accounting - post	.73	.44	.15	.13	.22	.13	.21	-								
7. Moral intent – finance – pre	.42	.51	.09	-.04	.29	.12	.01	.13	-							
8. Moral intent – finance - post	.46	.50	.26	-.06	.05	.01	.18	.24	.27	-						
9. Moral intent – management – pre	.90	.31	.07	.10	.13	.00	.09	.18	.09	.06	-					
10. Moral intent – management – post	.89	.52	.14	.05	.13	-.04	.15	.18	.20	.22	.26	-				
11. Moral intent – HR – pre	.36	.48	.01	.17	.22	.05	.17	.10	.23	.07	.10	.07	-			
12. Moral intent – HR - post	.32	.48	.15	-.05	.01	-.12	.01	.07	.11	.12	.19	.33	.29	-		
13. Honesty – pre	8.28	2.86	-.07	.01	.11	.09	.18	.16	-.02	.13	.15	.23	.10	.16	.58	
14. Honesty - post	8.25	2.67	.14	.04	.05	.02	.26	.21	-.03	.20	.11	.15	.15	.13	.42	.52

Note: correlations ≥ .15 are significant at p < .05 (two-tailed)
   Correlations ≥ .18 are significant at p < .01 (two-tailed)

Table 2. Ethics learning between beginning and end of semester

Measure	N	Beginning of semester		End of semester		d
		M	*SD*	*M*	*SD*	
Moral awareness	173	3.50	.72	3.55	.65	.07
Moral intent - accounting	173	.77	.42	.73	.44	-.09
Moral intent – management	173	.90	.31	.89	.52	-.02
Moral intent – finance	173	.34	.48	.42	.51	.16
Moral intent – HR	173	.36	.48	.32	.48	-.08
Personal honesty	173	8.28	2.86	8.25	2.66	-.01

DISCUSSION

In this study, we attempted to examine the effect of ethics teaching in a sample of undergraduate Polish students. First, we found that the gain in moral awareness, albeit in the expected direction, failed to reach statistical significance ($\underline{d}$ = .07, *n.s.*). In retrospect, we think that this might be due to the way moral awareness was measured. Specifically, there was one item to assess the level of awareness across four scenarios. Had we used one item to assess awareness for each scenario, we might have been able to capture the student sensitivity or awareness about the moral implication specific to each scenario. The measure used in this study might have confounded the above finding.

Second, ethics learning was elusive in this study because across four scenarios, there were no statistical significant gains in any of the ethics learning measures. There are several reasons for these findings. First, the moral dilemmas depicted in the scenarios are U.S. specific, e.g., the Securities Exchange Commission as depicted in the finance scenario, might have been an unknown entity to Polish students before taking this business ethics course. Thus, students in this study might not have been able to relate to the differences between what is legal versus ethical when it comes to U.S. laws concerning insider trading and or misstating financial reports. The finding of no significant gains in ethics learning in the HR scenario was consistent with a previous research using a U.S. student sample. In that study, Nguyen et al. found that the vast majority of the students perceived that lying about the layoff decision was ethical when withholding such information minimizes disruption in the workplace. In this study, we found that the mean moral intent for the HR scenario was the lowest of the four scenarios ($\underline{M}$ = .36 vs. $\underline{M}$ = .32) suggesting that Polish students, similar to U.S. students perceived lying as justifiable in this scenario.

Valentine and colleagues (2006) conducted a survey of small and medium business owners in Poland and found that financial management was the most problematic area for Polish businesses that want to adopt an ethical orientation [17]. Our finding was consistent with this. Similarly with the accounting and management scenarios, no ethics learning was recorded.

Our results concerning the lack of gain in ethics learning is disappointing. There are several reasons that might be responsible for this finding. First, the class size at this particular university in Poland was very large, about 340 to 400 students attending weekend classes. Thus, any learning might have been harder to capture had the class been of smaller size. Second, students in this study were older than traditional students, meaning they were full time professionals attending classes during the weekends. Previous research shows that age is positively related to deeply held values. The relatively stable personal value of honesty among these students over the duration of a semester in this study confirms that. Thus, we think for older students with more deeply rooted values than their younger peers, it is harder to expect learning as a behavioral change in these students after one business ethics course.

Consistent with prior research, we found that female students were more morally sensitive than male students [11][2] at the beginning of the semester. At the end of the semester, the gender difference disappeared. This suggests that the potential gain for male students in learning about moral awareness is greater than that of female (See Table 1).

It is important to note the considerably lower internal consistency estimates (Cronbach alpha) for personal honesty variable at both pre-test (α = .58) and post-test (α = .52) compared to that of American samples (α = .79 as reported in Nguyen, 2002 and α = .77 as reported in Nguyen et al., 2012). A post-hoc item-by-item examination reveals that students reported that they always admired the action of "helping a friend get through an examination" and/or "use a false ID to get into a restricted place". Whereas the above actions are considered unethical in the U.S., Polish students in this study somehow did not share this view. This might have explained the inconsistency in student responses, hence, the low Cronbach alpha estimates. Another plausible explanation for the low consistency in honesty variable is the cultural difference between Polish and American students. Because American students on average rank higher on individualism than Polish students [4], it is reasonable to expect that refusing to help a friend through an examination might be considered undesirable or unethical in Poland.

Our study, notwithstanding the findings, is the first to assess the effectiveness of a business ethics course at the university level in Poland. Our study shows that it will probably improve ethics learning. Future studies should replicate our study on a larger sample. Also, smaller class sizes should be the norm for ethics learning to be maximized. Because most small Polish business owners do not possess a college degree [7], we think that business ethics training should be offered to those owners in order to capture all market actors to improve the fight on anti-corruption. As Poland's objective is to join the Eurozone no later than 2019 [13], it is more important than ever before that future Polish managers be trained to make ethical decisions. Our study shows that the goal of enhancing ethics learning will not be easy to accomplish unless faculty start introducing more scenario-based teaching into the classrooms in Poland.

Contribution to business ethics literature
Our study was the first to address raising moral awareness in business ethics teaching in Poland. The findings of our study provoke more questions for future research than provide the answers to our current research questions. Nonetheless, we hope that our study is a small step toward the right direction in assessing business ethics education in higher education in Poland, a country with tremendous growth potential in the European Union.

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Appendix
Research vignettes used in the study

Accounting scenario: You're an accountant with a large accounting firm. One of your clients is the CFO of a large energy conglomerate. The CFO has just seen his company's losses from activities they are involved in. Rather than show the losses on the corporate income statement, the CFO would like for you to verify that these losses rightfully belong to a subsidiary company. In doing so, the company's stock prices will not be affected. What do you do?

Action: Refuse to comply with the CFO's request _____   Comply with the CFO's request ___

Finance scenario: You are a broker, representing a high-profile individual that is a friend of a CEO of a company. Your client has invested money in that company. One day your client instructed you to sell the stocks before news about the company that triggers the drastic decline of the company's stock price becomes public. Your client says the timing was coincidental. You believe otherwise. What do you tell the Securities and Exchange Commission when it contacts you about the incident?

Action: that your client's timing of selling the stocks was coincidental _____
        That your client's timing of selling the stocks was not coincidental _____

Human Resource Scenario: An employee asks you about a rumor she's heard that your department and all its employees will be transferred from New York to Pittsburg. You know the rumor to be true, but you'd rather not let the information out just yet. You're fearful that it could hurt department morale and lead to premature resignations. What do you say to your employee?

Action: The rumor was not true _____
        The rumor was true _____

Management scenario: As a sales manager, you just received your department's sales report for last month. Sales are down considerably. Your boss, who works 2,000 miles away in another city, is unlikely to see last month's sales figures. You're optimistic that sales will pick up this month and next so that your overall quarterly numbers will be right on target. You also know that your boss is the type of person who hates to hear bad news. You're having a phone conversation today with your boss. He happens to ask in passing how last month's sales went. What do you tell him?

Action: Tell him sales were down last month ____ Tell him sales were on target last month_____

SAT-MATH-SIMULATION-TESTS FOR BUSINESS STUDENTS: RESULTS AND ANALYSES

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ABSTRACT

Nine tests that simulated SAT math test were administered to students in School of Business, Richard Stockton College of New Jersey, from 2006 to 2011. These tests were for the purpose of assessing progress of students' quantitative aptitude. Students' scores in that SAT-math-simulation-test were compared to their SAT scores when entering college, indicating their academic achievements in college in quantitative capability. This paper summarizes the results of this six-year project, showing the relationship between the test scores and a bunch of factors such as gender, GPA, major and concentration, number of credit hours earned, and number of transfer hours.

1. INTRODUCTION

Since 2006, a 25-minute "*SAT-math-simulation-test*" has been administered in Quantitative Business Methods, a core course of Business program in Richard Stockton College of New Jersey. The test contains 20 questions that are picked from SAT Math Test. The purpose of the test is to assess students' quantitative capabilities and progresses. This method for assessment was developed in 2006 and its validity was justified in [20] Quantitative reasoning is a key capability that colleges expect their students to possess to deal with professional and academic challenges of today. To the chagrin of educators in higher institutions, that capability is lacking in many of them at graduation [21]. Data from the Department of Education shows that American literacy progress has stagnated during the past several years [18]. Some recent studies attempted to explore the underlying reasons for this state of affairs. Dar-Nimrod presented the findings on whether math ability was nature or nurture [7]. Ruffins addressed "math anxiety" as the worst enemy of studying math and the ways to overcome it [16]. Jones and Byrnes studied the influence of students' characteristics on studying math [10].

There have been numerous efforts in exploring expressions of basic quantitative reasoning elements and skills [14]. Wilkins put forward a framework of five components to cover different facets of mathematical literacy: content knowledge, reasoning, societal impact, development of math, and math disposition [21]. Hogan and Brezinski summarized quantitative skills into three types: numberosity, measurement, and computational estimation [8]. Ma looked at factors of mathematical achievement and their correlations by using regression trees [12]. Handelsman et al studied the relationship between a student's engagement and course achievement, and proposed a measurement for it [9]. Rourke and Anderson investigated the quantitative content analysis (QCA) and argued that QCA should be conceived of as a form of testing and measurement [15].

We introduce how "SAT-math-simulation-test" is generated and administered in Section 2. Results of the tests in the past six years on over eight hundred students are presented and analyzed in Section 3.

2. THE SAT-MATH-SIMULATION-TEST

SAT-math-simulation-test is an abridged version of SAT math test, which is composed of questions randomly selected from the quantitative part of past SAT exams, but much shorter than SAT test. There are 60 quantitative questions in a SAT test and students have 75 minutes to complete them. In their article in 2006 [20], the authors argued that a test of as few as 20 questions is statistically comparable to the SAT quantitative test consisting of 60 questions. A 25-minute test made up of 20 questions can be conveniently and flexibly infused in a class.

To generate the SAT-math-simulation-test, we first investigated ten past SAT tests. A SAT math test is composed of 60 questions. We grouped those questions into categories such as algebra, geometry, probability, problem solving, etc. The percent of the questions of each category in a SAT test was calculated. Twenty questions were then selected randomly from the ten SAT math tests according to the proportion of each category.

The 20-questions SAT-math-simulation-test was given to the students who took Quantitative Business Methods, which was a core course required for the business major. The test took only 25 minutes with 1¼ minute for each question. To motivate students to take serious on the test, extra credits were given to students who took the test and to answers that were correct. Six years' practice showed that the incentive worked very well.

The raw score of SAT-math-simulation-test is between 0 and 20, indicating number of questions a student answered correctly. To make it comparable to SAT score, we first convert it into the 0-60 "points-earned-score" following the formula of SAT test. Let C represent number of correct answers in SAT-math-simulation-test. That is, let C=raw score of SAT-math-simulation-test. Then, Point-earned-score = $3(C - 0.25(20-C))$. The

point-earned score is converted to a 200-800 SAT score by using SAT Conversion Table published in SAT exam books [4].

By using such a test that is comparable to SAT test, we can take a student's SAT test score as the "pre-test", and our assessment test as the "post-test", so as to assess the student's progress in quantitative aptitude in college.

SAT-math-simulation-test also stands by itself to tell useful information about students' status in their college studies. Especially, about half of the business students in Stockton College were transferred from community colleges, many of them did not have SAT scores. A SAT-simulation-test is then viewed as a "make-up" SAT test for them in assessment.

SAT-math-simulation-test is only one third of regular SAT math test, taking just 25 minutes. Therefore, it is easy to "sneak" into a class with little interference on class schedules.

3. RESULTS AND ANALYSIS OF NINE SAT-MATH-SIMULATION-TESTS

SAT-math-simulation-test was administered nine times to a total of 859 students from 2006 to 2011 in Quantitative Business Method class, a core course of business program at Stockton College. One same simulation-test was used for all the nine tests since 2006.

Students were given 25 minutes to complete the test, following the SAT standard of 1¼ minutes for each of the 20 questions in the simulation test. Extra credit was given to stimulate students' interest and to ensure their seriousness in taking the test.

Table 1 shows the summary of the nine tests. Average and median scores maintained pretty stable and consistent in those tests, around 547 and 557 respectively. It indicates that students' quantitative capabilities maintained stable in the past six years. But the standard deviations had a trend of increase with the time. Some faculty felt that students' quantitative capabilities were weaker than years ago. Our results do not support that hypothesis. But the faculty's feeling about students' mathematic capabilities may not be incorrect because their capacities are more diversified and spread over a larger range, represented by the larger standard deviations, which made teaching more difficult. The data in Table 1 also shows that, in the past six years, students who took the Quantitative Business Methods (QBM) course had kind of consistent academic background in terms of GPA, credit hours earned and transfer credit hours.

Table 1. Year-By-Yeat SAT-Math-Simulation-Tests Summary:										
Scoring base is 200-800 as for SAT Math test scoring base										
	Overall	*Spring 2006*	*Fall 2006*	*Fall 2007*	*Spring 2008*	*Fall 2008*	*Spring 2009*	*Fall 2009*	*Spring 2010*	*Fall 2011*
Number of students:	859	53	58	84	101	109	111	118	108	117
Average test score:	547.7	542.26	544.18	535.95	557.10	538.99	517.84	541.44	550.30	552
Median test score:	557.5	557.5	557.5	530.0	557.5	530.0	502.5	557.5	557.5	558
Standard Deviation:	104.50	64.94	78.08	98.87	90.27	111.94	103.53	105.7	110.22	112.58
Average Transfer Hours:	34.03	11.66	12.26	35.01	38.24	34.67	35.22	34.91	43.4	39.37
Average Credit Hours Earned:	69.97	68.14	62.31	76.26	76.09	71.8	74.91	63.53	74.02	61.18
Average GPA:	3.08	3.05%	3.05	3.09%	3.05	3.12	3.03	3.19	3.1	3.05

Table 2 gives the students' SAT scores when they entered the college. Of the 859 students who took SAT-math-simulation-test, only 460 had their college entry SAT scores. That is because many students were transferred from community colleges without the records of SAT scores. Similar to the results of SAT-math-simulation-tests, students' SAT scores maintained stable in terms of average and median. But the standard deviations of SAT scores did not show a trend of increase as in the case of the simulation-tests.

Table 2. Year-By-Year SAT Math Test Summary										
Scoring base is 200-800.										
	Overall	*Spring 2006*	*Fall 2006*	*Fall 2007*	*Spring 2008*	*Fall 2008*	*Spring 2009*	*Fall 2009*	*Spring 2010*	*Fall 2011*
Number of students:	460	51	55	47	44	50	57	63	41	52
Average SAT Math test score:	536.11	556.86	523.82	501.06	542.50	556.00	533.86	530.32	550.0	534
Median SAT Math test score:	540.0	570.0	520.0	500.0	545.0	545.0	540.0	540.0	570.0	520
Standard Deviation:	77.85	67.78	81.14	51.97	85.67	80	70.1	76.81	93.03	81.2

Since our SAT-math-simulation-test is comparable to SAT math test, the results of SAT-math-simulation-test in Table 1 can be used to compare with the SAT data in Table 2. Particularly, overall average of SAT-math-simulation-tests, 547.7, was 11 points higher than average SAT test score, 536.11; overall median of SAT-simulation-tests, 557.5, was 17 points higher than median of SAT, 540; but standard deviation of SAT-simulation-tests, 104.5, was 26 points greater than that of SAT tests, 77.85. The higher SAT-math-simulation-test average and median showed the progress of students' quantitative aptitude during their study in college.

In Table 3, female students are compared to male students in terms of SAT-math-simulation-test score, SAT score, GPA, and credit hours earned and transferred. In this six-year sample, male and female students were similar in GPA, number of credit hours earned, and number of transfer hours. But male students showed 31.66 points on average higher in SAT-math-simulation-test than female students, which could be explained by the 38 points difference on SAT averages between males and females. That is, when entering college, male students had 38 SAT points higher than females on average. Such a disparity remained almost same up to the time they took the QBM course.

Table 3. Comparisons between Genders, 2006-2011					
Female Students:					
	SAT-Math-Simulation-Test score on 800 base	SAT Math score on 800 base	Number of transfer credit hours	Number of credit hours earned	GPA
Number of students:	380	206	380	376	333
Average:	530.10	514.90	34.39	71.28	3.15
Median:	530.0	520.0	32.0	68.0	3.2
Standard Deviation:	101.97	68.93	30.57	23.84	0.54
Male Students:					
	SAT-Math-Simulation-Test score on 800 base	SAT Math score on 800 base	Number of transfer credit hours	Number of credit hours earned	GPA
Number of students:	479	254	479	479	428
Average:	561.66	553.31	33.75	68.95	3.03
Median:	557.5	550.0	32.0	66.0	3.1
Standard Deviation:	104.48	80.52	29.89	24.15	0.55

There are four concentrations for Bachelor of Science degree (BS) in Business in Stockton College, accounting, marketing, management, and finance. In addition, business school offers Bachelor of Art degree (BA) in Business. All business students must take the QBM course. Students' SAT-math-simulation-test scores vs. majors and concentrations are shown in Table 4. Facts showed here in this sample of 859 students in six years include:

(1) Students' quantitative capabilities across business concentrations varied, which were reflected in the average and median test score. The ranking of business concentrations in terms of average test score was: accounting (565.31), finance (551.62), bachelor of art in business (546.31), marketing (524.32), management (518.28). Such a ranking numerically verifies faculty's estimates about the disparity of students' mathematical capability across concentrations, and shows how big the disparity was.

(2) Students with non-business major had higher test scores than business students, which, again, numerically verifies the hypothesis that business students' mathematics is weak in general. Note that even students with "undeclared" major had higher test scores than business students.

Table 4. SAT-Math-Simulation-Test Scores vs. Students Major/Concentrations (2006-2011)									
Scoring base is 200-800 as for SAT Math test scoring base									
				Business Major			Hospitality	Non-Business	Undeclared
	Overall	Accounting	Marketing	Finance	Management	BA			
Number of students:	859	188	110	82	154	180	40	42	63
Average test score:	547.7	565.31	524.32	551.62	518.28	546.31	540.00	597.86	578.21
Median test score:	557.5	557.5	530	571.25	530	557.5	530	598.75	585
Standard Deviation:	104.50	105.86	97.62	98.35	103.99	99.40	94.52	89.44	122.62

Table 5 shows the scores of SAT-math-simulation-tests which varied with students' class level measured by their credit hours earned at the time taking the tests. We divide the spectrum of credit hours earned into six segments. Since the QBM course did not open to freshmen, the first segment, 0-31 hours, contained only 15 students, which is too small to be counted in our analysis. We noticed that from the second segment, 32-47 credit hours earned, the more hours earned the lower the average test scores were. It seems that this result tells that the more a student studies in college, the less capable s/he is in mathematics. That is not correct. As a matter of fact, students who were weak in mathematics tended to postpone their taking the QBM course. Even though QBM was listed as a 2000 level course so that a sophomore could take it, some students preferred to take this challenging but required course in the senior year due to their "fear of math". The postponement of taking QBM course by the students who were weak in mathematics pulled down the SAT-math-simulation-test score for junior and senior students.

Table 5. SAT-Math-Simulation-Test Scores vs. Groups with Various Credit Hours Earned (2006-2011)							
Scoring base is 200-800 as for SAT Math test scoring base							
		Credit Hours Earned at the Time Taking SAT-Simulation-Test					
	Overall	0-31	32-47	48-63	64-79	80-95	96 and over
Number of students:	859	15	128	180	234	172	130
Average test score:	547.7	566.83	578.20	564.44	545.63	533.92	514.21
Median test score:	557.5	585.0	585.0	557.5	557.5	530.0	502.5
Standard Deviation:	104.50	87.31	88.14	110.64	98.36	100.78	116.12

In Table 6, the spectrum of number of transfer credit hours at the time a student took SAT-math-simulation-test is divided into seven segments. There was an obvious tendency for transfer credits less than 65 hours: The more transfer credits a student had the lower his/her test score. A community college may provide up to 64 transfer credit hours for a four-year college as Stockton College. If a student's transfer hours were 64 or less, most of the transfer hours were from a community college. In other word, that the more courses a student took from a community college the lower his/her test score was can interpret, at least partially, the fact that the more transfer hours a student had the lower test score s/he had.

Compared to the overall test score, 547.7, students with 16 to 64 transfer credit hours have their test averages lower or much lower. Since the test score, 547.7, is based on all students including those without any transfer hours, the fact that the more transfer hours the lower test score implies that those who took more or all courses in Stockton tended to have high test scores than the transfer students. Therefore it can be viewed as an indicator that the quality of courses in Stockton College was better than that in community colleges in terms of enriching students with quantitative capabilities.

Table 6. SAT-Math-Simulation-Test Scores vs. Groups with Various Transfer Hours (2006-2011)								
Scoring base is 200-800 as for SAT Math test scoring base								
		Number of Transfer Hours at the Time Taking Test						
	Overall	0	1-15	16-31	32-49	50-63	64	65 and over
Number of students:	859	254	99	76	71	74	209	76
Average test score:	547.7	572.09	573.43	537.63	534.51	536.69	514.86	556.09
Median test score:	557.5	585.0	585.0	530.0	530.0	530.0	502.5	585.0
Standard Deviation:	104.50	92.86	113.09	91.96	92.56	91.29	111.09	118.93

For those with transfer hours 65 or higher, the average and median of their SAT-math-simulation-test scores were significantly higher than overall average and overall median. A reason behind this fact is that many such students were transferred from four-year-college or from foreign universities. They brought in transferred credit hours from, for example, universities in East Europe. Students with such an academic background usually performed better in mathematics, which pulled up the test score average and median in this segment.

4. FURTHER STUDIES

What the data of SAT-math-simulation-test in the past six years has indicated and implied, as summarized in previous section, are helpful in assessing our curriculum and pedagogy so as to improve students' capabilities of critical thinking and mathematics. Our further work includes investigating the reasons behind the facts revealed by the data by using statistics tools.

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COLUMBIA COUNTY BREAD AND GRANOLA: TO GROW OR NOT TO GROW

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ABSTRACT

Students are presented with challenging decisions facing a small, but growing artisan bakery regarding its potential partnership with a national natural foods chain. Its owner, Doug Michael, hoping to fulfill his passion to share nutritious breads related products with the broader community, launched Columbia County Bread and Granola (CCBG) in 2008. The national retailer, Trader Joe's sought to contract with CCBG for its granola products. The student is placed in the role of the business owner who struggles with the decision of whether to pursue a potentially dramatic growth opportunity.

Keywords: Entrepreneurship, small business growth, small enterprise expansion, decision-making, artisan bread industry

INTRODUCTION

This case evolved from a summer internship by two MBA students in August of 2011,
after CCBG approached their professor regarding its need for assistance in making decisions about growth and its production layout. At that time, Doug was considering purchasing an additional oven for baking or moving to a larger independently owned facility. The latter course of action would mean leaving the artisan culture of the community building, where CCBG had been located for a couple of years, and the hourly-rented kitchen behind.

Through the interns' work, a relationship formed between the College of Business team and CCBG. About two months after completion of the internship, Doug shared exciting news that the national retailer, Trader Joes, was interested in pursuing a contract with CCBG. Acceptance and fulfillment of a contract of this scale would present significant challenges to this small, loosely organized business. There was a lot to be excited about: opportunity for national branding, expansion of the product market, and the opportunity to reach thousands more consumers with the benefits of the company's products. However, there were concerns, as well, such as the capacity to produce the volume of product that would be expected, and the dilemma
presented by the profitability of the granola in contrast to the preferred "art of baking" and producing the less profitable artisan bread.

In responding to this case, capacity planning and analysis must be applied to a strategic question that is often faced by small businesses. Specifically, where is the balance between growth and fundamentally altering the business identity?

OVERVIEW OF THE CASE

At the outset Doug did not follow a clear path into the specialty bread business; instead his various life experiences led him to the small business he would eventually start. A cartoonist for many years, a literary agent's assistant for several more, and a newspaper reporter for other portions of his life, Doug hopped around the country. It was during the period in his life when he was laid off from his job, lost his health insurance, and contracted Lyme disease, that he developed an interest in nutrition, particularly the link between health and sprouted grains. Doug's research revealed that sprouted wheat bread could be bought in stores, but it was generally commercially produced. Furthermore, the existing recipes utilized a lot of flour, but only a small amount of sprouted wheat. Doug was inspired when, through trial and error, he developed a healthier bread recipe. He worked tirelessly on this development over the next few years, eventually selling his products at a local farmers' market.

He continued baking bread at home and selling it at local markets, until he decided to move operations out of his house and into a rented space in a community building. As Doug slowly built his new venture, he determined the defining characteristic of his bakery would be an uncompromising commitment to wholesome products, processes, and practices. For example, he built a network of local farmers who grew ancient grains such as spelt and emmer, and the heritage wheats that were popular 50-60 years ago. He also created a culture of innovation through experimentation. For example, it wasn't long before he realized he could extend his processes to make flax granola, a 100% gluten-free product.

Doug admitted that running the business was not his strong point. Keeping track of expenses, figuring out if prices yielded a profit, setting up a formal payroll system, and deciding on a form of business ownership were concerns for Doug, but those were things that were often left unattended. He was in business to share his passion and pour over the details of his products, not necessarily the details of the business. He was proud of his 4-year staying power, but he also wanted to gain more control over his business and increase profits. He had several plans in mind to help him achieve those goals and had structured the bare bones of a business plan to help guide him.

The phone call from Trader Joe's expressing interest in a contract with CCBG was a milestone. The merchandiser who spoke with Doug was interested in his granola, a product that already generated nearly 80% of sales of CCBG, but a product that was not Doug's passion. When Doug received the phone call he thought this could be his big break—a contract with which he could walk into any bank and get the loan he needed to substantially grow his business. He had to make a decision and do so quickly. No specifics—contract scope and length, prices, volumes, etc.—had been discussed, but honestly those were not at the heart of this decision. Doug seriously questioned whether CCBG could develop the capacity to leverage the proposed opportunity. Was it time to drastically alter the "feel" and trajectory of the business? Did he really want to do that?

WOLF RIDGE NAIL & WIRE, INC.

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ABSTRACT

This case examines the economic and industry conditions facing one of the last remaining U.S. manufacturers of hand-driven nails. Weakness in demand for nails due to the housing crisis, fluctuating steel prices, intense competition, and increasingly powerful retailers have presented the owners with many challenges. Just when conditions begin to appear to be improving, Wolf Ridge (WR) is blind-sided by a spurious legal challenge that could threaten its very existence. Students can be asked to analyze the economic conditions, industry dynamics, and WR's strengths and weaknesses. The financial data provided can assist students in their analysis and in their efforts to craft a well-supported recommendation for the owners.

INTRODUCTION

"It was the best of times, it was the worst of times…" thought John Merrill, Sr., as he prepared to host his company's annual Christmas party in 2010. He thought of the famous Dickens reference as he reflected on the past few years as the president and owner of Wolf Ridge Nail & Wire (WR). He was proud of the fact that Wolf Ridge was one of the last remaining U.S. manufacturers of hand-driven nail and wire products.   He and his son, John Merrill, Jr., acquired WR in 2001, and since that time, their family-owned enterprise had provided employment for 45 people in a small Midwest town, as well as profits for its owners in most of those years. Just when Merrill, Sr., believed that WR had weathered the worst of the economic downturn, he was blindsided by a legal matter that threatened to derail WR's very existence. John Merrill, Sr., had some major decisions to make, but tonight he needed to focus on providing some well-deserved holiday cheer for his guests.

ECONOMIC BACKGROUND

The Merrills acquired the WR nail business from a large, diversified steel products company in the midst of the last recession (2001), so they were familiar with tough economic times and the possible impact of a recession. However, this particular recession was quite different from the one in 2001—in the severity, the duration, and the dramatic way it affected the construction industry and credit markets. Beginning in 2007, the construction industry headed into a dramatic decline with the bursting of the housing bubble. The impact of this decline was magnified by the financial crisis that began in 2008. A credit crunch ensued whereby banks suddenly restricted the availability of loans to all borrowers, with the exception of those with only the highest credit ratings. These conditions brought new construction in the U.S. to a near standstill.   The

construction industry drives demand for nails, as well as for steel rods and wire used for concrete reinforcement. WR sales suffered a major downturn beginning in 2008.

The Great Recession (as some called it) included job losses in numbers not seen since 1982. The U.S. unemployment rate peaked at 10% in October 2010. Included in the layoffs were many mid- and upper-level employees, and this was also far less common in past recessions. Also, as the U.S. appeared to be climbing out of the Great Recession, companies were far more cautious in hiring; persistent warnings of a possible "double-dip recession" continued to be issued by respected economists. The Great Recession was also particularly troublesome because its effects were global. The economies of nations around the world are intertwined, thus amplifying the impact of the crisis and limiting effective remedies for a recovery.

The Great Recession, together with the housing glut, the uncertainty in the job market, and the credit crunch, triggered a dramatic pull-back in spending, an increase in savings rates, and a significant dip in consumer confidence (in February 2008, the Consumer Confidence hit an all-time low of 26).

INDUSTRY FACTORS

Nails are cut from coils of round steel wire. Nails can be cut into various lengths and diameters to accommodate various construction needs. Most nails receive a protective coating to prevent corrosion. The process by which a protective coating of zinc is applied to the nails is called galvanization. Some nails are coated with a plastic resin to enhance their grip, and others are coated with paint to match the color of the materials they are fastening together. There are about 300 different types of nails manufactured in the U.S. today. Nearly all of the technological and automation advances in nail manufacturing occurred over a century ago. There are wire-straightening machines and cutting machines (i.e., nail machines) in use today that are over 80 years old (see Appendix 1). Nails can be placed into two different categories: hand-driven and collated. The hand-driven nails must be "driven into" or "screwed into" the target material with the use of a hammer or drill operated "by hand." Hand-driven nails are packaged loose in boxes of various sizes. Collated nails are specifically made to be used in nail guns. Collated nails have special packaging that allows strips or "chains" of uniform nails to be loaded into a nail gun easily and safely (see Appendix 2).

Inputs used in the manufacture of nails include steel wire (of various gauges), zinc, tin, and zacalon flux (for the galvanization process), electricity (to power the equipment), and labor (mostly semi-skilled). Most of the steel wire is now sourced from China. Steel prices can fluctuate significantly due to market demand and supply spikes and dips, as well as market speculation. Imports of steel products have also been the subject of several trade disputes between U.S. steel companies and foreign steel manufacturers. These trade disputes have led to dumping accusations and legal actions by some U.S.-based steel companies against several foreign firms. These steel market and trade conditions create challenges for companies, like WR, whose fundamental raw material is steel. For example, WR *must* have steel to operate, and it must manage its steel inventory carefully so that it does not have too much or too little. However, it must try to guard against committing to large amounts of high-priced steel in the event that (a) steel prices go down, or (b) demand for its nails weakens. This places a great deal

of importance on conducting accurate market and economic forecasts. This is particularly difficult considering the size of WR.

Since acquiring WR, the co-owners had experienced an increasingly challenging competitive environment: many customers had begun to view hand-driven nails and wire products as commodities, thus placing tremendous pressure on manufacturer price competitiveness; much of the manufacturing of nail and wire products had been outsourced to Chinese companies, thus reducing the costs of manufacturing and, some would argue, the quality. The buyers of nail and wire products were primarily the big box hardware retailers, e.g., Home Depot, Lowes, Menards, Ace Hardware, True Value, home centers, and building materials distributors. Pricing pressures intensified throughout the first decade of the 21st century, as the downturn in construction accelerated.

Despite the intensely competitive market for commodity, hand-driven nails (i.e., common nails), there is an increasing demand for specialty nails that can be used with newer building materials like composite wood-fiber and cement-based siding and roofing. Also, nail manufacturers that are capable of applying new types of corrosion-resistant coatings can also distinguish themselves in the marketplace. Also, one niche market that has developed is for old-fashioned cut nails that can be used in authentic building restoration and preservation projects for historic buildings.

U.S. competitors in the hand-driven nail industry are now primarily distributors of Chinese-made nails. In other words, with the exception of WR nails, nearly all *manufacturing* of hand-driven nails is done in China now. This means that all of WR's current competitors are essentially distributors that source all of their finished nails from Chinese producers.

WR's primary competitors are Prime Source, National Nail, Mazel Co., and Tree Island. Tree Island is a niche player in the hand-driven nail sector. It makes and sells a limited number of specialty nails and competes on quality. Tree Island focuses on markets in the Pacific Northwest and Canada. The other three rivals compete on price. Each company outsources the manufacturing of its common hand-driven nails to Chinese manufacturers. The product quality and packaging quality is inconsistent. Nearly all of the big box hardware retailers purchase their hand-driven nails from one of these three low-cost competitors.

WOLF RIDGE NAIL & WIRE

Wolf Ridge manufactures hand-driven nails. These nails fall into eight types, according to use: roofing, framing, finishing & trim, siding, decking, drywall, staples, and specialty. Within category type, nails can have different lengths, heads, shanks, and coatings (see Appendix 3). In all, WR makes over 500 different kinds of nails and packaging. Each type of nail is packaged into boxes of different sizes—1 , 5, 10, 25, and 50 pound boxes, as well as 30 pound buckets. WR produces its own brand of nails ("Grip-Tite"), as well as private-label brands for certain large retailers. All WR nails are manufactured according to the Federal Specification (FF-N-105B) that covers wire, cut nails, spikes, wire, and staples. Federal specifications describe the technical and material requirements that must be met—in this case, by the nails—in order to be purchased by the Federal government. Of course this standard of quality is useful in marketing to non-government customers as well (see Appendix 4). The sales and distribution of WR nails

is managed by the Merrills, together with a building materials distributor who assists with sales and order fulfillment.

WR has found ways to compete in this unfavorable industry environment. First of all, WR keeps its costs as low as possible. WR has found ways of extending the life of its aging equipment and plant, which enables WR to minimize the need to invest additional capital in the business. Also, its labor costs are on the low end of the spectrum for manufacturers in the area. There are two reasons for this. First, the WR work force is comprised of non-union, semi-skilled workers, for the most part. Secondly, WR has a very stable, committed work force due to the fair and flexible management style used at the plant. Gain sharing is available to every employee on a quarterly basis, and holiday gifts are given at Thanksgiving and Christmas. A capable, Spanish-speaking controller was hired in 2008. A notable improvement in output by the mostly-Hispanic hand-packaging department can be directly attributed to this controller's positive influence. Of the 45 employees, there are only five salaried employees, including John Merrill, Sr.

Wolf Ridge also has found ways to boost sales. In addition to its numerous smaller customers (several building supply companies and small retailers), in 2004, WR secured one of the major hardware retail chains as a customer. This large account helped sustain WR in the post-2007 years. The opportunity to bid for this large account came about as a result of a fortuitous encounter between John Merrill, Sr., a well-respected and longtime participant in the nail industry, and the principal sales agents of a building materials distributor who were already selling several different product lines to this large retailer. These sales agents and John Merrill Sr. provided the expertise and credibility, and John Merrill Jr. provided the analytical prowess and strong communication skills (gained through his tenure with a large multinational corporation) that allowed WR to win this large account. The account was *won* because (a) the WR sales force knew the retailer's business model, (b) the retailer believed in the marketability of an American-made product, and (c) the retailer also respected WR's history of high product quality, unmatched customer service, and delivery flexibility. The account was *retained* by following through on those commitments. In fact, just two years after landing the account, WR, competing against the likes of Procter & Gamble and Black and Decker, won one of the few Vendor of the Year Awards from this major retailer.

From time to time, WR also sells non-branded, hand-driven nails to larger diversified nail companies that may have interruptions in their regular supply chains or that may have a special request from a customer for a particular type of nail that they do not have in stock. So, there are times when WR moves from being a rival to being a supplier for these companies.

Starting in late 2008, WR discovered an opportunity to supply the U.S. government with nails. The demand for building products by the U.S. government was driven by U.S.-led construction projects in Afghanistan. The primary criterion for winning this government contract was that the manufacturer had to produce the nail and wire products *in the U.S.* In addition, Wolf Ridge's product and service quality reputation also helped WR secure this large government contract. The impact of this contract was significant. These sales made up 15% of WR's total sales for the 2009. In addition, the nails manufactured for the contract were almost entirely two basic types of framing nails (i.e., just two sku's—"shop-keeping units"). This meant that WR could keep some

of its manufacturing costs low due to the long production runs that were possible. Also, the terms of the contract allowed WR to price these nails at 20% over its base price.

The 2009 government contract came at a crucial time for WR. This allowed the company to record its highest profits in a year where many, if not most U.S. manufacturers struggled—especially those closely tied to the construction industry. Unfortunately, negative trends continued. Orders from WR's largest customer remained sluggish, government orders were much smaller following the initial contract order, and WR lost its second biggest customer to the largest U.S. distributor of Chinese-produced products. This meant that WR would be even more dependent upon its single large retail customer. So, despite an unexpectedly successful 2009, WR faced a future that, at best could be called uncertain, and, at worst, unfavorable (see Appendix 5 for WR financials).

AN UNEXPECTED TURN

Unfortunately for the Merrills, there were still more storm clouds on the horizon for their small company. A WR employee of 16 years, Craig Johnson, had a small lawn care business to supplement his income. Johnson had asked Merrill, Sr. if he could be hired as the grounds keeper at WR. Merrill, Sr. agreed, and Johnson dutifully managed the grounds for two years; however, in 2008 Johnson decided to take a different full-time position with another company, thus ending his long-time employment with WR. Johnson was leaving WR on good terms, and he also wanted to retain the grounds keeping job at WR. This was agreed to, and for several additional months, Johnson continued to work at WR in that role. Merrill, Sr., however, became concerned about Johnson's lack of insurance coverage, and asked him to provide evidence of coverage in order for him to continue to maintain WR's grounds. When no such evidence was produced, Merrill, Sr. dismissed Johnson from his grounds keeping duties.

Unbeknown to either Merrill, Sr. or Merrill, Jr., Craig Johnson became embittered and revengeful about his dismissal. In mid-2008 Johnson filed a complaint with the local police department accusing WR of hiding and mishandling hazardous waste on its property. He claimed that WR had many leaking of hazardous waste sitting in a gravel area on its premises, and that WR had improperly disposed of some of this hazardous waste by spreading it on the gravel driveway and burying it under the aggregate. This waste is created as a by-product of the galvanization process (see Appendix 6 to see a galvanization machine). Johnson's accusations were forwarded by the town's police department to the state offices of the Department of Natural Resources (the DNR). After learning that the DNR had been privately interviewing WR employees, Merrill, Sr. invited the DNR to the plant. After touring the plant, DNR agents took samples of the waste from the barrels and from the soil on the property. The samples revealed inconsistent results. These inconsistent test results, together with Johnson's allegations, prompted a formal investigation of WR by the DNR.

The explanation provided by Merrill, Sr., concerning the waste contained in these barrels is as follows:

> Galvanization is required to prevent nails from rusting. This process had been
> done at this plant for over 30 years, and at other plants around the country, with

no environmental issues. No one wants nails that rust. A by-product of the galvanization process is this powdery waste. For years, the local landfill handled this waste for WR, but recent inconsistent test results caused the landfill to reject the waste. We were in the process of finding another disposal site for the waste and troubleshooting the inconsistent test results when the DNR began its investigation and saw the waste in barrels on the property. There was no attempt to hide or improperly dispose of the contents of the barrels. Despite Mr. Johnson's allegations, the plant has a long history of safe and ethical operations. In fact, a few years ago we won a state environmental award for an improved metal cleaning process we developed!

In reaction to these sudden actions and the serious accusations leveled by the DNR, the Merrills chose to stop galvanizing their own nails until the DNR investigation was over. WR disposed of all of the existing waste at an acceptable disposal facility. To provide galvanized nails for their customers, Wolf Ridge started shipping its nails to a company located 150 miles away for galvanization. The cost of outsourcing the galvanization process is 12 times greater than the cost for WR to galvanize in-house.

In the months following the search and seizure by the DNR in June of 2009, WR incurred close to $500,000 in costs associated with water testing, soil testing, reporting, and the outsourcing of galvanizing due to the investigation procedures and demands of the DNR. The Merrills firmly believed they were acting in accord with all DNR requests and that the test results would clear WR of all wrongdoing. So in November, 2010—17 months after the initial DNR visit—when the State Department of Justice informed the Merrills that it was investigating the possibility of filing criminal charges against Merrill, Sr. and the Wolf Ridge Plant Manager, they were stunned.

Yes, certain events in 2009 had created strong profits for WR amidst the most severe financial and construction downturn since the Great Depression, but other events in 2009 had ignited a firestorm of legal challenges that threatened the viability of the company. The U.S. was beginning to climb out of its economic and financial doldrums in 2010, but would it be too little and too late for Wolf Ridge? How should the Merrills manage their business going forward? How should it manage the legal challenges facing Merrill, Sr. and the plant manager? Merrill, Sr. was in his late 60s and had been contemplating retirement following the banner year of 2009; after all, his personal wealth is tied up in WR, and a comfortable retirement would likely require converting his wealth to more liquid assets. But after a difficult 2010, coupled with the criminal investigation by the Department of Justice, Merrill, Sr. feared that retirement may be out of his reach for some time. Merrill, Jr., was a co-owner of WR, but his primary job was as an executive with a large multinational corporation, so leaving the security of that position to lead WR was not a move he was prepared to make.

After the first of the year, the Merrills were going to have to make some tough decisions amidst great uncertainty. At the conclusion of their last meeting together, John Jr. and Sr. determined that there were at least three alternative courses of action for WR. (1) They could continue to search for new customers (other building materials companies and retailers) to try to win contracts based upon WR's reputation for quality, American-made products and service.

Demand for nails should be picking up, and with even more involvement by Merrill, Jr. on the sales side, perhaps WR could land one of the big retailers as its customer. In addition, the U.S. government may be placing another sizeable order in the near future. (2) Diversification may be the answer. After all, other nail companies make and sell steel mesh reinforcement products, fencing, and other steel products, why couldn't WR? It would require investing in new equipment and hiring more people, but by adding product lines that complement those that WR already made, they could take greater advantage of economies of scale in purchasing and distribution, thus lowering their costs and giving WR more bargaining power vis-à-vis their customers. (3) They could look for a buyer for WR, but who? Is there a manufacturer out there that would be interested in adding capacity to its existing nail production activities or one that is interested in adding nails to its stable of products? If so, who are they and how should the Merrills approach them? What is WR worth? Could WR be sold for enough to allow Merrill, Sr., a comfortable retirement?

Of course the DNR investigation of WR adds a significant layer of complexity to all of these decisions. Even though the Merrills were convinced that Merrill, Sr., and the plant manager would be cleared of all wrongdoing, it was not yet resolved, and the costs were mounting. Can WR survive in the short-run while incurring the additional legal and testing fees? If the Merrills ramp up their sales activities and are successful in landing several new contracts, WR will likely need to do its own galvanization in order to be price-competitive *and* profitable. What steps would need to be taken to ensure that WR can galvanize its nails without attracting negative attention from the DNR that could further damage WR? If the Merrills decided to diversify into related product lines, how difficult would it be to raise the necessary capital for the expansion? If WR tries to "grow" itself out of its problems, wouldn't Merrill, Jr. need to commit to WR on a full-time basis? Is he willing to do this? Finally, would these legal issues discourage any would-be buyers? If so, are there ways to reassure prospective buyers?

APPENDICES

Appendix 1: Nail Machine [1]
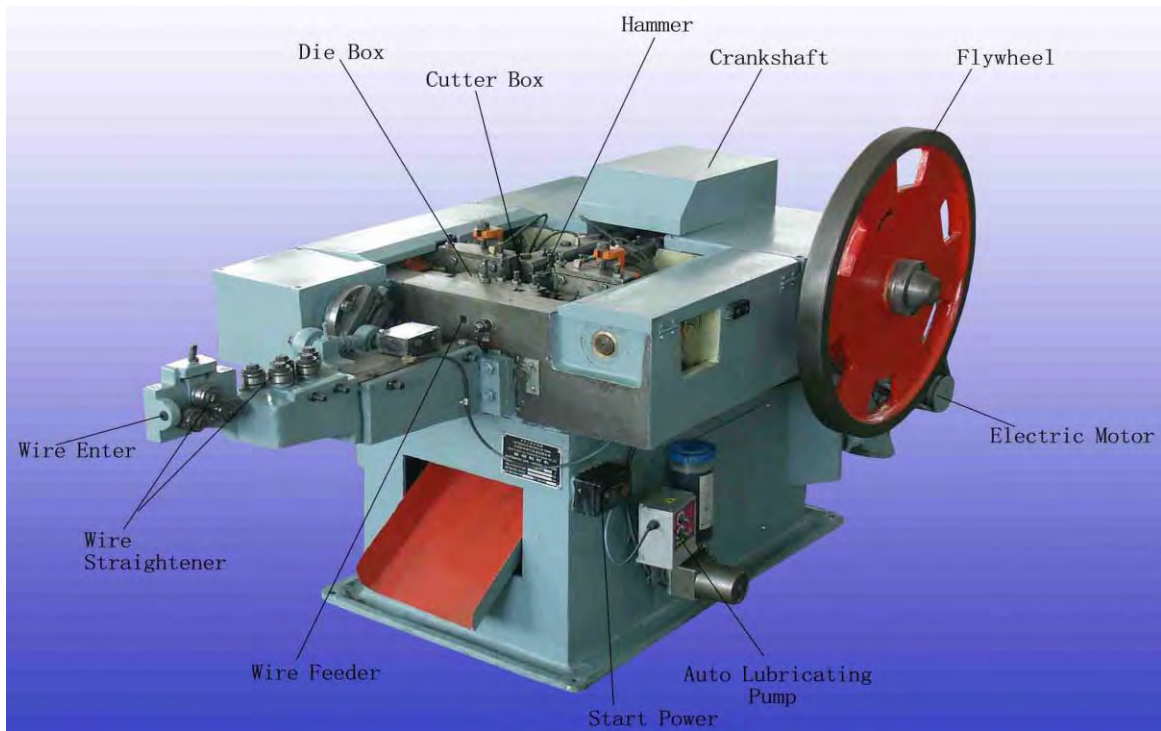
Appendix 2: Hand-driven vs. Collated Nails [2] [3] [4]

Appendix 3: Nail Types
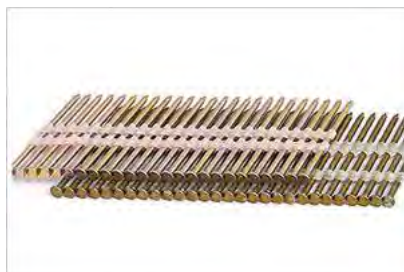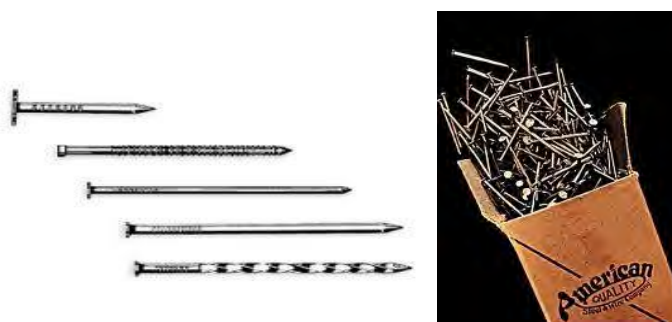
NAIL HEADS, SHANKS AND POINTS

Nail Heads

Flat Head

Deep Countersunk Head

Countersunk Head

Set Head

Nail Shanks

Smooth

Barbed

Ring Shank

Helical

Nail Points

Diamond Point

Diamond Point

Diamond Point

Diamond Point

Chisel Point

Chisel Point

Needle Point

Blunt Point
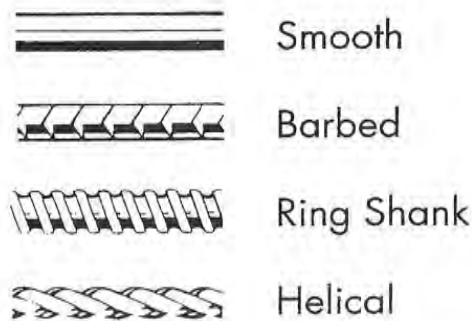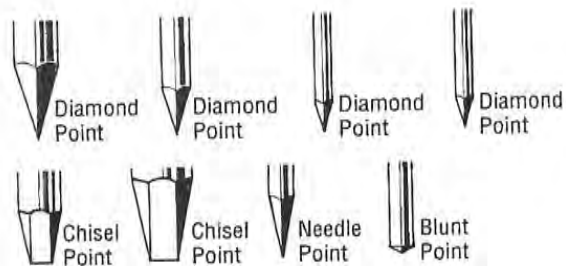
Appendix 4: Nail Quality Guide

A NAILMAKERS 6 POINT QUALITY CHECK

HEAD IS SMOOTH

CORRECT HEAD SIZE AND CENTERED

STRAIGHT SHANK

CORRECT WIRE GAUGE

THE POINT IS CENTERED

CORRECT LENGTH
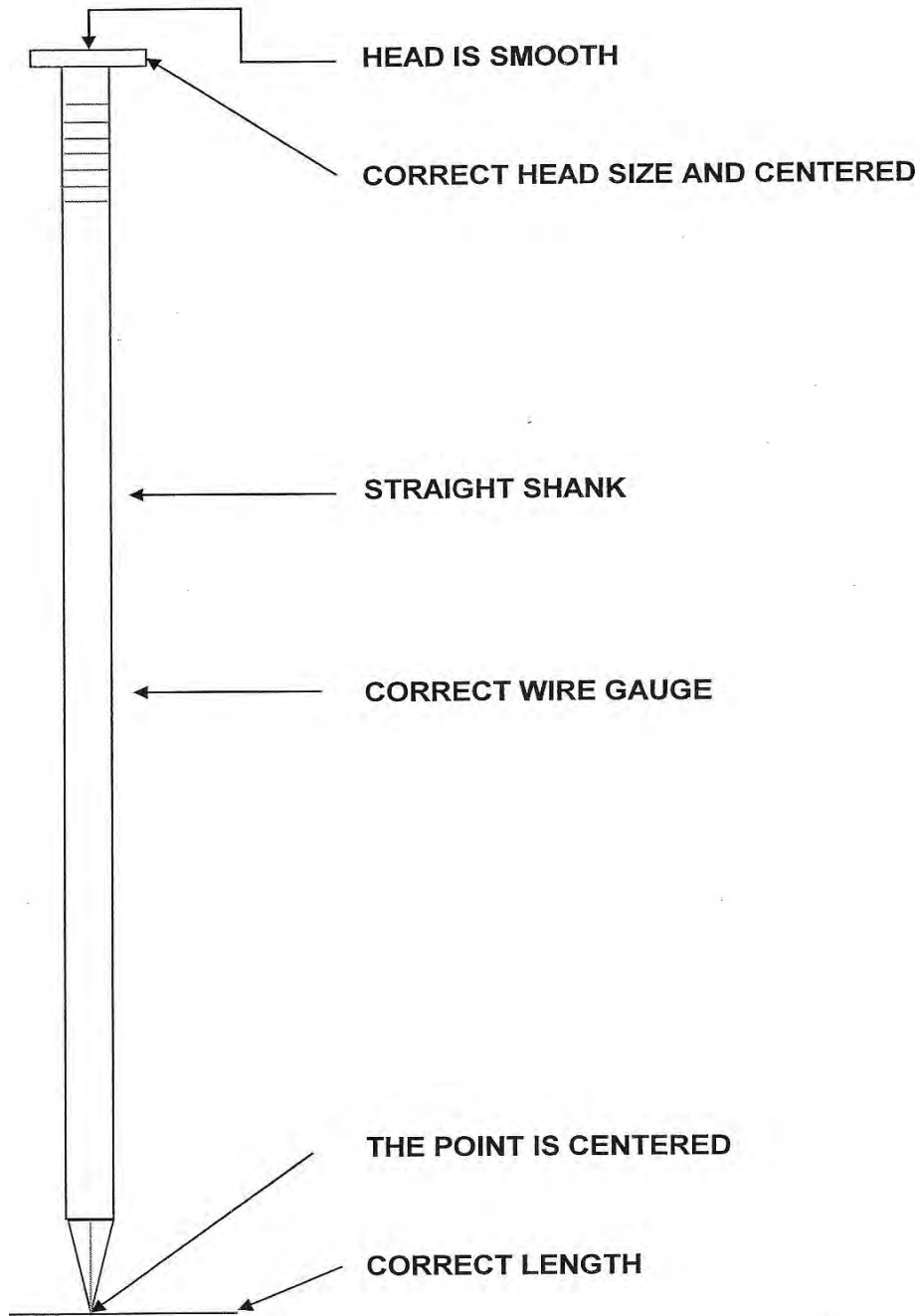
Appendix 5: WR Financial Data

(in $000s)	2004	2005	2006	2007	2008	2009	2010	2011	Past 3 Yr Avg	Past 4 Yr Avg	Past 5 Yr Avg	Past 7 Yr Avg
Sales	13,019	14,914	12,279	11,238	15,088	10,764	9,753	8,795	9,771	11,100	11,128	11,981
Net Income	396	258	-54	-399	-105	1,041	-100	-76	288	190	72	120
Add: LIFO Adjustment	319	-160	102	119	971	-482	29					
Real Net Inc. (using FIFO)	715	98	48	-280	866	559	-71	-76	137	320	200	232
Interest Expense	99	166	235	217	151	84	42	64				
Depreciation Expense	56	79	84	90	98	99	102	62				
Amortization Expense												
EBITDA	870	343	367	27	1,115	742	73	50	288	495	401	448
Adjustments to Income												
DNR Direct Costs						68	79	51				
Incr. Galvanizing Costs						42	256	230				
Management Changes								83				
Other				*0*	-225	-75						
Adjusted EBITDA	870	343	367	27	890	777	408	414	533	622	503	512
WR Value w/ Multiple of 5									**2,663**	**3,110**	**2,515**	**2,559**

Other Potential Synergies w/ Partnership:
Use of another company's "in the field" sales force
Purchasing power from combining raw material/other purchases
Selling each company's complimentary products to current and future customers
Consolidation of overhead costs

Appendix 6: Galvanizer [5]

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http://www.google.com/imgres?hl=en&tbo=d&biw=1680&bih=949&tbm=isch&tbnid=CErKzm
9hc7zfWM:&imgrefurl=http://zgmingyang.en.made-in-
china.com/productimage/RqDEPGCKJvYx-2f0j00ZCiEdvABiSuO/China-Z94-4c-Automiatic-
Nail-Making-Machine-for-Steel-Wire-with-Length-of-50-100mm.html&docid=w3N5aF-
p1S4xnM&imgurl=http://image.made-in-china.com/2f0j00ZCiEdvABiSuO/Z94-4c-Automiatic-
Nail-Making-Machine-for-Steel-Wire-with-Length-of-50-
100mm.jpg&w=2248&h=1584&ei=XF4BUZmXCOLC2gXIz4DQAg&zoom=1&iact=rc&dur=3
76&sig=115128745502179851003&page=1&tbnh=138&tbnw=207&start=0&ndsp=52&ved=1t:
429,r:0,s:0,i:82&tx=71&ty=48

[2] Hand-driven Nails http://www.biztrademarket.com/sell_Nails-Screws-and-
Rivets_7_63_493.htm

[3] Box of Nails
http://www.google.com/imgres?hl=en&tbo=d&biw=1680&bih=949&tbm=isch&tbnid=zqG5JM
FE7chaCM:&imgrefurl=http://kudzukottage.blogspot.com/2010/03/box-of-
nails.html&docid=ouVxiuTJW4RtIM&imgurl=http://4.bp.blogspot.com/_Ud4Zfqrgf5I/S6VHU
VgXM1I/AAAAAAAAAc4/qnUT3mLkW28/s400/nails.jpg&w=300&h=400&ei=jV0BUYTWB
8iq2QWUnYHICA&zoom=1&iact=hc&vpx=946&vpy=128&dur=39&hovh=259&hovw=194&t
x=103&ty=126&sig=115128745502179851003&page=1&tbnh=144&tbnw=106&start=0&ndsp
=46&ved=1t:429,r:5,s:0,i:111

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http://www.google.com/imgres?hl=en&tbo=d&biw=1680&bih=949&tbm=isch&tbnid=ah6VnSP
fvsljlM:&imgrefurl=http://www.tradekorea.com/products/collated_nails.html&docid=3occlXlP-
KNC_M&imgurl=http://web.tradekorea.com/upload_file/prod/marketing/mkt_files/company/f/fa
steners/img/oimg_2_3.jpg&w=420&h=320&ei=4F0BUe2-

McOg2QXdloDIDw&zoom=1&iact=rc&dur=428&sig=115128745502179851003&page=1&tbnh=139&tbnw=192&start=0&ndsp=45&ved=1t:429,r:5,s:0,i:97&tx=85&ty=58

[5] Galvanizing Machine
http://www.google.com/imgres?start=328&num=10&hl=en&tbo=d&biw=1680&bih=949&tbm=isch&tbnid=Xr7oKd55ANhpNM:&imgrefurl=http://www.gavlick.com/nail_master.html&docid=iQRXE2iRjxk4nM&imgurl=http://www.gavlick.com/nail_images/453-2009-4.jpg&w=300&h=225&ei=wlwBUbGOMYXu2QWOiYHADQ&zoom=1&iact=rc&dur=464&sig=115128745502179851003&page=7&tbnh=140&tbnw=192&ndsp=54&ved=1t:429,r:74,s:300,i:226&tx=86&ty=72

TEACHING AND DEVELOPING BUSINESS CASES: A FOCUS ON STUDENT LEARNING OUTCOME

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PANEL FORMAT

This panel explores the diverse student learning outcomes sought by instructors in three different domains of business education, together with ways in which cases can be constructed to facilitate students' achievement of those outcomes. Woven together by the thread of the panelists' common focus upon student learning outcomes, this panel discussion illuminates the value of this focus as a guide, not only for case teachers, but also for case writers. Divided into three parts, the session begins with four professors' descriptions of the student learning outcomes they seek from students' analyses of their assigned cases and the criteria by which each of the four selects cases to assign. The second part of the session will feature our fifth panelist, who will take the perspective of the case writer to explain "How to Write Useful Learning Objectives and Narrow Your Case Focus." The third and final segment of our session will consist of a moderated, integrative, discussion among panelists and audience members. The goal of this discussion will be to help panel participants learn how to integrate desired student learning outcomes into case writing and case teaching.

Business Cases, Learning Outcomes, Case Teaching and Development

A PRELIMINARY EXAMINATION OF STUDENT RESPONSES TOWARD STATISTICAL THINKING BASED COURSEWORK: A EXPLORATORY FACTOR ANALYSIS

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ABSTRACT

Pedagogical research in the area of statistics is both plentiful and nebulous. Prior research has consistently indicated a negative bias from students about statistics courses and the profession in general. However, the quest to find new pedagogies and technologies that improve student attitudes remains elusive. Using a pretest and posttest survey, student attitudes were clustered using EFA and shown to take a dramatic shift. Most noticeable was the increased level of confidence and usefulness of statistics. The results show promise using the applied, data driven approach but more research is needed to develop a sound theoretical basis on this finding.

Keywords: Statistics, Pedagogy, Teaching, Learning Theory, Computer Application

INTRODUCTION & LITERATURE REVIEW

The problem of student attitudes towards statistics is well documented. Past research has shown that students' ability to learn the material or to develop a mindset of 'statistical thinking' may be linked to preconceived or reflective attitudes towards the topic. Gal & Ginsburg indicate that statistics educators routinely mention that many students enter statistics courses with negative views or later develop negative feelings about the domain of statistics [3]. According to Perney & Ravid statistics courses are viewed by most college students as an obstacle standing in the way of attaining their desired degree and that it is not uncommon to see students who delay taking the statistics courses until just before graduation [6]. They also mention the high level of anxiety exhibited by the students in a statistics course on the first day of the term. Gal & Ginsburg also state that there are strong indicators that students' negative feelings about statistics education, and the effects of these feelings on resulting learning, knowledge and further interest in statistics, should occupy a major role in the minds of statistics educators [3]. According to Gal, Ginsburg & Schau statistics educators should know their students' attitudes and beliefs towards statistics before, during and after taking a statistics course [4]. However, as Gal & Ginsburg point out since statistics is a quantitative subject, transmitting the mathematical knowledge can often be the only focus in instruction ignoring the non-cognitive factors [3].

According to Gal, Ginsburg & Schau and Gal & Garfield students' attitudes may affect their level of statistical thinking skills that they need in and outside the classroom [2] [4]. Schau, et al. and Garfield & Gal demonstrate that positive attitudes correlate with positive outcomes in statistics courses [5] [8].

There are also studies that compare computer assisted instruction and the traditional method of teaching such as Ragasa and Shaltayev et al. [7] [9]. Ragasa compared computer assisted instruction (CAI) and traditional instruction [7]. Shaltayev et al. found no evidence that technology availability in classroom improves students' course performance if statistics software is used for teaching statistics [9]. Although the results are both limited and mixed, the use of office automation or computerized programs has shown to provide some progress in bridging the attitude gap.

The ability to use technology to teach statistics has significantly decreased the time to calculate the formulae used in both descriptive and inferential statistics. This has opened the opportunity to explore new approaches in teaching statistics. Traditionally, course pedagogy focuses on individual procedures, calculations and outputs. The problems and outcome are partitioned by chapter and do not allow the student to digest the larger landscape of using these procedures as part of a data analysis collection. Given the chapter – to – chapter focus of traditional pedagogical approaches it would be a stretch for a student to be able to properly identify, classify and solve a real-world problem without know what statistical procedure to use a priori.

METHODOLOGY AND RESULTS

Using the data analysis approach to teaching statistics has shown that students reflect a higher positive attitude towards statistics [1]. However, the latency of this improvement is not fully understood. Specifically, the following research questions have been formulated;

1) *What are the underlying latent factors that capture the preconceptions on how students view business statistics?*
2) *Upon completion of the course how do the latent factors change when compared to the pretest results?*
3) *What changes in the composition / size of the factor clusters occur from the pretest to the posttest?*
4) *Does the direction of the responses change (negative to positive, positive to negative) when comparing the pretest to the posttest factor clusters?*

To examine the attitudes of statistics students in an undergraduate setting, 109 pretest and 94 posttest usable surveys were conducted from a sophomore-level business statistics course at two AACSB accredited institutions. At both universities, the course is the second of two required statistics courses with the first being taught in the Mathematics department and the second in the School of Business. The survey used was from Wise which captures both attitudes about the topic as well as the field of statistics [10]. The survey was administered during the first day of class (pretest) and again during the last week of classes or during the final exam (posttest). The survey contained all 29 questions from the Wise survey along with 11 additional questions that captured gender, grade expectations, study habits, work hours and other related questions. This study focused only on the 29 questions that relate to the course and profession.

To better understand the latent underpinnings of student attitudes an exploratory factor analysis (EFA) approach was used to compare the pretest and posttest results for commonalities and differences. The Wise survey provides Likert scaling which is excellent for social research methods such as EFA. Furthermore, the Wise survey includes a wide range of questions that examine the pedagogical topic of statistics as well as the applied and practical use of statistics in both industry and everyday life.

RESULTS

Pretest

The Varimax procedure using SPSS® software was applied to determine the pretest and posttest results. Only the 29 questions related to student attitudes were examined to determine if there were any latent correlations. The additional 11 questions were omitted and may be included for future research (see discussion section). Factors with an eigenvalue of at least one and a factor loading of at least .50 were retained.

Five factors were derived from the pretest results. The results of the exploratory factor analysis show seven factors that explain approximately 64.6% of the variation. Each of the factor groupings represented a mix of questions from the field as well as the topical issues of statistics.

The pretest means are calculated and the majority of the response means is at 3.0 or below and indicates a level of indifference or negativity towards statistics. This result is reflected in the responses regardless if they are related to the field or to the profession of statistics. The means based on a 5-point scale with 5 representing Strongly Agree to Strongly Disagree and the response values were reversed for negative-based survey statements.

Posttest

The post test was administered during the last week of the 16-week semester. The results for the factor loadings generated the same number of factors and explained 58.6% of the variance. The results from the means also produced different results from the pretest. Many of the averages improved, which indicate a more positive and/or confident feeling about the course and profession.

Pre vs. Posttest Means

The questions from the pretest were compared to the posttest to examine any significant changes in the individual survey questions using the Wilcoxon Signed Ranks Test procedure for independent samples. Also, the changes were examined to determine if the comparison could provide further insights on the factor analysis groupings. The results of the two surveys were compared to determine any significant differences between the response means.

Discussion

The initial clustering of the pretest indicates a negative and apprehensive attitude towards the course and the profession. In general, the students felt the course was not beneficial to their personal learning or to their future professions. A noted lack of quantitative / mathematical skills was also found. However, the need for scientific research was regarded as important and this

question was a unique outlier to all of the other factors. The biggest cluster of the seven latent variables clearly centered on the lack of understanding and fear of the course itself. The lack of statistical thinking (understanding) has been well cited in past research so it is of no surprise to find this the largest factor in the pretest group. Clearly, a student's experience prior to entering a business statistics course is wrought with difficult and negative events.

The posttest results both reshuffled and reduced the number of latent variables. The results also indicate a more confident or positive view of the course and of the field in general. The largest of the five factors, Statistical Acumen, shows a stark contrast to the Emotional Dissonance variable found in the pretest. Students also found value in the use of statistics in both personal and professional endeavors. The shift between the pretest and posttest also shows a much lower level of trepidation towards math and statistical tasks. The pedagogy of teaching a course using a data-based approach is to focus on the business problem and to use a statistical software package to interpret the solution. This process is an applied approach that is used in research and industry today. It also appears to provide confidence and relevance to the role of inferential statistics in solving problems.

The means test found several significant changes in the responses. The attitudes towards nervousness mystery and complicated nature of statistics significantly improved. Also, the professional value of statistics improved. These findings offer some hope in solving the trepidation and bias that has plagued our profession both in and out of the classroom.

CONCLUSIONS AND FUTURE RESEARCH

The results of this study provide promise that the use of a data analysis approach may provide a more appropriate result for business students who need the requisite skills to make objective decisions in their future field or endeavor into industry. We would argue that this approach also supports the pedagogical procedures that are used in case-based MBA programs.

Future research in this area would benefit from the development of a theoretical model that captures the latent variables from a larger study. We would also argue that a more exhaustive approach be used to determine the best constructs as well as the most robust survey items that should be used to capture this information. Additional information such as demographic data such as gender, class standing, prior math experience, etc. should be considered and thoroughly examined for additional latent relationships. Furthermore, other surveys exists such as SATS-36 could provide a more robust insight on the underlying constructs that leverage student attitudes towards the discipline [8].

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STUDENT CLASS SCHEDULING WITH
LINEAR PROGRAMMING

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ABSTRACT

This paper describes a case that illustrates a real-life application that is understandable to undergraduate business students in an introductory management science course. The case shows how to use a simple integer linear programming model to find an optimal class schedule for a student. The case analysis is followed by an optional assignment in which students formulate their own class schedule using the similar approach. This case-and-assignment combination offers students several benefits: an interesting example they can identify with, applying an optimization method immediately in their own life, and experiencing the modeling process from start to finish.

Teaching optimization, scheduling, integer programming

1.   INTRODUCTION

Class scheduling, from the perspective of a school or a department, is a difficult problem. Typically, each course must be assigned an instructor, time slot(s) during the week, and a classroom. At any given time slot, at most one course can be assigned to an instructor and a room. The requirements and preferences of the instructors, estimated enrollment of students, and characteristics of the course must also be taken into account. There is extensive literature on the class scheduling (see for examples [1] [3] [4] [5] [6] [8]). From the perspective of the student, class scheduling is not as complicated as creating an entire schedule of classes for the department, but it involves balancing numerous desires and constraints. At many universities, students typically spend a significant amount of time choosing classes to take each term, poring over many alternative schedules that may fit around their internship and work schedule and discussing with others the advantages and disadvantages of various courses and instructors.

The case presented here shows how a student's class schedule can be designed using a linear programming model. It is simple enough for an introductory undergraduate management science course. It is highly motivating and relevant to the students. After the case discussion, students are asked to formulate their own class schedule for the upcoming term. This follow-up assignment lets students see the benefit of using an optimization method in their own life. In addition, they gain the experience of undergoing all the typical steps of the quantitative decision making process: problem definition, model development, data collection, model solution, and implementation.

Teaching cases and pedagogical articles that cover the use of optimization models for scheduling exist in the management science literature. For example, Birge (2004) and Trick (2004) both address using integer programming in scheduling sports teams. However, to the best of our knowledge, class scheduling by students - as an application of optimization - has not been addressed in a teaching case or article. The next section contains the case and the assignment given to the students. It is followed by discussion of background and teaching objectives in section 3 and case analysis process in section 4. Our experience with the case-and-assignment combination is discussed in section 5 and alternative approaches are given in section 6.

2.   CASE AND ASSIGNMENT DESCRIPTION

2.1 Case: Kelly's Class Scheduling

Kelly is a senior majoring in finance at Smith University with one more semester left to go. After a graduation audit, she was told she has five more courses she needs to take: Business Strategy (MGT 490), International Finance (FIN 358), one service-learning course and any two finance elective courses. A service-learning course is a requirement at the university that has a community service component. Many of the service-learning courses are offered by the Computer Information Systems Department, and Kelly would like to take one of those. In particular, two courses she finds interesting are Intergenerational Computing (CIS 102T), which involves teaching senior citizens how to use the computer, and Web Design for Non-Profit Organizations (CIS 102W). After looking at the finance course offerings, she noticed four potential finance elective courses she would consider taking: Data Analysis in Finance (FIN 325), Risk Management (FIN 352), Options, Futures and Swaps (FIN 356) and Fixed Instruments and Markets (FIN 359). Kelly would like to avoid morning classes because her internship requires her to work a few hours in the morning most of the weekdays.

As she makes up her schedule, Kelly would like to keep in mind her priorities. Her priorities are first, the content of the course, second, the reputation of the instructor, and the third, the timing of the course. She decided she will assign a rating between 1 and 5 to each course section under consideration.   From the online class schedule, she has made a list of course sections offered. These data are given in Table 1. All of the courses have at least two alternative sections. Some sections meet once a week for three hours, and some meet twice a week alternating between one-hour and two-hour periods. Note an "hour" at Smith University is 55 minutes long. To get the rating of the course sections, Kelly took into account three factors, content, instructor, and timing. The rating is the weighted average of the three factor ratings. She rated the content of the course based on her interest in it, and this is a value from 1 (poor) to 5 (extremely interested). The reputation of the instructor is also a value from 1 to 5, coming from published student comments (www.ratemyprofessors.com) and word of mouth from classmates. The timing of the course is also a number from 1 to 5, and takes into account things such as the times that most of the senior class gets together in the Common Rooms to watch shows such as *Glee, The Walking Dead,* and *Jersey Shore*.

Questions

Determine a schedule of classes for Kelly that will yield the maximum total rating.

(1)   Kelly heard a rumor that the management department is considering offering an online section of MGT 490 taught by Professor Dan Braun. Kelly had a good experience with Prof.

Braun when she took Introduction to Management course from him. In addition, as an online course does not have meeting times, it would not conflict with other courses. She would give such a course rating of 5. How would Kelly's schedule change if this online course became available?

Table 1: Available courses data

Course	Title	Meeting Time(s)	Rating
MGT 490	Business Strategy	M 6-8:45 pm	4.3
MGT 490	Business Strategy	T 6-8:45 pm	3.8
MGT 490	Business Strategy	W 6-8:45 pm	3.5
MGT 490	Business Strategy	F 6-8:45 pm	3.5
MGT 490	Business Strategy	M 1:25-2:20 pm & W 1:25-3:15 pm	4.6
MGT 490	Business Strategy	T 1:25-3:15 pm & Th 1:25-2:20 pm	2.7
FIN 358	International Finance	W 6-8:45 pm	3.5
FIN 358	International Finance	T 1:25-3:15 pm & Th 1:25-2:20 pm	3.3
CIS 102T	Intergenerational Computing	W 2:30-5:15 pm	4.4
CIS 102T	Intergenerational Computing	Th 2:30-5:15 pm	3.1
CIS 102W	Web Design for Non-Profit Org'ns	T 6-8:45 pm	3.7
CIS 102W	Web Design for Non-Profit Org'ns	W 2:30-5:15 pm	3.5
FIN 325	Data Analysis in Finance	Th 6-8:45 pm	3.0
FIN 325	Data Analysis in Finance	M 1:25-2:20 pm & W 1:25-3:15 pm	3.7
FIN 352	Risk Management	M 6-8:45 pm	3.6
FIN 352	Risk Management	M 1:25-3:15 pm & W 1:25-2:20 pm	3.9
FIN 356	Options, Futures and Swaps	T 6-8:45 pm	3.2
FIN 356	Options, Futures and Swaps	T 1:25-3:15 pm & Th 1:25-2:20 pm	3.4
FIN 359	Fixed Instruments and Markets	M 6-8:45 pm	3.0
FIN 359	Fixed Instruments and Markets	W 6-8:45 pm	3.5

(2)   Kelly would like to see if she can have a schedule that requires her to attend class only three days a week. She feels such a schedule may help her allocate her time better between study

and relaxation. She may consider it if this does not lower her maximum rating too much. Determine the maximum rating three-day schedule.

2.2 Follow-up Assignment: Make Your Own Schedule
The purpose of this assignment is to create a good schedule for your next semester. If you will not be taking classes next semester, you can create a hypothetical schedule as if you were going to repeat your current semester during the upcoming semester.

Part 1: Formulate the problem and collect data. **(This part is due before the case discussion.)**
- What is important to you as you make up your schedule? If there is more than one important consideration, see if you can rank them. (For example, quality of instructor, time of the day, course content, etc.) What are the constraints? For example, no class on certain day of the week, at least one day off from classes, work schedule, time of day, etc.
- What are the courses you need to take next semester?
- What are the courses you might take next semester if they fit in your schedule, but could take later?
- List all the possible course sections that you could take from the online class schedule.
- Assign a rating to each of these sections. The rating would depend on the factor(s) that are important to you. If you are indifferent, you can assign the same rating (say, 1) to each section.

Part 2: Formulate the model and solve.
- Determine your optimal class schedule by following the method used in the case analysis. Specifically, using your own data from Part 1, build a model in Excel and solve with Excel Solver.

Part 3: Summarize the solution.
- What is the optimal schedule? Make a list of the courses with the meeting times.
- Make an alternate schedule that you might use if one of the course sections in your optimal schedule is closed.

Part 4: Evaluation:
- Do you plan to use the schedule you came up with from this method? Why or why not?

3.   BACKGROUND AND TEACHING OBJECTIVES

The case, "Kelly's Class Scheduling," has been used in MGT 355 at Pace University, a junior-level introductory management science course required of all undergraduate students in the business school. This course typically covers decision analysis, forecasting, linear programming (may include some network models), Monte Carlo simulation, inventory models, queueing models, and project scheduling. Students are juniors and seniors who have taken a finite mathematics (a freshman level course covering introduction to probability concepts, linear programming and basic financial mathematics) and a statistics course as pre-requisites. A substantial portion of students have very weak quantitative skills, and many have only rudimentary knowledge of Excel.

The main objective of this case is to expose students to a realistic, but fairly basic, optimization model that even the weaker students can formulate and solve on their own. For all students, formulating upcoming semester's schedule is an important part of their student life. Since class scheduling is a familiar situation, the instructor does not need to spend time on any background information, and students do not need to read any background material to understand the case. The case discussion takes approximately 1 ¼ hours.

This case alone was used for class discussion for two semesters with varied data. During that time, several students indicated they would like to try to build their own class schedule following the same method. In the most recent semester, we added "Make Your Own Schedule" assignment as a follow up to the case. The addition of such an assignment helps students retain the modeling concepts, see how the optimization model can be applied to their own life and experience the whole process of problem definition, data collection, modeling, analysis and the evaluation.

4.   CASE ANALYSIS PROCESS

4.1 Preparation
The way we have integrated the case and the follow-up assignment is to show how to solve the case in class then have students work on their own schedule. The case is discussed after the students have been exposed to linear programming and simple transportation and assignment models. The case discussion is timed just before the registration period, after the subsequent semester's course offerings become available online.   Both the case and the assignment are handed out before the case discussion. They are also asked to read the case and complete Part 1 of the assignment where they:

- Identify the important priorities and requirements for the next semester's schedule
- Using the online class schedule, make a list of the course sections they would consider taking
- Rate each course section based on their priorities

Hence, when they come to the case discussion, students have defined their problem, have collected the relevant data, and are motivated to learn how to model the problem. The case discussion proceeds in the following steps:

1. Organize the data in a table with distinct time slots as rows and courses as columns.
2. Find a near-optimal solution by a simple greedy heuristic of choosing the highest ranking choice at each step.
3. (Optional) Express the problem as a linear programming model.
4. Formulate the model in Excel and solve with Excel Solver.
5. (Optional) Discuss variations to the model such as limiting the number of school days and adding the option of online courses.

Due to the space limitation, we do not describe every step in detail here. The teaching note with detailed steps, the full algebraic model and the Excel solution file are available from the corresponding author.

The key step in the modeling process is to organize the data in a table in a way that is understandable and manageable. Such a data table is shown in Figure 1. The rows in the data table represent distinct meeting patterns, the columns represent distinct courses, and the entries correspond to the course section ratings. The rows are allowed to overlap in time. For example, one row might represent the meeting pattern of Mondays 1:25-2:20 pm and Wednesdays 1:25-3:15 pm and another row might represent the meeting pattern of Wednesdays 2:30-5:10 pm. (These rows correspond to time slots 7 and 8 in Figure 1.) The possibility of a student choosing courses in the overlapping time patterns is eliminated by adding an appropriate constraint. This approach is simpler than having rows represent all of the non-overlapping time periods throughout the week (for example, 8 rows for Monday, 8 rows for Tuesday, etc.), which can quickly become unwieldy when courses have a variety of meeting patterns.

Figure 1: Data table

	A	B	C	D	E	F	G	H	I	J
3	Data									
4										
5					Available Courses, Time slots, and Ratings					
6			Courses							
7			1	2	3	4	5	6	7	8
8		Time Slots	MGT 490	FIN 358	CIS 102T	CIS 102W	FIN 325	FIN 352	FIN 356	FIN 359
9	1	M Eve	4.3					3.6		3
10	2	T Eve	3.8			3.7			3.2	
11	3	W Eve	3.5	3.5						3.5
12	4	Th Eve					3			
13	5	F Eve	3.5							
14	6	M 1:25-3:15 W 1:25-2:20						3.9		
15	7	M 1:25-2:20 W 1:25-3:15	4.6				3.7			
16	8	W 2:30-5:15			4.4	3.5				
17	9	T 1:25-3:15 Th 1:25-2:20	2.7	3.3					3.4	
18	10	Th 2:30-5:15			3.1					

In general, we have found it helpful in our introductory course to experiment and explore hypothetical solutions before formally modeling the problem. This helps students develop intuition and understand the model when it is presented. For this purpose, the second step is important. We have borrowed a version of the minimum-cost method from the transportation model algorithm for this, choosing the highest-rated cell each time instead of the minimum-cost cell. For example, in the first step, we choose the cell in row 7 and column 1 with 4.6, the highest rating. The corresponding course, MGT 490 meeting at MW 1:25 pm is added to the schedule. Then row 7 and column 1 are crossed out, and next, we choose the cell with the highest rating among the remaining cells. These steps are repeated until all of the rows and columns are crossed out. This approach leads to a schedule with the total rating of 18.8. This greedy heuristic makes intuitive sense, and the act of crossing out rows and columns that are

"done" (highlighting the corresponding cells in Excel) visually drives home the point that each decision eliminates many other potential choices. The first two steps, organizing the data in a table and using some intuitive logic to make choices, are valuable lessons in themselves even if students do not retain the optimization modeling concepts in the long run.

4.2 Basic Model

The model we use is a variant of assignment model with binary decision variables. We explain that for each available course section, we either take it or not take it, so we can assign a "yes-or-no" variable for each, the same way as in assignment models. Let

$$x_{ij} = \begin{cases} 1, & \text{if course } j \text{ is taken at time slot } i \\ 0, & \text{else} \end{cases} \quad (i = 1, 2, \ldots, 10; j = 1, 2, \ldots, 8)$$

The objective is to maximize the total rating from the courses in the schedule:

$$\sum_{i=1}^{10} \sum_{j=1}^{8} c_{ij} x_{ij}$$

where c_{ij} = rating of the course j at time slot i shown in the data table in Figure 1.

The constraints need to be formulated to account for following requirements:

1. Do not take more than one section of each course.
2. Do not take more than one class during any time slot or during any set of overlapping time slots.
3. Take MGT 490 and FIN 358.
4. Take exactly two courses out of FIN 325, 352, 356, and 359.
5. Take one of CIS 102T and CIS 102W.
6. Take exactly five courses.

Figure 2 displays the Excel model with the optimal solution and formulas shown in cells. Each row sum in column K represents the number of courses taken during the corresponding time slot (or during a number of overlapping time slots), and each column sum in row 38 represents the number of sections taken of the corresponding course. The fourth and the fifth requirements are shown in rows 44 and 45. Of course, the nonnegativity constraint should be specified in Excel Solver.

As the problem size is small, it is not necessary to limit the decision variables to only the existing course sections. Here, it should be clarified to the students that because the ratings for non-existing course sections are 0, including non-existing course sections in the Excel model does not affect the solution.

Notice the model can be represented by a minimum-cost network flow problem (MCNFP) with integer right-hand-side values. Because of total unimodularity, there is no need to add integer constraints to ensure the integer optimal solution [7, Ch7 and 13]. In addition, because of the

first two requirements, no variable will be assigned a value higher than one, so there is no need for upper bound constraints on the variables.

Figure 2: Excel model with the formulas

	A	B	C	D	E	F	G	H	I	J	K	L	M
5					Available (								
6		Courses											
7			1	2	3	4	5	6	7	8			
8		Time Slots	MGT 490	FIN 358	CIS 102T	CIS 102W	FIN 325	FIN 352	FIN 356	FIN 359			
9	1	M Eve	4.3					3.6		3			
10	2	T Eve	3.8			3.7		3.2					
11	3	W Eve	3.5	3.5						3.5			
12	4	Th Eve					3						
13	5	F Eve	3.5										
14	6	M 1:25-3:15 / W 1:25-2:20						3.9					
15	7	M 1:25-2:20 / W 1:25-3:15	4.6				3.7						
16	8	W 2:30-5:15			4.4	3.5							
17	9	T 1:25-3:15 / Th 1:25-2:20	2.7	3.3					3.4				
18	10	Th 2:30-5:15			3.1								
19													
20	Model												
21													
22		Decision Variables											
23			Courses										
24			1	2	3	4	5	6	7	8	Time Slot Const		
25		Time Slots	MGT 490	FIN 358	CIS 102T	CIS 102W	FIN 325	FIN 352	FIN 356	FIN 359	Time Slot Taken	Limit	
26	1	M Eve	1	0	0	0	0	0	0	0	=SUM(C26:J26)	≤	1
27	2	T Eve	0	0	0	0	0	0	0	0	=SUM(C27:J27)	≤	1
28	3	W Eve	0	1	0	0	0	0	0	0	=SUM(C28:J28)	≤	1
29	4	Th Eve	0	0	0	0	0	0	0	0	=SUM(C29:J29)	≤	1
30	5	F Eve	0	0	0	0	0	0	0	0	=SUM(C30:J30)	≤	1
31	6	M 1:25-3:15 / W 1:25-2:20	0	0	0	0	0	1	0	0			
32	7	M 1:25-2:20 / W 1:25-3:15	0	0	0	0	0	0	0	0	=SUM(C31:J32)	≤	1
33	8	W 2:30-5:15	0	0	1	0	0	0	0	0	=SUM(C32:J33)	≤	1
34	9	T 1:25-3:15 / Th 1:25-2:20	0	0	0	0	0	0	1	0	=SUM(C34:J34)	≤	1
35	10	Th 2:30-5:15	0	0	0	0	0	0	0	0	=SUM(C35:J35)	≤	1
36													
37		Course Constraints											
38		Course Taken	=SUM(C26:C35)	=SUM(D26:D35)	=SUM(E26	=SUM(F26	=SUM(G26	=SUM(H26	=SUM(I26:	=SUM(J26:	=SUM(C38:J38)		
39			=	=	≤	≤	≤	≤	≤	≤	=		
40		Required	1	1	1	1	1	1	1	1	5		
41													
42		Other Constraints											
43				Taken		Required							
44		One CIS course		=SUM(E26:F35)	=	1							
45		Two FIN Electives		=SUM(G26:J35)	=	2							
46													
47		Objective Function											
48		Total Rating	=SUMPRODUCT(C9:J18,C26:J35)										

4.3 Extensions

In Kelly's Class Scheduling case, the first question asks to find the optimal schedule. The second and the third questions give variations to the model. If the students are asked to build their own schedule as a follow-up assignment, some will think of other variations pertinent to

their situation that are not included in the case. This can lead to a lively class discussion. First, we discuss the variations that are mentioned in the case.

Question 2 in Case - Online Courses. Online courses can be added to the model simply by adding a time slot named "online." Since there is no concern of time conflict for online courses, we do not need a time slot constraint for the online time slot.

Question 3 in Case - Limiting the Number of School Days. Many students tend to be concerned with limiting the number of days they have to be at school. This can be handled with additional variables as follows:

$$y_k = \begin{cases} 1, & \text{if any course is taken on day } k \\ 0, & \text{else} \end{cases} \quad (k = M, T, W, Th, F)$$

As Kelly does not want to come to school more than 3 days of the week, we need a constraint:

$$y_M + y_T + y_W + y_{Th} + y_F \le 3$$

The relationship between x and y variables is on the days for which $y = 1$, Kelly can take classes, and on the days for which $y = 0$, she cannot take classes. Hence, we need a constraint for each day of the week that says: the number of courses taken on that day should be no more than a multiple of the corresponding y value. This multiple can be any value greater than or equal to the total number of courses that should be taken. Hence, the additional constraints (using only the relevant variables) can be written as:

$$
\begin{aligned}
x_{11} + x_{16} + x_{18} + x_{66} + x_{71} + x_{75} & \le 5y_M \\
x_{21} + x_{24} + x_{27} + x_{91} + x_{92} + x_{97} & \le 5y_T \\
x_{31} + x_{32} + x_{38} + x_{66} + x_{71} + x_{75} + x_{83} + x_{84} & \le 5y_W \\
x_{45} + x_{91} + x_{92} + x_{97} + x_{10,3} & \le 5y_{Th} \\
x_{51} & \le 5y_F \\
y_M + y_T + y_W + y_{Th} + y_F & \le 3 \\
y_M, y_T, y_W, y_{Th}, y_F & = 0 \text{ or } 1
\end{aligned}
$$

The addition to the Excel model is shown in Figure 3. In Solver, in addition to the new variables and constraints in Figure 3, binary constraints for y variables need to be included. Below, we discuss other various issues that may arise when students build their own schedules.

- *Need for multiple schedules.* In building their own schedules, students usually like to have alternative schedules. Some other constraints might arise after the optimal schedule is found. These could include courses that close before they can register, changes in work schedules, and so on. A simple way to handle this is to run solver after deleting the rating of a course that is likely to fill up or the ratings of the time slots that may become unavailable. It can be also be handled by adding constraints forcing some variables to be 0 (for course sections that might not be allowed) or 1 (course sections that might have to be chosen).

Figure 3: Additional variables and constraints in the three-day schedule Excel model

	H	I	J	K	L	M
42	**Number of School Days Constraints**					
43		School Day?		No. of classes on this day		
44	M	1		=SUM(C26:J26,C31:J32)	≤	=$K$40*I44
45	T	1		=SUM(C27:J27,C34:J34)	≤	=$K$40*I45
46	W	1		=SUM(C28:J28,C31:J33)	≤	=$K$40*I46
47	Th	0		=SUM(C29:J29,C34:J35)	≤	=$K$40*I47
48	F	0		=SUM(C30:J30)	≤	=$K$40*I48
49						
50	Sum	=SUM(I44:I48)			≤	3

- *No class certain day of the week (say Friday).* Do not include courses that are held on that day in the data table or assign 0 rating to the corresponding variables.

- *No more than two evening courses.* This can be formulated as: sum of variables that correspond to evening sections ≤ 2.

- *Paired courses.* For example, Introduction to Business (BUS 150) that meets MW 1:25 must be taken with Introduction to Computing (CIS 101) that meets W at 2:30. The pair of these course sections should be treated as one course.

- *Co-requisites.* Managerial Accounting (ACC 204) is a co-requisite to Introduction to Finance (FIN 206), so if a student takes FIN 206, he needs to take ACC 204 as well, but not vice versa. The constraint should be: number of FIN 206 sections taken ≤ number of ACC 204 sections taken.

5.   EXPERIENCE

As the solution of the case was discussed in class, we focus the discussion of our experience on the follow-up assignment. In the semester we included the "Make Your Own Schedule" assignment, the assignment was collected from 46 students. Approximately 40 students had no trouble with the basics: building a table from the list of their course sections, taking no more than one class per time slot, taking no more than one section of the same course, using Excel =SUM and =SUMPRODUCT functions and solving with Excel Solver. Three others did the problem using only the heuristic and skipped the optimization model, and three students turned in a nonsensical solution. Among those who understood the basics, a common error was forgetting a constraint for overlapping time slots. Grading of the assignment took more time than usual since it was individualized. However, it was not overly burdensome as everyone had formulated the same type of model.

As a part of the assignment submission, students were asked the question, "Do you plan to use the schedule you came up with from this method? Why or why not?" Out of 46 students who submitted the assignment, 33 students said yes, 3 said no, 4 were unsure, and 6 did not answer. Among the three students who said no, two were graduating students (so they will not be registering for classes) and one apparently did not understand the case and submitted a completely wrong solution. Some of the stated reasons for using the optimal schedule was as follows:

"Solver did the thinking for me when it comes to figuring out what time to take each class and that was very cool."

"Usually when making my schedule, I would make chart after chart with all the alternatives. This saved me a lot of time!"

"I do plan to use this schedule because it incorporates all my constraints and solver's optimal solution is my own optimal solution. Additionally, it allows me to put in more hours at work."

Some reasons for being unsure were:

"I might use this schedule for my classes next semester if my current work and internship situation stay the same."

"I would like to use this method I came up with, but I would prefer to make my own schedule myself. This takes too much time to choose classes."

"I plan to use the schedule as a guideline because my work schedule can change and I need to get more information on the professors before deciding on the final schedule."

Of course, the situation can change between the completion of this assignment and the actual registration. To follow up, students were asked on an anonymous end-of-semester survey whether they ended up using the optimal schedule they obtained from this assignment. Approximately 40 percent chose the response "yes," 30% chose the response "yes with some changes," and the remaining 30% responded "no." The reasons for not using the optimal schedule were: a desired class filled up (the most common reason), changed mind about what courses to take or what days to take courses, found out new requirements or new prerequisites after talking to the adviser, work schedule changed, and forgot to account for some constraints in the model, and made mistakes in the assignment.

It is not clear whether this assignment helped students save time in building their class schedule. There were mixed opinions as seen in the comments above. The assignment forced students to collect and systematically organize all their options and use a new method to make the decision. This may have taken more time than their usual trial-and-error method. However, most students felt this method improved the quality of their decision. On the student course evaluation, the optional comment section contains the question "what aspects of this course did you like the most?" Several students responded along the lines of "practical applications to everyday life/real world."

6.   ALTERNATIVE APPROACHES

In our experience, the class scheduling case was used in an introductory course with limited time and a substantial portion of students with weak quantitative skills. Thus, our approach was to go through the entire process in detail inviting students to give input at each step. The emphasis was on the assignment, and the case discussion was viewed as a means to completing the assignment. However, there are a number of alternative approaches other instructors might consider. Whichever approach is used, instructors may find it worthwhile to modify the case data based on the courses and meeting times offered at their institution. It helps increase students' interest when they recognize the familiar settings.

Having students create their own schedules allowed them to apply what they learned immediately in their own life, and increased their enthusiasm about the subject. However, assigning such an individualized assignment may not be practical or feasible for many instructors. Some of the possible problems are grading burden, difficulty of coordinating with the registration schedule, and insufficient number of class choices to make an interesting model. Hence, many instructors may choose to assign the case itself rather than include a follow-up assignment. The case can be analyzed in class, and students can be assigned to submit the finished solution. In that case, we suggest the following steps.

1. Before the case discussion, ask the students to read the case and build a data table with distinct time slots as rows and courses as columns. To guide the students, instructors may want to distribute an Excel template that contains only the basic layout of the data and the model.
2. Review the data table in class.
3. Explain the greedy heuristic and show the first step or two. Have students finish the rest. Review the results of heuristic.
4. (Optional) If using algebraic model, introduce the decision variables. Using the heuristic solution, illustrate the objective function. Write in words some of the constraints and translate into algebraic expressions. Ask students formulate some of the other constraints.
5. Explain that each cell in the blank table of the shell represents course in a time slot. The value in that cell could be either one (indicating take that course in that time slot) or zero (don't take that course in that time slot). Illustrate the heuristic solution by placing 1's in the corresponding cells.
6. Ask students to submit the case solution by completing and solving the model. Students should be able to do this assuming they have been exposed to an Excel model of transportation or assignment problem.

Question 3 in the case is difficult for inexperienced undergraduate students. If students are assigned to solve the case, we recommend either omitting this question or replacing it with a question about specific three-day combinations. For instance, can Kelly have Monday/Wednesday/Friday schedule? How about Monday/Tuesday/Thursday?
In a more advanced course, the case could be assigned as a homework problem without much class discussion. In that case, instructors may want to distribute a template with more information, giving guidance on the constraints and the objective function. Another approach is to completely discuss the case solution in class then give students an assignment of modifying

the case model to account for various situations. These can include the variations included in the teaching notes. Other variations such as scheduling for two terms could be considered.

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AN APPLICATION OF SCHEIN'S THEORY OF ORGANIZATIONAL CULTURE TO EXPERIENTIAL LEARNING

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ABSTRACT

In this paper we show how organizational culture can influence the process of teaching and research using an experiential case involving the racetrack betting market. This paper extends the research of Rappaport and Richter in which they describe an experiential approach to teaching decision making and statistics using the racetrack betting markets. The cultural differences between the racetrack and the academic environment are shown to have an important impact on the development of the case. Particular attention is given to the part of Schein"s theory that defines three different levels of organizational culture. Each of these levels is shown to have a distinct role in determining the effectiveness of the case.

INTRODUCTION

In this paper we show how organizational culture can influence the process of teaching and research using an experiential case involving the racetrack betting markets. This paper extends the research of Rappaport and Richter [41] in which they describe an experiential approach to teaching decision making and statistics using the racetrack betting markets. In this paper they showed how the class can be transformed into a mini-simulcast center, whereby the races are simulcast from the Internet and projected onto a computer screen. Rappaport and Richter [42] also extended the experiment to include a full blown field trip to the actual racetrack; they described the results of the field trip that was implemented in the spring of 2009 and how it impacted the educational process beyond the classroom exercise. In this paper we show the relevance of some of the theories organizational culture with particular emphasis on some of Schein"s theory to gain insight into the case.

ORGANIZATIONAL CULTURE

An organization can be defined as a social group which distributes tasks for a collective goal. In this paper we view both the university and the racetrack as organizations within a larger social context. In both cases many of the individuals that are part of the organization may have goals that are separate and distinct from (although not inconsistent with) the goals of the formal organization. Thus for example the desire to either research or study a particular discipline are individual goals of students or faculty, but collectively define the broader goal of the university to develop an environment for research and learning. In the racetrack we assume the organization to include not only the staff and management, but also the trainers, owners and the bettors who wager on the races. The owners, trainers and bettors, all have individual goals to make the appropriate decisions to maximize their winnings or income, and they are an essential part of the overall organization of the racetrack.

Edgar Schein [46] defines organizational culture as "a pattern of shared basic assumptions that was learned by a group as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way you perceive, think, and feel in relation to those problems". Ravasi and Schultz [43] state that organizational culture is a set of shared mental assumptions that guide interpretation and action in organizations be defining appropriate behavior for various situations. Organizational culture affects the way people and groups interact with each other, with clients and with stakeholders [24]. In this paper we study some of the differences in culture between the

university and the racetrack and show how these differences can influence any group of students, teachers or researchers who attempt to integrate aspects of the racetrack betting markets in an academic environment.

ACADEMICS VS PRACTITIONERS

We begin our analysis by using the first and most cursory level of Schein‟s theory of organizational culture to better understand these cultural differences [46]. At this level of Schein‟s model are attributes that can be seen, felt and heard by the uninitiated observer- collectively known as artifacts. Artifacts comprise the physical components of the organization that relay cultural meaning. Denison [18] describes artifacts as the tangible aspects of culture shared by members of an organization. Verbal, behavioral and physical artifacts are the surface manifestations of organizational culture. Rituals, the collective interpersonal behavior and values as demonstrated by that behavior, constitute the fabric of an organization‟s culture. The contents of myths, stories, and sagas reveal the history of an organization and influences how people understand what their organization values and believes. Language, stories and myths are examples of verbal artifacts and are represented in rituals and ceremonies. Technology and art exhibited by members of an organization are examples of physical artifacts.

Publications on horse racing by either academics or practitioners can be considered written artifacts that relay meaning about the underlying culture of the group. Academic papers tend to rely on formal models to test rigorous hypotheses about the horse racing betting markets. The practitioner publications tend to use simplified tables and charts, as well as anecdotal evidence to support a given belief. There are many interesting cases of individual racehorses that make up the lore and history of horse racing. The dichotomy between the academic and the practitioner approach is an issue in many fields of study where there is a gap between theory and practice. A good example of this would be the differences in approach between practicing financial analysts on Wall Street and academic researchers in the field of finance and economics. But the dichotomy between theory and practice is particularly acute in the study of horse racing because of the striking contrast between the cultures of the academic world and that of the racetrack.

The academic research can be separated into two major groups; the first group deals primarily with the development of decision strategies for making horses race selections. These papers generally use very sophisticated models to increase the accuracy in making horse race selection decisions ([4], [9], [15], [22], [27], [39], [45], [47], [48], [52], [55]). A second group of articles are concerned with the study of risk. Virtually all of the empirical work analyzing risk preferences in the horse race betting markets shows the representative bettor to be risk loving, which has resulted in what is called the "favorite-longshot" bias; an established feature of the betting markets whereby longshots win less often than their subjective probabilities imply and favorites win more often (i.e. bettors tend to prefer long shots to favorites because they are motivated by the possibility of a large payout). There has been a considerable amount of research studying this phenomenon ([1], [16], [40], [44], [49], [50], [51], [54], [57], [58]).

On the popular side, there are a large number of publications and information sources available to the average horseplayer to help them better understand the sport and make better decisions. The most important source of information is the Daily Racing Form (DRF), a newspaper-style publication which can be an important tool for the handicapper or horseplayer. The DRF provides a large amount of statistical information about each horse such as detailed past performance lines, lifetime records, amount of money earned, and a myriad of other pieces of

information that can be used for either casual or serious study. There are also numerous books on the subject that provide a variety of theories on how to best interpret the information provided by the DRF. For example a number of well known handicappers such as Andrew Beyer ([5], [6], [7]) have written books on this topic. The DRF also publishes books that study special aspects of horse race handicapping, such as how to interpret such factors as speed and pedigree ([10], [13], [23], [25], [28], [29], [34], [53]).

Contrasting and comparing the academic works with the trade publications helps us to better understand the dichotomy that exist between the academic world and the real world; one can consider them as studying the same phenomena using a different perspective or approach. The one is more theoretical and scientifically rigorous whereas the other is more anecdotal but more real world oriented. Most academic researchers would probably view the popular literature as unscientific and superficial, whereas the average horseplayer would probably view the academic research as unpractical, even if they could understand them. The dissemination and processing of knowledge can be seen in relative terms and dependent on the point of view of the audience that the knowledge is intended for. Deal and Kennedy [17] defined organizational culture as "the way in which things get done around here". This is a concise way of describing the different approaches of the practitioners and the academics in the horse racing field.

Horse players, owners, breeders, and racing analysts are most likely influenced to a great extent by individual cases and anecdotal information as opposed to rigorous scientific studies. Take for example the study of the correlation between the racing performance of a racehorse and his or her performance in breeding. It is well known in the racing world that Secretariat, who many would consider the finest racehorse of the 20th century, was at best a mediocre sire. This isolated case would have almost no statistical relevance in any formal academic study, but most likely has impacted the decision making process of many owners and breeders. Another example would be the study of the relative performance of male and female racehorses. The phenomenon of the famous female racehorse Zenyatta in her ability to beat the finest male racehorses in the Breeders Cup Classic no doubt has had a great influence in how owners and breeders view the racing potential of female racehorses. The various myths and stories of horse racing relay cultural meaning to the practitioners of the field, which can eventually have an impact their decisions. For the academic researcher the rigors of scientific research form the surface manifestations of his or her organizational culture, where the main goal is the dissemination of knowledge to other researchers.

The organizational communication perspective on culture views culture in different ways, the first of which is traditionalism, which views culture through objective things such as stories, rituals and symbols [35], similar to Schein's first level of organizational culture. Islam and Zypher [26] discuss many types of communication that contribute in creating an organizational culture. One could clearly study in more depth the differences in the various aspects of communication with the respect to the practitioners and academics in the horse racing field.

Another example of cultural differences relates to how horseplayers and academic researchers deal with the concept of risk and return. As mentioned above, the academic research on the horse race betting markets has illustrated the so-called "favorite-longshot" bias, whereby the expected return per dollar wagered is higher for the favorite than for higher odds horses. Quandt was one of the first academics to seriously research this phenomenon ([1], [40]). Thus the academic research would recommend playing the favorite and in general the lower odds horses, whereas the average racetrack bettor generally prefers the higher odds horses. One of the authors of this paper, Jack, at one point was attending the races and had just made a fairly large wager on the

favorite of one the races, inducing one of the regulars at the track to criticize him, implying that playing the favorite was a suckers bet. In reply, Jack referred to the research of Quandt who is a well known Princeton economist and probably one of the more noteworthy of the academics that have studied the "favorite-longshot" bias. Jack tried to be diplomatic by saying that although Quandt was a famous economist the horseplayer was probably a better handicapper than Quandt, but that he should at least respect the results of his academic work. But no matter what argument Jack used, he could not have a serious conversation with the horseplayer about this issue. There was no reason for Jack to continue the debate because the cultural divide seemed to inhibit the possibility of having any meaningful dialogue.

In this paper we take the point of view both the academic and the practitioner approach is viable because cultural elements shape the way in which the analysis is done. This may sound like heresy in an academic paper, but we justify this "holistic" approach because the horse race betting markets are ultimately a form of entertainment infused with a lot of history and emotional content. Very few would become either bettors or horse owners on any rational economic basis- the expected return for the bettors is negative (equal to the track takeout) and the average return for horse owners is also negative. Participation in the horse racing markets is based upon many cultural elements that bond people to the sport. Many horseplayers consider themselves to be part of a sort of informal club, forming their own version of a "sub-culture". The owners, breeders and trainers have also developed patterns of culture that are unique to the horse racing industry. Conclusions that may appear to be "unscientific" to the academic researcher may be appropriate given the cultural climate often based upon years of experience, and anecdotal events that may have both emotional content and entertainment value. On the flip side, the practitioner may often be skeptical of the "scientific" approach because it may not reflect the cultural elements that can embody the environment of the racetrack. Indeed, because of large variations of many of the variables and the time dependent nature of the sport, the sample size required to test scientific hypotheses in the horse racing field may be prohibitively large. The dichotomy between the practitioner and the academic becomes even more intriguing since many researchers are probably also horse racing fans which can develop interesting synergies between the various cultural forces.

THE CLASSROOM EXPERIMENT

Now we describe an experiential case that attempts to simulate the race track by transforming the classroom into a mini-simulcast center, whereby races are simulcast to the class from the Internet and projected onto a computer screen. The experiment is designed to take place in a computer lab whereby each student would have access to his or her own computer so that he or she can monitor the betting patterns, watch the races of his or her own choice, as well as have access to an Excel spreadsheet in order to generate the appropriate statistical results. The students would also have access to the past performance information published by the DRF which is also available on-line.

A series of Excel spreadsheet programs would be used to monitor the performance of each team using a variety of statistical results. The experiment allows the students to enter the wagering pools for the win bets and the spreadsheet would then calculate the percentage of money bet on each horse as well as the odds that would result from the money wagered.

w = the amount of money bet on horse i=1,2,… n
  x = the fraction of the total bet on horse i
  t = the track takeout (the percentage of the money deducted by the track from the wagering pool for expenses, taxes, etc.; assumed to be 18%)
  O= odds of horse i
  O= (1-t)/x − 1

Another spreadsheet could be used by the students to calculate the mean return per $ bet and the standard deviation per $ bet for various wagering possibilities. Students would enter the name of the horse, the amount bet, the final odds, and a 0 or 1 depending upon whether the horse lost (0) or won (1) the race. The program would calculate the total amount wagered, the amount won, the expected return per $ bet, and the standard deviation per $ bet.

The following formulas represents these results:

O_i = odds of wager i (n= the total number of wagers)
V_i = 1 if wager i wins
V_i = 0 if wager i loses
W_i = the amount of money bet on wager i
E = mean return per dollar bet
S = standard deviation per dollar bet

$$E = \frac{\sum_{i=1}^{n}\left(W_i V_i (O_i + 1) - W_i\right)}{\sum_{i=1}^{n} W_i}$$

$$S = \sqrt{\frac{\sum_{i=1}^{n} W_i \left(V_i (O_i + 1) - 1 - E\right)^2}{\sum_{i=1}^{n} W_i - 1}}$$

Using this program, the students can monitor the results of their decisions by generating the mean return per dollar bet and the standard deviation per dollar bet as the decision making process is carried out. The mean return and standard deviation for different odds groups has been calculated from a sample of 8,021 horses [44]. These numbers can be used as benchmarks for the long-term average and the standard deviation of the return for betting on different odds groups. Another spreadsheet calculates the 99% limits for the sampling distribution for horses with different odds groups and sample sizes. A sampling distribution is the distribution of the mean return based upon selecting all possible samples of size n.

The following formulas represents these results:

E_i = expected return per dollar bet for odds group i

S_i = standard deviation of return per dollar bet for odds group i

 n = sample size

L_i = lower 99% confidence limit for the mean return per dollar bet for odds group i

U_i = upper 99% confidence limit for the mean return per dollar bet for odds group i

$$L_i = E_i - \frac{3S_i}{\sqrt{n}}$$

$$U_i = E_i + \frac{3S_i}{\sqrt{n}}$$

This is an experiential learning case whereby a hands on practical approach can enhance the learning experience. The use of experiential learning techniques has been shown to be important in statistics courses ([2], [21], [59]). Requiring students to apply theory to real life situations can engage them in higher order thinking and may encourage long-term memory retention as they personalize the subject matter [3]. Many researchers have highlighted the importance of social interactions or the „human moment‟ to educational outcomes. Experiential learning techniques may allow students to experience the more intangible aspects of institutions such as a sense of inclusion or community [11]. Later on, we will explore the cultural manifestations of a full blown field trip to the racetrack which is a natural extension of the classroom experiment.

Any outside observer would notice that the process of classroom instruction would be quite unique in this case. In particular, the use of on-line horse racing gambling sites would represent a fairly radical departure from the traditional classroom environment. The integration of a real-time gambling experience into the classroom would no doubt affect the overall atmosphere of the class and influence the way in which the students interact with themselves and with the instructor. The first level of Schein‟s theory deals with artifacts, the organizational attributes that can be seen, felt and heard by the uninitiated observer. The use of the horse racing sites would be seen by any outside observer as an obvious way in which the cultural landscape of the classroom has been defined.

However it is Schein‟s second level that provides a more insightful view of the cultural components of this case. The second level of Schein‟s theory deals with the professed culture of an organization‟s members- the values [46]. Shared values are individual‟s preferences regarding certain aspects of the organization‟s culture. At this level local and personal values are widely expressed within the organization. Thus the attitudes and values of the students, the teacher, his or her colleagues, as well as the administration would all play an important role in the successful

execution of this experiment. A relevant issue would be the willingness of the various stakeholders to accept a fun-filled game like environment that would simulate many aspects of the racetrack or the casino. The values of the instructor would probably be the most critical since students usually embrace new approaches to learning, and university administrations generally do not interfere with the internal aspects of classroom instructor unless there are major complaints from either students or faculty.

A more problematic issue relates to the professed values of the stakeholders with respect to their view of gambling as an acceptable form of entertainment in society in general and in particular its use in the classroom either explicity or implicitly via simulation. It is beyond the scope of this paper to study the multitude of values that individuals and various groups have formed with respect on the legitimacy of gambling in our society. In our particular case we found that the activity of gambling was generally accepted by the various stakeholders involved in the process. The university is situated in Philadelphia, a politically and socially liberal northeastern city very close to Atlantic City and although the university is Roman Catholic, there appeared to be nothing about the university that would seem to inhibit students from expressing their interest in any form of gambling. Most of the students seemed to have experienced some form of gambling within their family and/or social circle and many of the faculty and administration seemed to be familiar with the gambling experience having visited Atlantic City to one extent or another. In addition many of the male students seemed to have engaged in some form of sports betting, some of which may not be technically legal depending upon one‟s interpretation. The instructor, who is the creator of the experiment, is no doubt an avid horse fan and clearly instrumental in creating the cultural environment within with the case was accepted. This example illustrates how organizational culture can influence and be influenced by the individual personalities of its members and can thus be studied within the field of personality psychology and identity. Organizational culture can often be taught to a person much like culture is taught by his or her parents, thus potentially changing his personal culture [20]. Indeed employees and people applying for a job are often advised to match their personality to a company‟s culture [8]. Some researchers have made case studies research on personality changes within the context of organizational culture [32].

THE FIELD TRIP EXPERIMENT

Now we study the final phase of the experiment which is to implement a full blown field trip to the racetrack. Although the field trip seemed like a natural extension of the case, it was much more of a controversial issue on the campus. The field trip was seen by many to be "crossing the line". The dichotomy between the culture of the racetrack and the university became much more pronounced and problematic within the context of the field trip. The field trip can be seen within the context of Entrepreneurial Organizational Culture (EOC), whereby the culture can value creativity and tolerance of creative people, believing that innovating and seizing market opportunities are appropriate behaviors to deal with problems of survival and prosperity [33].

The cultural issues relating to the implementation of the field trip can best be studied by using the third and deepest level of Schein‟s theory of organizational culture [46]. At this level, the organization‟s tacit assumptions are found. These are the elements of culture that are unseen and not cognitively identified in everyday interactions between organizational members. These are often the elements of culture which are often taboo to discuss inside the organization. Many of these „unspoken rules‟ exist without the conscious knowledge of the membership. Those with

sufficient experience to understand this deepest level of organizational culture usually become acclimatized to its attributes over time, this reinforcing the invisibility of their existence. Using this model, understanding paradoxical organization behaviors becomes more apparent. For instance, an organization can profess highly aesthetic and moral standards at the second level of Schein''s model while simultaneously displaying curiously opposing behavior at the third and deepest level. This theory also supports the beliefs of many researchers that organizations often have differing cultures and subcultures ([17], [31]). Parker [37] suggests that complex organizations might have many cultures and that such sub-cultures might overlap and contradict each other.

The gradual acceptance and eventual implementation of the field trip is a good example of Schein''s third level of organizational culture. Initially there was a significant amount of formal resistance to the idea of the field trip. The compliance officer from the athletic department was particularly concerned about the regulations of the NCAA which frowns upon any form of involvement of the athletes with gambling. Many faculty were also concerned about the students absence from their classes for a trip to a gambling facility. The fact that the institution was religiously based (Roman Catholic) was also cited as a reason against the field trip. In this paper we show how many of these obstacles were overcome by taking advantage of many of the tacit and implicit relationships that existed at the university. This a good example of the dynamics that occur at Schein''s third level of organizational culture- the unseen cultural influences that exist at the basis of the organization.

The eventual acceptance and formal approval of the field trip was obtained by a process that was carried out in a measured way and occurred over a period of many semesters prior to the field trip. Needless to say, the reception of the students was generally very favorable, since students are generally receptive to anything new or exciting. When the idea of the field trip first surfaced there was a critical mass of positive reactions from the students, and a significant amount of peer pressure played an important role in the socialization process. The interactions between the faculty developer and other business faculty also played an important role in the process of influencing the various stakeholders. The prior and current research and publications of the faculty developer in the horse racing field created a positive synergy with many of his peers and also created a positive climate within the teaching environment. Research oriented faculty generally look positively on any force that can motivate their colleagues to carry out research and publications.

The Dean was a more passive stakeholder in the process willing to accept any innovations as long as there were no significant complaints. The positive feedback on the course evaluations and the lack of any significant negative feedback from either the students or the other faculty kept him in a more or less positive outlook with respect to the teaching experiment.

Perhaps the strongest source of conflict resulted from the concern of the NCAA compliance officer that the field trip could be perceived as a violation of the spirit of the NCAA rules concerning the involvement of student athletes in any form of gambling. Although student athletes were officially permitted to gamble on the races, the NCAA clearly frowned upon any form of involvement in gambling. Beliefs and assumptions are often difficult to measure but they provide the foundation from which behavior and action spring [19]. The attitude of the compliance officer was influenced by the statements and policies of the NCAA but also most likely by her own belief and value system. The Dean of students seemed to have a similar view on the matter, and indeed stated directly that her own personal decision would be to opt against such a trip.

This source of conflict was mitigated to a large extent by the development of a handicapping contest whereby the prize money was to be donated to charity (and that no money was to be directly distributed to any student). Several of the Greek organizations agreed to participate in the contest which also created some positive synergies with the student affairs area. This approach seemed to alleviate much of the tension between the compliance officer and the faculty developer (it was the compliance officer who suggested the charity concept). The faculty developer also cooperated with her by supplying her with a list of all the student athletes that would potentially go on the trip.

The faculty developer was fortunate enough to obtain a $2000 contribution from a wealthy horse owner and breeder to help fund the costs of the field trip (i.e. money for buses and prize money for the handicapping contest). This apparently created many positive synergies because it provided an atmosphere of legitimacy to the entire experiment. Another positive development occurred when the faculty developer connected with one of the board of trustees who owned racehorses with her husband. He (i.e. the board member''s husband) contacted one of the leading trainers at the track to implement some visits to the barn area for a small group of students which also increased the potential for a stronger relationship with the racetrack management. No doubt the Dean was impressed when at an informal dinner with the board, this particular board member expressed a significant amount of enthusiasm about the project.

These influences show the relevance of hidden and tacit relationships that can have a significant impact on the final outcome of an organization and the cultural message that it gives. The positive effect of the involvement of horse owners results in part from their socio-economic status. The influence of the university board member was particularly important since the effect of her socio-economic status was strengthened by her status as a board member. The relevance of diversity and demographics was also apparent since the culture of the backstretch of the racetrack is quite distinct and is generally restricted to only the owners, trainers and the general barn workforce. The focus on this aspect of horse racing clearly created more cultural influences on the students.

The case shows the relevance of diversity and general demographic factors in the transmission of organizational culture ([14], [30], [36], [38], [56]). The age of the students was no doubt a positive factor contributing to the overall success of the experiment, since young people generally are willing to accept new ideas. Ironically, it is fairly well known that the racetrack population is aging as they have not been able to attract younger people in any significant way. So in some sense the field trip was as much an experiment for the racetrack as it was for the students and the school. In addition various demographic and socio-economic factors influenced the process because of the interest of the board member, the contribution of the wealthy horse owner and the subsequent visit to the backstretch.

The successful implementation of the field trip was no doubt a function of the leadership of the faculty developer who facilitated the process in a slow, measured pace. Burman and Evans [12] argue that it is leadership that affects culture rather than management and describe the difference. In the corporate world, culture is something that is often very hard to change and employees often need time to get used to any new ways of organizing the workplace.

CONCLUSIONS

In this paper we showed how cultural influences can play an important role in defining the attributes of an experiential case and affecting its potential for success. Particular attention was paid to some of Schein"s theory of organizational culture where he describes three levels of cognitive levels of organizational culture: artifacts, values, and tacit assumptions. The third level, that of tacit assumptions, is the most intriguing of the three because these are elements of culture that are unseen and not identified in day to day interactions between organizational members. We found that this cognitive approach was an excellent way to explain how the field trip was eventually given formal approval, as well as gaining the overall acceptance of the campus community. We also cited many other researchers of organizational culture to show how some of their ideas were applicable to our case.

We believe that many of the ideas expressed in this paper can be generalized to almost any attempt by an instructor to innovate or change the educational process, particularly in a business school. Choosing a particular environment within which to conduct an experiential case can involve cultural dynamics in almost any situation. Even the decision to choose a particular style of teaching can have cultural overtones- for example using more online interactions with the students can be more effective when the students are more culturally oriented to the use of technology. The efforts to interact with the external community with the goal of developing internships and job placement can be influenced by the cultural attributes of the instructor, the school, as well as the external contacts and external organizations. For example setting up an internship at an abortion clinic might be problematic, although not necessarily impossible, at a religious based institution. Political considerations can often be studied from a cultural standpoint, so that a better understanding the how various cultural forces affect the organization and its members can be useful in facilitating change in many situations.

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Financial Statement and Functional Level Strategies

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Determining an organization's financial position in terms of its strengths and weaknesses is an essential first step in the formulation of functional level strategies. As such, one of the primary goals of an introductory finance course should be to expose students to the relationship between the financial statements (i.e., the balance sheet and the income statement) and the functional level strategies. For example, if there is a problem with an organizations cost of goods sold, where would one look to address the problem? Or if the CEO wanted to increase the organization's earning per share by ten cents, where should he or she go to generate the necessary profit? This paper will focus on how specific financial ratios can be used by management to determine key leverage points for implementing its strategies.

Euro Crisis: A Historical Perspective

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Abstract

The euro area lives difficult times putting into jeopardy the survival of the euro zone and the stability of the global macro economy. The European sovereign debt crisis is an ongoing financial crisis that has made it difficult or impossible for some countries in the euro area to re-finance their government debt without the assistance of third parties. European authorities and government face questions they didn't think they would face: should they act as a community or break it? What financial and monetary governance should be implemented and at which cost? The presentation aims to point out these questions in a historical perspective.

AN EXAMINATION OF SHAREHOLDERS' RESPONSES TO SPORTS VENUE SPONSORHSHIP ANNOUNCEMENTS

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ABSTRACT

This paper examines the shareholder responses to corporate sponsorships of professional sports venues in the NFL, MLB, NBA and NHL. Using an event study methodology, we studied 45 sponsorships that occurred between 2001 and 2009. While prior research on sponsorships occurring before the end of 2000 showed a positive impact, our results show that shareholders generally have either a neutral or negative response to these sponsorships. However, we also find that NFL sponsorships result in statistically significant losses to the wealth of those firms' shareholders. We hypothesize that the NFL sponsorships are perceived negatively because of their higher cost and because the relatively few games played yearly in that league reduces the opportunity for visibility and brand exposure.

Keywords: Event Studies, Sports, Advertising and Promotion

INTRODUCTION

There are many forms of sponsorships that exist in the world today. With the rise of consumerism, companies have been constantly searching for new ways to promote their products and services. Every year, thousands of people attend various sporting, music, and other special events at company-sponsored venues. Millions more watch those events on network television where broadcasters refer to the venue by its corporate sponsor's name [5]. Given the rising popularity of various social media outlets, along with an increasingly diluted media base, a well-placed sport sponsorship can achieve several of the firm's marketing goals. Those goals include media objectives (e.g., achieving cost-effectiveness or reaching target markets), marketing objectives (e.g., brand promotion, generating purchase intention, or generating a sales increase), and broader corporate objectives (i.e., image-based promotions) [6].

Given the many potential benefits that sport sponsorships can bring to a company, it is understandably the leading category of sponsorship spending with 69% of a sponsoring firm's marketing expenditure going toward this particular type of advertising [8]. With such a large

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[1] At the time of this project, the lead author was an undergraduate senior and finance major in the College of Business at Bryant University. This project was part of a directed study overseen by Cao's co-author who is a Professor of Finance at Bryant. Mr. Cao is now employed as a financial analyst at Bose Corporation.

commitment of a company's capital, some have questioned if corporate naming rights of sport venues justify their high costs. Are sport sponsorships more than an ego trip for the top executives and their clients of sponsoring companies [2] or could they actually be a shrewd way to allow the sponsoring company to reach a large audience of potential customers? Since most sport venue sponsorships are multi-year obligations, the sponsoring organizations have not only planned to commit their financial resources for the foreseeable future, but they also need to recognize the opportunity cost of their sponsorship expenditures.

Several studies have addressed the value of the major sports sponsorships but all of these are now a decade or more old. Since the early 2000's, two phenomena have had a major impact on society – the global financial crisis as a result of the housing bubble burst, and the rising popularity of social media. The 2007 – 2012 global economic distress has undoubtedly affected the sports venue sponsorships landscape. More specifically, during the most trying period of the economic downturn, multiple stadiums and arenas' names sponsored by failed firms were replaced by companies who agreed to become the new sponsors of those sports facilities. Naturally, the value of those agreements during this period was substantially less than those negotiated prior to the economic decline. Even so, given the sponsors' shrinking market capitalizations, stockholders' opinions about the value of these transactions may have changed.

The second factor that has come into full force during the new millennium is the growth in advertising through social media. Within the past decade, websites such as Facebook, Twitter, and YouTube all have become household names within the social media community. As a result of the popular Facebook fan pages, professional athletes' countless tweets, and various YouTube channels showing the highlights of events, sports coverage has expanded beyond the traditional channels of television, newspaper, and the internet. However, it is difficult to predict whether this growth in social media makes the naming rights of sports venues more valuable or less so. Perhaps these sponsorships are a way to cut through this complex media or perhaps this complex media results in more dilution of value.

The purpose of this study is to examine the value of major U.S. sports venue sponsorships in the new millennium and to test whether the findings of previous research still hold. Consistent with prior research in this area, we employ an event study methodology but limit our sample to sponsorships from 2001 to 2011. Our focus is on sponsorships of the venues that house the four major professional sports leagues (National Football League: NFL, Major League Baseball: MLB, National Basketball Association: NBA, National Hockey League: NHL) in the United States. Unlike previous studies, we extend our analysis beyond the overall sample and look at the impact of sponsorships by league. This paper is organized as follows. In the next section, we provide a review of the existing literature. Next, we present our sample and methodology and follow this with a discussion of our results. We end with a conclusion and summary.

LITERATURE REVIEW

Clark, Cornwell, and Pruitt's [1] carried out an event study involving forty-nine stadium- and arena-naming-rights agreement announcements dealing with teams in the NFL, MLB, NBA, and NHL. They concluded that, for those companies who agreed to sponsor the teams on or before December 31, 2000, the average firm experienced an overall net-of-market increase in share prices (i.e., abnormal return) of 1.65 percent. Given the changes in the mean stock prices' statistically significant results at the time of the participating firms' first announcement of a sponsorship agreement, the authors concluded that sports sponsorships do have marketing merits and not simply undertaken primarily for the sponsoring firm's executives to enhance their egos at the expense of corporate shareholders. Although the study covered sponsorships of the four professional sports leagues in this country, it did not examine the average shareholder response to sports sponsorship announcements by league.

Becker-Olsen [5] also conducted an event study to examine the stockholders' sentiments toward sponsorship agreements across all four professional sports leagues in the United States. Using a sample size of 39 observations, Becker-Olsen found mixed responses to this specific type of sponsorship investment. Given the focus of this research was to see if sports venue sponsorships increased long-term shareholder wealth, the author concludes that they may not be the optimal choice when trying to satisfy stockholders' ultimate objectives. Even though the Becker-Olsen and Clark, Cornwell and Pruitt studies used similar data from the four major sports leagues in America, they drew different conclusions. This provides others with incentives to conduct further research into this topic.

In an article in the popular press, Michael A. Leeds [4] observed that an increasing number of companies had purchased naming rights to professional sports stadiums and arenas during the years leading up to the internet bubble. However, once the technology bubble popped, many of those firms experienced severe financial woes and some even filed for bankruptcy. Despite the financial hardships and the need to preserve resources, many of these firms continued their sponsorships instead of seeking other companies to take over the naming rights. As a result of this seemingly irrational behavior, the author examined the stock price effects to determine the stockholders' reaction to their companies' purchase of naming rights. After reviewing the results of forty-four facilities in the professional sports leagues including the NFL, MLB, NBA, and NHL, the author found that, similar to Becker-Olsen's results, only one stadium sponsorship agreement showed a statistically significant positive return.

Other studies have focused on corporate sponsorship of teams outside the United States. For example, Spais and Fillis' [7] studied the stock market reaction to the sponsorship announcement between Fiat S.p.A. and Juventus Football Club S.p.A. In this particular study, unlike the aforementioned studies, the authors looked at stockholders' behavior from the perspective of the sponsored organization and examined whether or not the official sponsorship announcement had a greater impact on the daily returns and variance of Juventus's stock or

Fiat's. After looking at 123 daily stock prices of both companies, the authors conclude that the official football sponsorship agreement impacted Juventus's stock more than it did on Fiat's. More specifically, the impact on Juventus' stock was negative, while the impact on Fiat's stock was positive. The argued, therefore, that the sponsor (Fiat) benefited more from this announcement than the sponsored organization (Juventus). Unlike the most studies in this area, this one focused on only two business entities and thus it may be difficult to make generalizations about other transactions.

Tsiotsou [9] examined Olympic and sport federation sponsorships at both the international and national levels. While the author, similar to previous authors, did conduct an event study, Tsiotsou also employed stakeholder theory to extend the analysis. Using a sample of eleven sponsors from the 2004 Athens, Greece Olympic Games, the author concluded that the national and international investment marketplace's stockholders felt indifferent to the acquisition of Olympic and other sport sponsorships.

In their most recent paper, Fillis and Spais [3] examine the impact of actual sporting events and their spillover effect on the behavior of investors of sponsoring firms. Their sample included 2,612 daily stock log-returns of twenty-eight publicly traded firms that sponsored fifteen major sports events from 2000 to 2009 including the Olympic Games, UEFA European Football Championships, FIFA World Cups, FIBA European Basketball Championships, and FIBA World Championship. Unlike previous studies, they examined stock price behavior during the sporting events using GARCH model. The authors concluded that stock returns and volatility changed significantly during and after the sporting event compared to the pre-event period. Furthermore, the results indicate that stock price effects caused by sports events' sponsorship programs are firm-specific and sporting event specific.

SAMPLE AND METHODOLOGY

We identified 45 announcements of sponsorships of sports venues that are home to members of the National Football League (NFL), Major League Baseball (MLB), National Basketball Association (NBA), and National Hockey League (NHL). Appendix 1 lists the sponsorships included in the sample and shows the sponsoring company, the named venue, the announcement date, league and, where disclosed, the term and value of the contract. Sponsorship announcements were retrieved from major news sources including the Wall Street Journal, New York Times, National Post, Business Wire, The Associated Press, PR Newswire, etc. We used the newspaper databases along with Lexis Nexus Academic databases to retrieve the sponsorship agreements. In order to be eligible for our data set, the date of each unique announcement must occur during the period from January 1, 2001 to December 31, 2011. We excluded sponsorship extensions where existing sponsorships agreements between firms and their current teams were renewed for additional periods.

All of the companies included in this sample were publicly traded firms listed on either the New York Stock Exchange (NYSE) or the National Association of Securities Dealers Automated Quotations (NASDAQ). Daily stock return data for each sponsoring firm was calculated from historical prices and dividends, retrieved via Yahoo Finance. Market returns for the same period were proxied by the returns to the Standard & Poors 500 (S&P 500) index. In determining each sponsor's abnormal returns, we used an event window of twenty days prior to and after the event day, preceded by a parameter estimation period of two hundred days. As a result, for each eligible sponsor, we gathered daily stock and market returns for 241 days.

For each announcement, we estimated the parameters (α and β) of the market model over the 200 days preceding the 41 day event window using the following regression equation:

$$= \alpha_S + \beta_S R_{M,t} + \varepsilon \quad (1)$$

Where $R_{S,t}$ is the return to stock S on day t, α_S and β_S are the intercept and slope coefficient of the regression for stock S, $R_{M,t}$ is the return on the market on day t and ε is the regression error. Using these parameters, we estimated abnormal returns ($AR_{S,t}$) for each stock S during each day t of the 41 day event window as follows:

$$AR_{S,t} = \quad - [\, \alpha_S + \beta_S R_{M,t} \,] \quad (2)$$

We report the abnormal return on day 0, the date of the announcement, and for five additional multiple day periods. For multiple day periods, we calculate the Cumulative Abnormal Return ($CAR_{S,\,period}$) for each company S as the compound return over the period. For example, the Cumulative Abnormal Return over the period from day -1 (the day before the announcement) to day +1 (the day following the announcement) is calculated as:

$$CAR_{S,\,-1\,to\,+1} = (1+AR_{S,-1})(1+AR_{S,0})(1+AR_{S,+1}) \quad (3)$$

We report our finding for six different event study intervals as outlined in Table 1 below.

Table 1: Event Study Intervals	
Description	**Notation**
Day of the Announcement	Day 0
One day Prior to and After the Day of the Announcement	-1 to +1
Three days prior to and after the Day of the Announcement	-3 to +3
Five days prior to and after the Day of the Announcement	-5 to +5
Ten days prior to and after the Day of the Announcement	-10 to +10
Twenty days prior to and after the Day of the Announcement	-20 to +20

RESULTS

The results for our entire sample are shown in Table 2 below[2]. The overall results, in the top line, show negative but statistically insignificant abnormal returns over each of the six intervals. Based on only this finding, one must conclude that stockholders did not react to the sponsorship announcement. While this result is counter evidence to any assertion that sponsorships are what Crimmins and Horn [2] call management ego trips, it also indicates that shareholder do not perceive any value to the sponsorships. That is, the lack of any positive abnormal return suggests that the benefits from sports venue sponsorships are fully eaten up by their cost.

Table 2: Abnormal Returns Summary Table												
Event Study Interval	Day 0		-1 to +1		-3 to +3		-5 to +5		-10 to +10		-20 to +20	
Categories	Abnormal Returns	t-test Results	Abnormal Returns	t-test Results	Abnormal Returns	t-test Results	Abnormal Returns	t-test Results	Abnormal Returns	t-test Results	Abnormal Returns	t-test Results
Overall	-0.2477%	-1.26	-0.5155%	-1.53	-0.6889%	-1.12	-0.1407%	-0.17	-0.3453%	-0.35	-0.3198%	-0.23
NFL	-0.9943%	-2.63**	-2.2184%	-3.36**	-2.8911%	-2.28**	-2.7662%	-2.01*	-2.8621%	-1.51	-6.8316%	-2.07*
MLB	0.1916%	0.47	0.7078%	1.19	0.5558%	0.29	1.1833%	0.57	3.4594%	1.71	4.4145%	2.77**
NBA	-0.3651%	-1.04	-0.2405%	-0.67	-1.1313%	-1.77	0.3656%	0.21	-2.2697%	-1.06	1.4261%	0.48
NHL	0.1453%	0.38	-0.2482%	-0.34	0.5915%	0.71	0.6341%	0.46	0.4858%	0.32	0.0712%	0.03

Table 2 also shows the abnormal returns for sponsorships by league. While MLB[3], NBA and NHL sponsorships show the same statistically insignificant returns as for the overall sample, NFL sponsorships consistently showed negative and statistically significant abnormal returns. Therefore, it appears that the stockholders of firms sponsoring NFL stadiums were not happy in learning that their companies just spent millions of shareholder money to secure the sponsorship agreements with various NFL teams. At the same time, the stockholders of those firms who just became sponsors of MLB ballparks, and NBA and NHL arenas felt indifferently about those sponsorship agreements.

What might explain why NFL sponsorships are differentially negative? One factor may be the relative cost of NFL sponsorships which averaged as the most expensive in our sample. Table 3 shows the average value of sponsorship agreements by league. The average cost of the 10 of 11 sponsorships for which financial details were disclosed was $132.29 million compared to $122.81 million for MLB, $42.40 million for the NBA and $66.25 million for the NHL. As a percentage of the sponsoring firms total market capitalization, the differential cost is even more

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[2] Significance levels are indicated as ** for significant at the .05 level (two-tailed test) and * for significant at the .10 level (two-tailed test). Since the sample size is small, the critical values for t vary by league. For example, at the .05 significance level, the critical values for t are 2.105, 2.228, 2.262, 2.228 and 2.179 for the overall, NFL, MLB, NBA and NHL respectively.

[3] The t-statistic for the -20 to +20 interval for MLB is at a highly significant level but given that the other intervals are insignificant, we believe that this result is likely spurious. At the .05 level, one would expect that one in 20 t-stats would be at significant levels even in a random drawing from a true mean zero sample. Further, efficient market theory suggests that markets react quickly to new information so it is unlikely that the impact of an announcement would show up only after such a length of time has passed.

substantial. As a percentage of market capitalization, the NFL sponsorships in our sample were almost twice as expensive as the next most expensive league, MLB.

Table 3: Average Value of Sponsorship Agreement and Impact of the Sponsorship on Total Market Cap, by League		
League	Average Value of Sponsorship Agreement	Average Impact of the Sponsorship on Total Market Cap
NFL	$132.29 Million	-1.1229%
MLB	$122.81 Million	-0.5964%
NBA	$42.40 Million	-0.2789%
NHL	$66.25 Million	-0.3346%

The lack of brand exposure frequency may be another reason why stockholders reacted negatively to NFL sponsorships. While NFL sponsorships are the most expensive, NFL teams play only eight regular season home games, plus one or two preseason games (that are often not televised) plus, the occasional playoff game, if the team makes the playoffs and has home field advantage. In comparison, MLB teams play 81 home games and the NBA and NHL each play 41 home games. On a per game basis, NFL sponsorships are dramatically more expensive than those in the other three leagues. As a result of this limited exposure, shareholders of NFL sponsors may feel that their firms ought to pay the least amount of money to acquire those sponsorship agreements or that the cost as a proportion of the firms' total market cap should be the lowest, rather than the most costly.

Additionally, social media may exacerbate the problem of limited exposure for NFL venues. In postseason play, NFL teams play single-elimination games to determine the winner while the other leagues play a series of games to determine who moves on to the next round. Therefore, for a postseason game in the NFL, the sponsoring company's brand will only be mentioned across various social media channels for the duration of that game. In contrast, for playoff game series in MLB, NBA, and NHL, those sponsoring firms' brands will be mentioned across social media sites such as Facebook, Twitter, and YouTube for the duration of the series. Furthermore, because there is generally a one-week gap between NFL games and a few-days gap for games played in other professional sports leagues, there are more opportunities for social media activity promoting companies affiliated with MLB, NBA, and NHL, than the NFL. The resulting reduction in opportunities for brand promotion and less social media traffic, combined with the high sponsorship costs, may explain the negative impact of NFL sponsorships.

It is possible that the reason that most sponsorships do not affect shareholder returns is that, while the deal values may seem large in absolute terms, they actually represent a very small proportion of the equity value of the sponsoring firm. To test this hypothesis, we used a regression model with the abnormal return as the dependent variable and the value of the deal as a proportion of the total market capitalization of the sponsoring firm as the independent variable. To do this, we had to eliminate 12 sponsorship announcements for which deal details were not disclosed. Using the data from Value Line, Yahoo, and each sponsor's annual report, we estimated the market capitalization of each firm as the total number of outstanding common

shares times the average of the firm's high and low stock price for the year in which the announcement occurred.

Tables 4 shows the results of the regression with the dependent variable specified as the announcement day (day 0) and Table 5 shows the results with the dependent variable defined as the three day announcement window from day -1 to day +1[4]. Consistent with the earlier findings, the sign of the variable "Impact of Sponsorship on Total Market Cap" is negative but statistically insignificant. This lack of explanatory power may be explained in two possible ways. Either, the benefits from sponsorship offset the costs or the small sample size resulting from the relative few sponsorships over time reduces the power of the tests below the threshold of significance.

Table 4: Impact of the Sponsorship on Total Market Cap on "Day 0"				
	Coefficients	Standard Error	t Stat	P-value
Intercept	4.43406E-05	0.0036	0.0124	0.9902
Impact of Sponsorship on Total Market Cap	-0.4558	0.4005	-1.1380	0.2638

Table 5: Impact of the Sponsorship on Total Market Cap on "-1 to +1"				
	Coefficients	Standard Error	t Stat	P-value
Intercept	0.0003	0.0058	0.0588	0.9535
Impact of Sponsorship on Total Market Cap	-0.7821	0.6485	-1.2059	0.2370

To further examine this effect along with difference between leagues, we also ran these regressions with dummy variables for the leagues[5]. However, to do this, our sample had to be further reduced to avoid the issue of double counting. This adjustment was necessary because there are four venues in which the sponsoring companies agreed to sponsor the stadiums or the arenas that supported teams from two different leagues. Sun Life Financial Inc.'s sponsorship of Sun Life Stadium was shared between NFL's Miami Dolphins and MLB's Florida Marlins; Overstock.com Inc.'s sponsorship of O.Co Coliseum was shared between NFL's Oakland Raiders and MLB's Oakland Athletics; The Toronto-Dominion Bank's sponsorship of TD Banknorth Garden was shared between NBA's Boston Celtics and NHL's Boston Bruins and Wells Fargo & Company's sponsorship of Wells Fargo Center was shared between NBA's Philadelphia 76ers and NHL's Philadelphia Flyers. Therefore, the results in Tables 6 and 7 reflect the elimination of these four sponsored venues along with the previously eliminated sponsorships with undisclosed values.

Again, for brevity, we show the results for the announcement day (day 0) and the three day announcement interval (day -1 to +1). Other intervals showed similar results. The results are

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[4] Regressions with the dependent variable defined over the other four event intervals showed the same results and are omitted for brevity.

[5] To avoid collinearity problems, we specified three dummy variables, for NFL, MLB and NBA venues. By definition, the impact of the NHL is captured in the intercept.

again consistent with earlier findings. The variable "impact of sponsorship on total market cap" is not significant. However, the coefficient for the NFL dummy variable is significant at the .0765 level with the day 0 regression and weakly significant at the .1086 level for the regression using the three day event interval.

Table 6: Impact of the Sponsorship on Total Market Cap on "Day 0", by League				
	Coefficients	Standard Error	t Stat	P-value
Intercept	0.0078	0.0066	1.1733	0.2532
Impact of Sponsorship on Total Market Cap	-0.1963	0.4992	-0.3932	0.6980
NFL	-0.0171	0.0092	-1.8584*	0.0765
MLB	-0.0035	0.0086	-0.4019	0.6916
NBA	-0.0180	0.0102	-1.7747	0.0897

Table 7: Impact of the Sponsorship on Total Market Cap on "-1 to +1", by League				
	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.0003	0.0102	-0.0291	0.9771
Impact of Sponsorship on Total Market Cap	-0.0924	0.7689	-0.1201	0.9055
NFL	-0.0236	0.0141	-1.6723	0.1086
MLB	0.0121	0.0132	0.9146	0.3703
NBA	0.0022	0.0156	0.1431	0.8875

CONCLUSION

It is clear that sports venue sponsorships are expensive business propositions and this paper sought to answer whether shareholders of firms that sponsor major sports venue perceive that their firms are making shareholder wealth maximizing decisions. Further, because of change in both the economy and the increased role of social media, we wanted to extend earlier research into the new millennium. Using an event study methodology, we studied 45 sponsorships that occurred between 2001 and 2009 involving professional sports venues for the NFL, MLB, NBA and NHL. Our results show that sponsorships over the last decade were less valuable to shareholders than those occurring before the turn of the new century. Clark, Cornwall and Pruitt [1] found statistically significant positive returns to shareholders using a sample that ended in 2000 in contrast to our findings that shareholders generally have either a neutral or negative response upon learning the fact that their companies just decided to allocate millions of dollars to become the sponsor of various professional sports teams' playing facilities.

While we found the impact of sports venue sponsorships to be neutral over the entire sample, we found that NFL sponsorships results in statistically significant losses to the wealth of those firms' shareholders. We hypothesize that the NFL sponsorships are perceived negatively because of their higher cost and because the relatively few games played yearly in that league reduces the opportunity for visibility and brand exposure.

Appendix 1: All Sponsors					
Sponsorship Venue Name	Sponsor Company	Announcement Date	Length of Deal	Total Amount of Deal	League
Bank of America Stadium	Bank of America Corporation	3/1/2004	20 Years	$140 Million	NFL
Heinz Field	H.J. Heinz Company	6/15/2001	20 Years	$57 Million	NFL
Invesco Field at Mile High	Invesco Ltd.	1/29/2001	20 Years	$120 Million	NFL
Lincoln Financial Field	Lincoln National Corporation	6/3/2002	20 Years	$139.6 Million	NFL
LP Field	Louisiana-Pacific Corporation	6/6/2006	10 Years	$30 Million	NFL
M&T Bank Stadium	M&T Bank Corporation	5/6/2003	15 Years	$75 Million	NFL
MetLife Stadium	MetLife, Inc.	8/23/2011	25 Years	$400 Million	NFL
O.Co Coliseum	Overstock.com Inc.	4/27/2011	6 Years	Undisclosed	NFL
Qwest Field	CenturyLink, Inc.	6/24/2004	15 Years	$75 Million	NFL
Sun Life Stadium	Sun Life Financial Inc.	1/20/2010	20 Years	$100 - $140 Million	NFL
University of Phoenix Stadium	Apollo Group Inc.	9/26/2006	20 Years	$154 Million	NFL
AT&T Park	AT&T, Inc.	2/3/2006	Undisclosed	$58 Million	MLB
Chase Field	JPMorgan Chase & Co.	9/23/2005	30 Years	$66 Million	MLB
Citi Field	Citigroup, Inc.	11/13/2006	20 Years	$400 Million	MLB
Minute Maid Park	The Coca-Cola Company	6/5/2002	28 Years	$170 Million	MLB
O.Co Coliseum	Overstock.com Inc.	4/27/2011	6 Years	Undisclosed	MLB
Progressive Field	Progressive Corporation	1/11/2008	16 Years	$58 Million	MLB
Rogers Centre	Rogers Communications Inc.	11/29/2004	Indefinite	$25 Million	MLB
Sun Life Stadium	Sun Life Financial Inc.	1/20/2010	20 Years	$100 - $140 Million	MLB
Target Field	Target Corporation	9/15/2008	25 Years	$75 - $200 Million	MLB
U.S. Cellular Field	United States Cellular Corporation	1/31/2003	20 Years	$68 Million	MLB
AT&T Center	AT&T, Inc.	1/11/2006	Undisclosed	Undisclosed	NBA
Bankers Life Fieldhouse	CNO Financial Group, Inc.	12/22/2011	Undisclosed	Undisclosed	NBA
Barclays Center	Barclays PLC	1/17/2007	20 Years	Undisclosed	NBA
Chesapeake Energy Arena	Chesapeake Energy Corporation	7/22/2011	12 Years	$42.6 Million	NBA
FedEx Forum	FedEx Corporation	10/16/2002	20 Years	$90 Million	NBA
Izod Center	PVH Corporation	10/4/2007	5 Years	$7 Million	NBA
Oracle Arena	Oracle Corporation	10/27/2006	10 Years	$30 Million	NBA
TD Banknorth Garden	The Toronto-Dominion Bank	3/3/2005	20 Years	$100 Million	NBA
Time Warner Cable Arena	Time Warner Cable Inc.	4/8/2008	20 Years	Undisclosed	NBA
Toyota Center	Toyota Motor Corporation	7/23/2003	Undisclosed	Undisclosed	NBA
Wells Fargo Center	Wells Fargo & Company	7/2/2010	13 Years	$18.2 Million	NBA
BankAtlantic Center	BankAtlantic Bancorp, Inc.	9/6/2005	10 Years	Undisclosed	NHL
Consol Energy Center	Consol Energy Inc.	12/15/2008	21 Years	$105 Million	NHL
First Niagara Center	First Niagara Financial Group Inc.	8/25/2011	15 Years	Undisclosed	NHL
Honda Center	Honda Motor Company, Ltd.	7/19/2006	15 Years	$60 Million	NHL
Office Depot Center	Office Depot, Inc.	9/13/2002	10 Years	$20 - $25 Million	NHL
PNC Arena	PNC Financial Services Group Inc.	12/15/2011	Undisclosed	Undisclosed	NHL
Prudential Center	Prudential Financial, Inc.	1/5/2007	20 Years	$100 Million	NHL
RBC Center	Royal Bank of Canada	9/19/2002	20 Years	$80 Million	NHL
Rogers Arena	Rogers Communications Inc.	7/6/2010	10 Years	Undisclosed	NHL
Scotiabank Place	Bank of Nova Scotia	1/11/2006	15 Years	$30 Million	NHL
Scotiabank Saddledome	Bank of Nova Scotia	10/8/2010	5 Years	Undisclosed	NHL
TD Banknorth Garden	The Toronto-Dominion Bank	3/3/2005	20 Years	$100 Million	NHL
Wells Fargo Center	Wells Fargo & Company	7/2/2010	13 Years	$18.2 Million	NHL

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Information Based Trading Around Earnings Announcements and Market Efficiency:

An Approach of Adopting Volatility of S&P 500 Stocks

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Abstract

This research contributes to the existing literature by establishing and reaffirming the existence of informed traders in the stock market through analysis of short selling activities. It also shows that volatility of stock prices is informative in that increases in volatility, as opposed to returns, proxy the release of private information about the financial position of firm to the market. We further find that informed traders increase market efficiency by reducing the delay time of private information to the market.

Introduction

Current literatures broadly apply only stock returns to examine the response rate of stock prices to the market information. We believe, however, that returns reflect only partial market information about the stock. Volatility in many studies has also proved to be a good indicator of future information. Departing from previous studies, we will apply the concept of volatility into market efficiency to further model the reaction speed of stock price to information efficiency.

Discussions about market efficiency given the Efficient Market Hypothesis usually lead to discussions on information efficiency. Fama (1970) define an efficient market, as a market in which stock prices precisely reflect all available information in the market correctly, sufficiently, and rapidly. Hasbrouck and Schwartz (1988) find that the stock price of a firm has two functions in the market (1) as information spreader and (2) the central location, if you will, for different information around the markets to be reflected in. In normal market conditions, which are conditions in which stock prices are not being constrained due to circumstances like the inability to short stocks etc., where information is free flowing, and where all market participants are knowledgeable of information about firms

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at the same exact time, we can see that markets are strong form efficient. Putting these conditions aside, given our end result of quick price changes to fundamental prices, we only need to see how quickly prices do revert to fundamentals in order to be able to tell whether or not markets are efficient. Therefore, when markets do not change quickly to news (news not being available to all agents) we can consider this as an asymmetric information market. This asymmetric information market will direct the price to deviate from its fundamental value and therefore lead to an inefficient market, or formally, a weak form efficient market.

Let's take a more technical look at the mechanics of trading involved given this market efficiency talk we've discussed here, to get a better understanding of what we mean by an asymmetric information market. First of all, for purposes of simplicity, let's say that in our story here on market efficiency, the entire market and all of its participants (assuming that participants are current owners, and current non-owners of the stock [non-owners are people that have current outstanding bid orders in the market]) are only trading in one firm. What's more, the market participants, are located in different locations in the country (assume the U.S. for no good reason), and all are trading the stock virtually (through the internet), and that no one knows who the other participants are, and have no way of contacting them. In this story of ours, information related to the firm are disseminated three ways to the public, (1) through SMS messages to all participants that are subscribed to get the messages through SMS, (2) through email, also to all participants that are subscribed to get the email, and (3) Through the daily evening national news television broadcast. As you can tell so far, it's obvious that some of these information dissemination services vary in speed to which information is sent to or received by its recipients [market participants]. For participants that are subscribed to SMS services on their cellular phones, they would

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obviously get first dibs on information right away, much earlier than lets say email recipients (given that email recipients only check their email a handful of times throughout the day). No need to mention it, but those who watch the news to get the latest information will be totally in the dark once an event happens in the morning until the evening once it's reported on the news. Let's further assume that the number of people who are subscribed to each method of information acquisition about the firm are spread evenly; so, one-sixth of the participants who are owners of the firm are subscribers to the SMS service and one-sixth of the participants who are non-owners are also subscribers to the SMS service. The ratio of owners to non-owners is also spread evenly to the email subscription service and to the daily evening news. Now, let us assume that our bid and ask spreads for the firms are spread evenly, and that the density of those spreads are also equivalent [when we talk about density with respect to bid and ask, we are not only concerned with the first level of bids and asks above and below the last price, but are also considering the number of orders past the first price layer]. Density in our story here is of utmost importance because it dictates the price movement (return) and its velocity (volatility) once news begins to spread. So, let us say something bad happened to the company, or negative news, and let us say that the company immediately reports this negative news to all market participants using all three methods of dissemination. The first people to get ahold of new negative news are participants that are subscribed to the SMS service. We know that the participants that are subscribed to the SMS service are both owners and non-owners, and we know that owners currently own stock, and non-owners do not own stock but have bid orders in the market in order to buy these stocks once the price drops to or below what they bidding. We also know that not all bid and ask orders are only placed by SMS subscribers; bid and ask order levels are intermingled by all different news

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subscribers. Once the negative news is revealed to SMS subscribers, the owners will start selling the stock, they will not sell the stock using ask order, they will sell the stock using market orders. Non-owners that are subscribed to the SMS service will also begin to withdraw their bid orders. The selling by owners and withdrawal of bid order by non-owners will put downward pressure on the price, and will lead to a collapse or thinning in density of the bid side of the bid – ask spread. Another way to look at this, as we discussed in our supply/demand relationship earlier, is that if there is an oversupply of the stock, given demand, price will decrease. As the price collapses, participants that are watching the stock, who are subscribed to the two other news sources will see this price movement in the stock, and as a result, might or might not react. So let's go off on a tangent a little bit here and see why they 'might or might not react'. If participants are accustomed to seeing this volatile movement in the stock, then they might think that nothing abnormal is happening, however, if they are not accustomed to this volatile movement, then investors will sense that something is wrong and react accordingly. This is where our abnormal volatility regression variables comes in, we offset market, industry and the stock's own historic volatility in order to extract the volatility that is solely from news being revealed. Meanwhile, as the price precipitously drops, but continues to be within the threshold of the normal trading range, non-owner participants that have no clue of the negative news that the firm has disseminated as of yet might perceive these lowered prices as an opportunity to buy; thus, acting as a wall, pushing the price slightly up. It is important to note that this constant change in pushing and pulling may not reflect in returns in magnitude, but will certainly reflect as increases in volatility; what's more, as the news travels we will see a gradual decrease in volatility as consensus builds and investors travel towards the optimum price. As the news is gradually disseminated

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to all market participants, we will see the withdrawal of bids from non-owners, and conversions from asks orders to market sell orders by owners until we reach the point where the price falls to the fundamentals based on the news.

Literature Review

By examining earnings announcement events to investigate the speed of stock price adjustment Mendenhall and Fehrs (1999) used an insider trading information database and found that the speed of price adjustment was faster before the announcement of retain earnings than it was after the announcement. Chen and Rhee (2010) used Vector Autoregression Model and Cumulative Impulse Response to investigate the price adjustment speed to new information. Dimson (1979) applied a Beta coefficient to test the information's influence on the speed to which price adjusts accordingly. Phillips (2011) also used the options market as an illustration to observe the effects of the launch of a complimentary derivatives product, such as options, on short sales. He also used returns to monitor the speed of response to new information.

We believe that returns only disclose part of all available information on the market and not all the information. To highlight our point, Ni, Pan, and Poteshman (2008) showed that the options market could facilitate investors in discovering future information by releasing future pertinent information. Therefore, under an efficient market, investors could fully expose the efficiency of information by investigating the variability of the volatility of the stock as a proxy to information flows. Ni, Pan, and Poteshman (2008) find that the options market is uniquely suited for trading on information via changes in volitility. Their paper provide evidence to support options volume as informative about future volatility by

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showing that volatility in the options market is positively related to the subsequent realized volatility of the underlying stock. A natural interpretation of this finding is that investors choose to trade on private information through the options market. They further found that net demand for volatility impacts the prices of options, and that the impact increases when informational asymmetry increases in the days leading up to the earnings announcement day.

Seminal papers on information efficiency such as Dimson (1979), provide support that individual stocks react the acceptance of public information through changes in stock returns. In order to support his findings of informational efficiency of individual stocks, he used a Beta coefficient in market model to observe the reaction level of returns for individual stocks to the acceptance of public information. Chordia and Swaminathan (2000) further developed Dimson's Beta coefficient by directly observing the speed of which the stock price adjustment occurs. Chordia and Swaminathan find that stocks with high trading volumes have faster speed of response to market information than stocks with low trading volumes. Using the Beta coefficient applied in Dimson (1979), Chen and Rhee (2010) used a coefficient of lagged periods of market returns in both up and down market conditions to investigate the delay of price adjustments. They found that short sale constraints influence adjustment speed (delay) of stock price to publicly available information.

Phillips (2011) utilized the same method to empirically examine the relationship between short sale constraints and market efficiency. He considered, in his research model, not only the information of market returns for current and lagged periods, but he also considered the private information of lagged periods, and the indicated variable of imbalanced returns. He further applied the difference of explained intensity of base and

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extended the regression models to observe whether or not short sales constraints would affect the delay of information. According to the method of measuring stock price adjustment delays in Hou and Moskowitz (2005), market returns could be a very good proxy for stocks responses to new information in the markets.

Traditional Capital Asset Pricing Model (CAPM) holds the opinion that idiosyncratic risk could be eliminated away by holding a well-diversified investment portfolio; therefore, systematic risk would be the only factor that influences asset prices. However, recent empirical studies have found that the risk intensity of stocks is mainly due to the idiosyncratic risk of individual stocks. This conclusion was different from CAPM's argument that only systematic risk would have an effect on returns. We consider the notion that many previous literatures have indicated, which is, that volatility was informative as well. By using volatility to investigate the speed to which information travels rather than returns is a more direct way.

Recent literature that attempt to break through the traditional method of returns was performed by Campbell, Lettau, Malkiel and Xu (2001). They successfully divided the volatility of stock returns into market, industry, and firms' idiosyncratic volatility by using a disaggregated approach. Xu and Malkiel (2003) additionally applied both direct a decomposition method and a disaggregated approach method to decompose volatility of stock returns into systematic volatility and idiosyncratic volatility. Xu and Malkiel (2003) found that corporate private information could be reflected to its stock price faster when the institutional investors held a higher percentage of that company's stock.

Data

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We apply our research to the 416 S&P-500 listed firms that have their fourth quarter earnings announcements of 2010 on December 31st for our research and we obtain data from 25 days before to 20 days after December 31st. The reason why we choose these stocks and the same day is because: (1) Choosing the same day of announcement for our entire sample allows us to discount other influences on volatility and returns. (2) By being listed on the index, S&P-500 firms must comply with uniform standards required by Standard and Poor's in addition to other standards required by the government. Our study differentiates itself from previous studies because we choose to use only S&P-500 listed big cap stocks with corresponding derivatives products, as previous studies choose non-big cap stocks to compare. The problem with choosing non-big cap stocks, as with previous studies, is that smaller firms sometimes do not have the resources to efficiently and accurately disclose information to the public.

Methodology

Due to the nature of our research, namely the use of high frequency data, it would be more suitable to use the approach method outlined by Campbell, Lettau, Malkiel and Xu (2001). According to the calculation method used in Brandt, Brav, Graham, and Kumar (2010), for each stock j that belongs to industry I on day t, the intraday firm residual can be computed by subtracting the industry-i return:

$$\varepsilon_{ijst} = r_{ijst} - r_{ist}$$

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where r_{ijst} is the return of sth 5-minutes interval on day t of stock j that belongs to industry i and r_{ist} is the valued weighted return of industry I in s^{th} 5-minutes interval on day t.

Then we obtained the day-t idiosyncratic volatility (σ^{id}_{ijt}) of stock j in industry I by

$$\sigma^{id}_{ijt} = \sqrt{\sum_s \varepsilon^2_{ijst}}$$

Industry volatility:

Using the daily idiosyncratic volatility estimates for all stocks, we calculate the value weighted average volatility for each industry as:

$$\sigma^{ind}_{it} = \sum_j w_{ij,t-1}\sigma^{id}_{ijt}$$

where w_{ijt} is the day-t weight of stock j belonging to industry-i.

Last, we compute value weighted average of the daily industry idiosyncratic volatilities to obtain the average market idiosyncratic volatility across all firms in a given day market volatility:

$$\sigma^m_t = \sum_i w_{i,t-1}\sigma^{ind}_{it}$$

where w_{it} is the day-t weighted industry-i.

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We apply the volatility calculation method for high frequency data used in Andersen, Bollerslev, Diebold, and Labys (2001) for the total volatility of stock:

$$\sigma_{ijt}^{Total} = \sqrt{\sum_s r_{ijst}^2}$$

We should have $\sum \beta = 1$ in the base model below if the market responded to the new information efficiently. Otherwise, the market was inefficient.

$$\sigma_{ijt}^T = \alpha + \beta_{id,t}\sigma_{ijt}^{id} + \beta_{ind,t}\sigma_{it}^{ind} + \beta_{m,t}\sigma_t^m + \varepsilon_{ijt}$$

To comply with the setup from Phillips (2011), we have two extended models below:

$$\sigma_{ijt}^T = \alpha + \beta_{id,t}\sigma_{ijt}^{id} + \beta_{ind,t}\sigma_{it}^{ind} + \sum_{n=1}^{5}\beta_{ind,t-n}\sigma_{i,t-n}^{ind} + \beta_{m,t}\sigma_t^m + \sum_{n=1}^{5}\beta_{m,t-n}\sigma_{t-5}^m + \varepsilon_{ijt}$$

(Public information extended model)

When the public information is released, we use the extended model by introducing five previous idiosyncratic volatilities of industry and market.

$$\sigma_{ijt}^T = \alpha + \beta_{id,t}\sigma_{ijt}^{id} + \sum_{n=1}^{5}\beta_{id,t-n}\sigma_{ij,t-n}^{id} + \beta_{ind,t}\sigma_{it}^{ind} + \beta_{m,t}\sigma_t^m + \varepsilon_{ijt}$$

(Private information extended model)

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When the company information is released, we use the extended model by introducing five previous idiosyncratic volatilities of that particular stock.

We then apply the following delay measures used by Brandt, Brav, Graham, and Kumar (2010) to examine the transaction delay level of informed trading caused by short sales constraints before and after the earnings announcement.

The first delay measure, the R^2 ratio, measures the proportional difference between the base model and the extended model (lagged model).

$$\text{Public } D_{rsq} = 1 - \frac{R^2_{base}}{R^2_{Pub-extended}}$$

$$\text{Private } D_{rsq} = 1 - \frac{R^2_{base}}{R^2_{Pri-extended}}$$

If $R^2_{extended}$ is close to R^2_{base}, then D_{rsq} is close to 0. The difference between $R^2_{extended}$ and R^2_{base} increased, the D_{rsq} will increase.

The second delay measure, the coefficient ratio, measures the ratio of the lag-weighted sum of the lagged market return coefficients relative to the sum of all the regression coefficients.

Public D_{beta}

$$= \frac{\sum_{n=1}^{5}\{n[\text{abs}(_{ind,t-n}) + \text{abs}(_{m,t-n})]\}}{\text{abs}(_{id,t}) + \text{abs}(_{ind,t}) + \text{abs}(_{m,t}) + \sum_{n=1}^{5}(\text{abs}(_{ind,t-n}) + \text{abs}(_{m,t-n}))}$$

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$$\text{Private } D_{beta} = \frac{\sum_{n=1}^{5} n[abs(\ _{id,t-n})]}{abs\left(\ _{id,t}\right) + abs\left(\ _{ind,t}\right) + abs\left(\ _{m,t}\right) + \sum_{n=1}^{5} abs(\ _{id,t-n})}$$

The greater the delay in stock price adjustment, the larger the lagged regression coefficients and the larger the D_{beta} delay measure.

The third delay measure, the standard error adjusted coefficient ratio, augments the Coefficients Ration measures by weighting each coefficient by its own standard error.

$$\text{Public } D_{se} = \frac{\sum_{n=1}^{5} \{n[\frac{abs(\ _{ind,t-n})}{se(\ _{ind,t-n})} + \frac{abs\left(\ _{m,t-n}\right)}{se\left(\ _{m,t-n}\right)}]\}}{\frac{abs\left(\ _{id,t}\right)}{se\left(\ _{id,t}\right)} + \frac{abs\left(\ _{ind,t}\right)}{se\left(\ _{ind,t}\right)} + \frac{abs\left(\ _{m,t}\right)}{se\left(\ _{m,t}\right)} + \sum_{n=1}^{5}[\frac{abs(\ _{ind,t-n})}{se(\ _{ind,t-n})} + \frac{abs\left(\ _{m,t-n}\right)}{se\left(\ _{m,t-n}\right)}]}$$

$$\text{Public } D_{se} = \frac{\sum_{n=1}^{5} n\frac{abs(\ _{id,t-n})}{se(\ _{id,t-n})}}{\frac{abs\left(\ _{id,t}\right)}{se\left(\ _{id,t}\right)} + \frac{abs\left(\ _{ind,t}\right)}{se\left(\ _{ind,t}\right)} + \frac{abs\left(\ _{m,t}\right)}{se\left(\ _{m,t}\right)} + \sum_{n=1}^{5}\frac{abs(\ _{id,t-n})}{se(\ _{id,t-n})}}$$

Volatility responded differently, i.e. asymmetric response, to positive and negative information.

In order to monitor the behaviors of idiosyncratic volatilities' response to negative information, we create a dummy variable, V. Where V=1 if $r_{ijts} < 0$. Otherwise, V=0. And calculate the downside volatility for the stock, industry and market.

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Downside Volatility for stock j of Industry I on day t:

$$\sigma_{ijt}^{id-Down} = \sqrt{\sum_s V_{(V=1, r_{ijts}<0)} \varepsilon_{ijst}^2}$$

Downside Volatility for Industry I on day t:

$$\sigma_{it}^{ind-Down} = \sum_j w_{ij,t-1} \sqrt{\sum_s V_{(V=1, r_{ijts}<0)} \varepsilon_{ijst}^2}$$

Downside Volatility of the market on day t:

$$\sigma_t^{m-Down} = \sum_i w_{i,t-1} \sum_j w_{ij,t-1} \sqrt{\sum_s V_{(V=1, r_{ijts}<0)} \varepsilon_{ijst}^2}$$

We then introduced those three downside volatilities into these two models, the public negative information extended model and the private negative information extended model:

$$T_{ijt} = + _{id,t}\, id_{ijt} + _{ind,t}\, ind_{it} + ^{neg}_{ind,t}\, ind-D_{i,t} + \sum_{n=1}^5 {}_{ind,t-n}\, ind_{i,t-n} + \sum_{n=1}^5 {}^{neg}_{ind,t-n}\, ind-D_{i,t-n} +$$

$$_{m,t}\, m_t + ^{neg}_{m,t}\, m-D_t + \sum_{n=1}^5 {}_{m,t-n}\, m_{t-n} + \sum_{n=1}^5 {}^{neg}_{m,t-n}\, m-D_{t-n} + _{ijt}$$

(Public negative information extended model)

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$$T_{ijt} = \alpha + \beta_{id,t} R^{id}_{ijt} + \beta^{neg}_{id,t} R^{id-D}_{ijt} + \sum_{n=1}^{5} \beta_{id,t-n} R^{id}_{ij,t-n} + \sum_{n=1}^{5} \beta^{neg}_{id,t-n} R^{id-D}_{ij,t-n} + \beta_{ind,t} R^{ind}_{it} +$$

$$\beta_{m,t} R^{m}_{t} + \varepsilon_{ijt}$$

(Private negative information extended model)

D^{neg}_{rsq} is calculated as the R^2 ratio of the negative extended model related to the extended model.

$$\text{Public } D^{neg}_{rsq} = 1 - \frac{R^2_{Pub-extended}}{R^2_{Pub-neg-extended}}$$

$$\text{Private } D^{neg}_{rsq} = 1 - \frac{R^2_{Pri-extended}}{R^2_{Pri-neg-extended}}$$

Higher values of the D^{neg}_{rsq} reflect greater delay in the speed of the price adjustment to new negative information.

Furthermore, we computed the D^{neg}_{beta} and D^{neg}_{se} variables to obtain the additional measures of the price delay related to the new negative information.

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Public D_{beta}^{neg}

$$= \frac{\sum_{n=1}^{5}\{n[\ abs\left(_{ind,t-n}^{neg}\right) + abs(_{m,t-n}^{neg})]\}}{abs\left(_{id,t}\right) + abs\left(_{ind,t}\right) + abs\left(_{ind,t}^{neg}\right) + abs\left(_{m,t}\right) + abs\left(_{m,t}^{neg}\right) + \sum_{n=1}^{5}(abs(_{ind,t-n}) + abs\left(_{ind,t-n}^{neg}\right) + abs\left(_{m,t-n}\right) + abs(_{m,t-n}^{neg}))}$$

$$Private\ D_{beta}^{neg} = \frac{\sum_{n=1}^{5} n[\ abs\left(_{id,t-n}^{neg}\right)]}{abs\left(_{id,t}\right) + abs\left(_{id,t}^{neg}\right) + abs\left(_{ind,t}\right) + abs\left(_{m,t}\right) + \sum_{n=1}^{5}[abs(_{id,t-n}) + abs\left(_{id,t-n}^{neg}\right)]}$$

Public D_{se}^{neg}

$$= \frac{\sum_{n=1}^{5}\{n[\ \frac{abs\left(_{ind,t-n}^{neg}\right)}{se\left(_{ind,t-n}^{neg}\right)} + \frac{abs(_{m,t-n}^{neg})}{se\left(_{m,t-n}\right)}]\}}{\frac{abs\left(_{id,t}\right)}{se\left(_{id,t}\right)} + \frac{abs\left(_{ind,t}\right)}{se\left(_{ind,t}\right)} + \frac{abs\left(_{ind,t}^{neg}\right)}{se\left(_{ind,t}^{neg}\right)} + \frac{abs\left(_{m,t}\right)}{se\left(_{m,t}\right)} + \frac{abs\left(_{m,t}^{neg}\right)}{se\left(_{m,t}^{neg}\right)} + \sum_{n=1}^{5}\{n[\frac{abs(_{ind,t-n})}{se(_{ind,t-n})} + \frac{abs\left(_{ind,t-n}^{neg}\right)}{se\left(_{ind,t-n}^{neg}\right)} + \frac{abs\left(_{m,t-n}\right)}{se\left(_{m,t-n}\right)} + \frac{abs(_{m,t-n}^{neg})}{se\left(_{m,t-n}^{neg}\right)}]\}}$$

$$Private\ D_{se}^{neg} = \frac{\sum_{n=1}^{5} n\frac{abs\left(_{id,t-n}^{neg}\right)}{se\left(_{id,t-n}^{neg}\right)}}{\frac{abs\left(_{id,t}\right)}{se\left(_{id,t}\right)} + \frac{abs\left(_{id,t}^{neg}\right)}{se\left(_{id,t}^{neg}\right)} + \frac{abs\left(_{ind,t}\right)}{se\left(_{ind,t}\right)} + \frac{abs\left(_{m,t}\right)}{se\left(_{m,t}\right)} + \sum_{n=1}^{5}\{n[\frac{abs(_{id,t-n})}{se(_{id,t-n})} + \frac{abs\left(_{id,t-n}^{neg}\right)}{se\left(_{id,t-n}^{neg}\right)}]\}}$$

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We also tested to see how the price adjustment speed will behave to positive information. We create another dummy variable, K. Where K=1 if $r_{ijts} > 0$. Otherwise, K=0. And calculate the upside volatility for the stock, industry and market.

Upside volatility for stock j of industry I on day t:

$$\sigma_{ijt}^{id-Up} = \sqrt{\sum_s K_{(K=1,r_{ijts}>0)} \varepsilon_{ijst}^2}$$

Upside volatility for industry I on day t:

$$\sigma_{it}^{ind-Up} = \sum_j w_{ij,t-1} \sqrt{\sum_s K * \varepsilon_{ijst}^2}$$

Upside volatility of the market on day t:

$$\sigma_t^{m-Up} = \sum_i w_{i,t-1} \sum_j w_{ij,t-1} \sqrt{\sum_s K * \varepsilon_{ijst}^2}$$

We constructed the upside models:

$$\sigma_{ijt}^T = \ + \ _{id,t}\sigma_{ijt}^{id} + \ _{ind,t}\sigma_{it}^{ind} + \ _{ind,t}^{pos}\sigma_{i,t}^{ind-U} + \sum_{n=1}^5 \ _{ind,t-n}\sigma_{i,t-n}^{ind} + \sum_{n=1}^5 \ _{ind,t-n}^{pos}\sigma_{i,t-n}^{ind-U} +$$

$$_{m,t}\sigma_t^m + \ _{m,t}^{pos}\sigma_t^{m-U} + \sum_{n=1}^5 \ _{m,t-n}\sigma_{t-n}^m + \sum_{n=1}^5 \ _{m,t-n}^{pos}\sigma_{t-n}^{m-U} + \ _{ijt}$$

(Public positive information extended model)

$$\sigma_{ijt}^T = \ + \ _{id,t}\sigma_{ijt}^{id} + \ _{id,t}^{pos}\sigma_{ijt}^{id-U} + \sum_{n=1}^5 \ _{id,t-n}\sigma_{ij,t-n}^{id} + \sum_{n=1}^5 \ _{id,t-n}^{pos}\sigma_{ij,t-n}^{id-U} + \ _{ind,t}\sigma_{it}^{ind} +$$

$$_{m,t}\sigma_t^m + \ _{ijt}$$

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(Private positive information extended model)

We then obtained all the delay measurements from the upside models by the following formulas

$$\text{Public } D_{rsq}^{pos} = 1 - \frac{R^2_{Pub-extended}}{R^2_{Pub-pos-extended}}$$

$$\text{Private } D_{rsq}^{pos} = 1 - \frac{R^2_{Pri-extended}}{R^2_{Pri-pos-extended}}$$

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Public $D_{\text{beta}}^{\text{pos}}$

$$= \frac{\sum_{n=1}^{5}\{n[\,\text{abs}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)+\text{abs}(\ _{\text{m,t-n}}^{\text{pos}})]\}}{\text{abs}\left(\ _{\text{id,t}}\right)+\text{abs}\left(\ _{\text{ind,t}}\right)+\text{abs}\left(\ _{\text{ind,t}}^{\text{pos}}\right)+\text{abs}\left(\ _{\text{m,t}}\right)+\text{abs}\left(\ _{\text{m,t}}^{\text{pos}}\right)+\sum_{n=1}^{5}(\text{abs}(\ _{\text{ind,t-n}})+\text{abs}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)+\text{abs}\left(\ _{\text{m,t-n}}\right)+\text{abs}(\ _{\text{m,t-n}}^{\text{pos}}))}$$

$$\text{Private } D_{\text{beta}}^{\text{pos}} = \frac{\sum_{n=1}^{5} n[\,\text{abs}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)]}{\text{abs}\left(\ _{\text{id,t}}\right)+\text{abs}\left(\ _{\text{id,t}}^{\text{pos}}\right)+\text{abs}\left(\ _{\text{ind,t}}\right)+\text{abs}\left(\ _{\text{m,t}}\right)+\sum_{n=1}^{5}[\text{abs}(\ _{\text{id,t-n}})+\text{abs}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)]}$$

Public $D_{\text{se}}^{\text{pos}}$

$$= \frac{\sum_{n=1}^{5}\{n[\,\frac{\text{abs}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)}+\frac{\text{abs}(\ _{\text{m,t-n}}^{\text{pos}})}{\text{se}\left(\ _{\text{m,t-n}}\right)}]\}}{\frac{\text{abs}\left(\ _{\text{id,t}}\right)}{\text{se}\left(\ _{\text{id,t}}\right)}+\frac{\text{abs}\left(\ _{\text{ind,t}}\right)}{\text{se}\left(\ _{\text{ind,t}}\right)}+\frac{\text{abs}\left(\ _{\text{ind,t}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{ind,t}}^{\text{pos}}\right)}+\frac{\text{abs}\left(\ _{\text{m,t}}\right)}{\text{se}\left(\ _{\text{m,t}}\right)}+\frac{\text{abs}\left(\ _{\text{m,t}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{m,t}}^{\text{pos}}\right)}+\sum_{n=1}^{5}\{n[\frac{\text{abs}(\ _{\text{ind,t-n}})}{\text{se}(\ _{\text{ind,t-n}})}+\frac{\text{abs}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{ind,t-n}}^{\text{pos}}\right)}+\frac{\text{abs}\left(\ _{\text{m,t-n}}\right)}{\text{se}\left(\ _{\text{m,t-n}}\right)}+\frac{\text{abs}(\ _{\text{m,t-n}}^{\text{pos}})}{\text{se}\left(\ _{\text{m,t-n}}^{\text{pos}}\right)}]\}}$$

$$\text{Private } D_{\text{se}}^{\text{pos}} = \frac{\sum_{n=1}^{5} n\,\frac{\text{abs}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)}}{\frac{\text{abs}\left(\ _{\text{id,t}}\right)}{\text{se}\left(\ _{\text{id,t}}\right)}+\frac{\text{abs}\left(\ _{\text{id,t}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{id,t}}^{\text{pos}}\right)}+\frac{\text{abs}\left(\ _{\text{ind,t}}\right)}{\text{se}\left(\ _{\text{ind,t}}\right)}+\frac{\text{abs}\left(\ _{\text{m,t}}\right)}{\text{se}\left(\ _{\text{m,t}}\right)}+\sum_{n=1}^{5}\{n[\frac{\text{abs}(\ _{\text{id,t-n}})}{\text{se}(\ _{\text{id,t-n}})}+\frac{\text{abs}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)}{\text{se}\left(\ _{\text{id,t-n}}^{\text{pos}}\right)}]\}}$$

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Results

We applied all three delay measures to model the differences in the both private and public, in situations where both positive and negative returns exist. Again, 'negative' means that information that we receive is a results of a negative surprise in the earnings announcement, 'positive' means that information that we receive is a result of a positive surprise in the earnings announcement. Also, 'public' means that we augment the model with five previous idiosyncratic volatilities of industry and market, 'private' means that we use five previous idiosyncratic volatilities of that particular stock. The informational differences between public and private is a unique measure that is a contribution of our research, when we regress on lagged idiosyncratic volatilities, we can distinguish between the release of pubic verses private information. This information differential will allow us to further measure the delay responses of informed traders as opposed to un-informed trades. If the information is public (and all participants in the market become aware of this information) then the scenario shown in the example mentioned before should take part. However, if the information is private (meaning that it's not obvious to non-sophisticated investors) then the efficiency of that information should be much better. The delay measures are different measures used to measure the responses to news, as outlined by Phillips (2011). The faster the news is disseminated to market participants the lower the delay measurement.

20

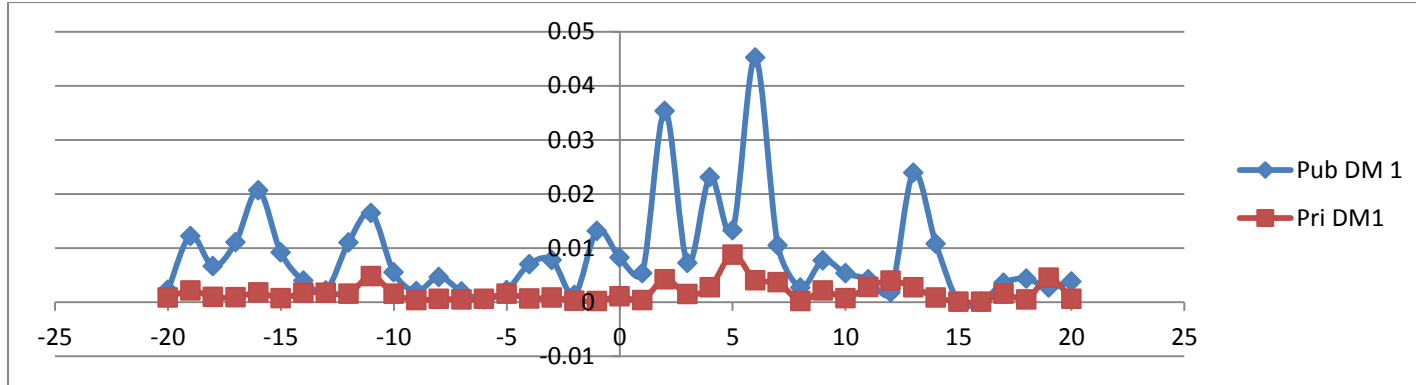Group A: Public-Private Information Group

Figure 1: Private Delay Measure I VS. Public Delay Measure I

Table 1: t-Test for Private Delay Measure I VS. Public Delay Measure I

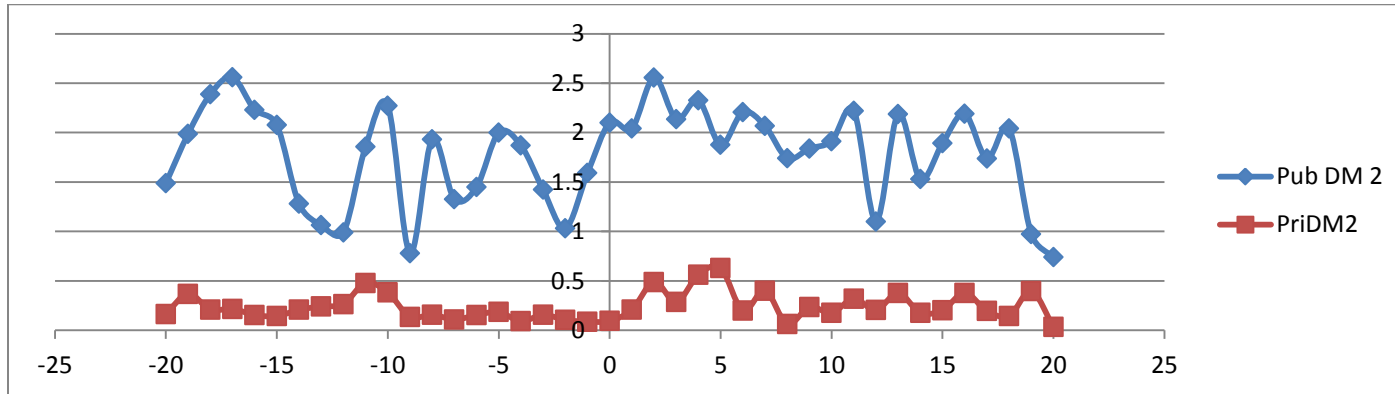| t-Test: Paired Two Sample for Means		
	Pub DM 1	*Pri DM1*
Mean	0.008825674	0.00177229
Variance	8.82559E-05	3.02343E-06
Observations	41	41
Pearson Correlation	0.466429159	
Hypothesized Mean Difference	0	
df	40	
t Stat	5.179234344	
P(T<=t) one-tail	3.33859E-06	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	6.67718E-06	
t Critical two-tail	2.02107539	

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Figure 2: Private Delay Measure II VS. Public Delay Measure II

Table 2: t-Test for Private Delay Measure II VS. Public Delay Measure II

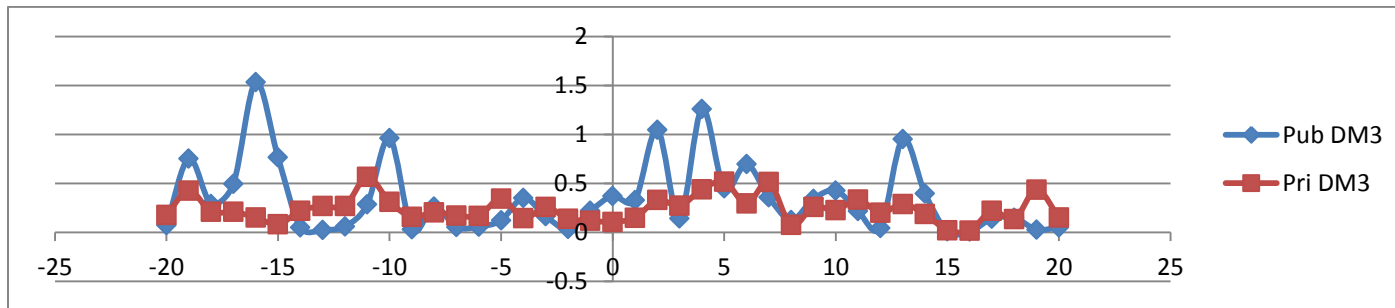| t-Test: Paired Two Sample for Means		
	Pub DM 2	Pri DM2
Mean	1.780749464	0.239012894
Variance	0.238076376	0.019197752
Observations	41	41
Pearson Correlation	0.365633694	
Hypothesized Mean Difference	0	
df	40	
t Stat	21.65416397	
P(T<=t) one-tail	5.27918E-24	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	1.05584E-23	
t Critical two-tail	2.02107539	

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Figure 3: Private Delay Measure III VS. Public Delay Measure III

Table 3: t-Test for Private Delay Measure III VS. Public Delay Measure III

t-Test: Paired Two Sample for Means		
	Pub DM3	*Pri DM3*
Mean	0.345478713	0.239245842
Variance	0.137683135	0.01693549
Observations	41	41
Pearson Correlation	0.262214967	
Hypothesized Mean Difference	0	
df	40	
t Stat	1.891733983	
P(T<=t) one-tail	0.03289099	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.06578198	
t Critical two-tail	2.02107539	

23

Table 4: Summary Stats for Public-Private Information Group

Average, Minimum and Maximum of Delay Measures						
	Pub DM 1	Pri DM1	Pub DM 2	Pri DM2	Pub DM3	Pri DM3
Average	0.00883	0.00177	1.78075	0.23901	0.34548	0.23925
Min	0.0001	0.0001	0.7402	0.03354	0.00709	0.01938
Max	0.0452	0.00879	2.5594	0.62944	1.53353	0.56712

24

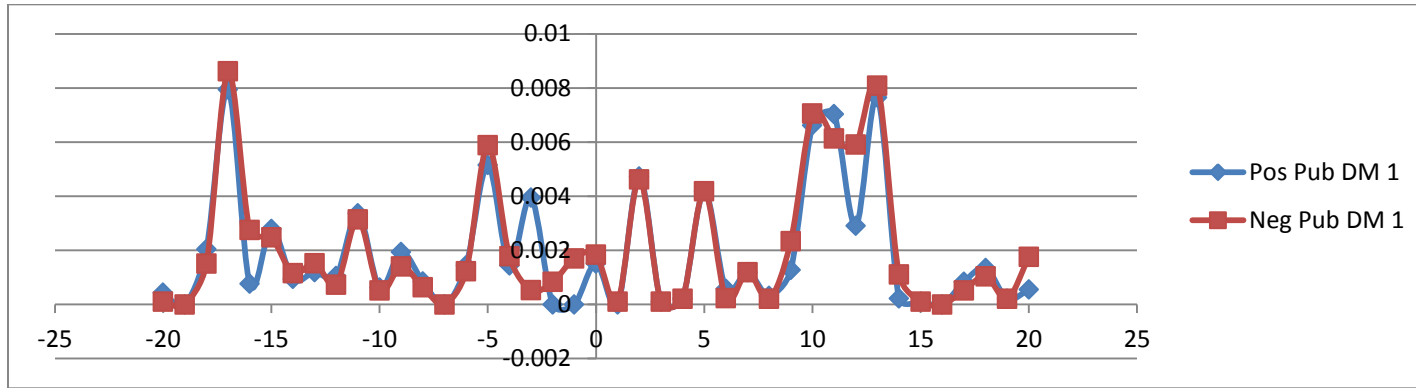Group B: Positive-Negative for Public-Private Information Group

Figure 4: Positive - Public - Delay Measure I VS. Negative - Public - Delay Measure I

Table 5: t-Test for Positive - Public - Delay Measure I VS. Negative - Public - Delay Measure I

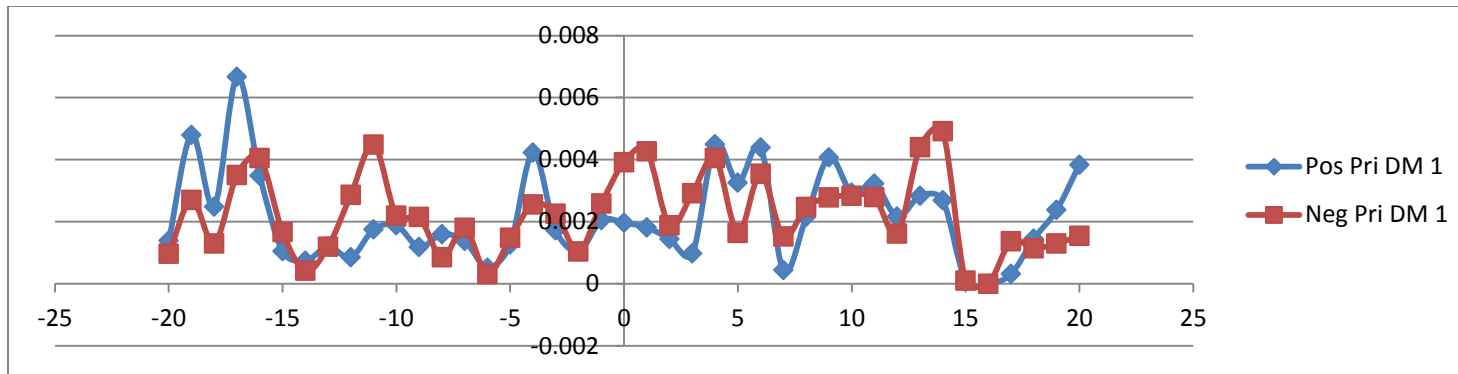| t-Test: Paired Two Sample for Means		
	Pos Pub DM 1	*Neg Pub DM 1*
Mean	0.001890178	0.002037057
Variance	5.09652E-06	5.5695E-06
Observations	41	41
Pearson Correlation	0.91981695	
Hypothesized Mean Difference	0	
df	40	
t Stat	-1.011279794	
P(T<=t) one-tail	0.15898049	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.31796098	
t Critical two-tail	2.02107539	

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Figure 5: Positive- Private- Delay Measure I VS. Negative- Private-Delay Measure I

Table 6: t-Test for Positive- Private- Delay Measure I VS. Negative- Private-Delay Measure I

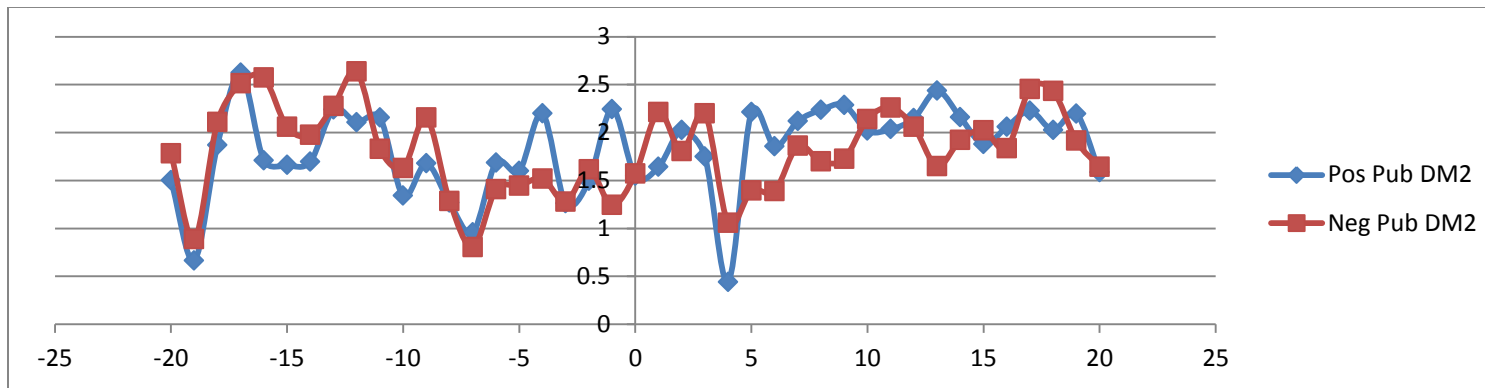| t-Test: Paired Two Sample for Means		
	Pos Pri DM 1	*Neg Pri DM 1*
Mean	0.002150664	0.002228903
Variance	2.13838E-06	1.63573E-06
Observations	41	41
Pearson Correlation	0.546650854	
Hypothesized Mean Difference	0	
df	40	
t Stat	-0.380955386	
P(T<=t) one-tail	0.352626123	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.705252245	
t Critical two-tail	2.02107539	

26

Figure 6: Positive- Public- Delay Measure II VS. Negative-Public- Delay Measure II

Table 7: t-Test for Positive- Public- Delay Measure II VS. Negative-Public- Delay Measure II

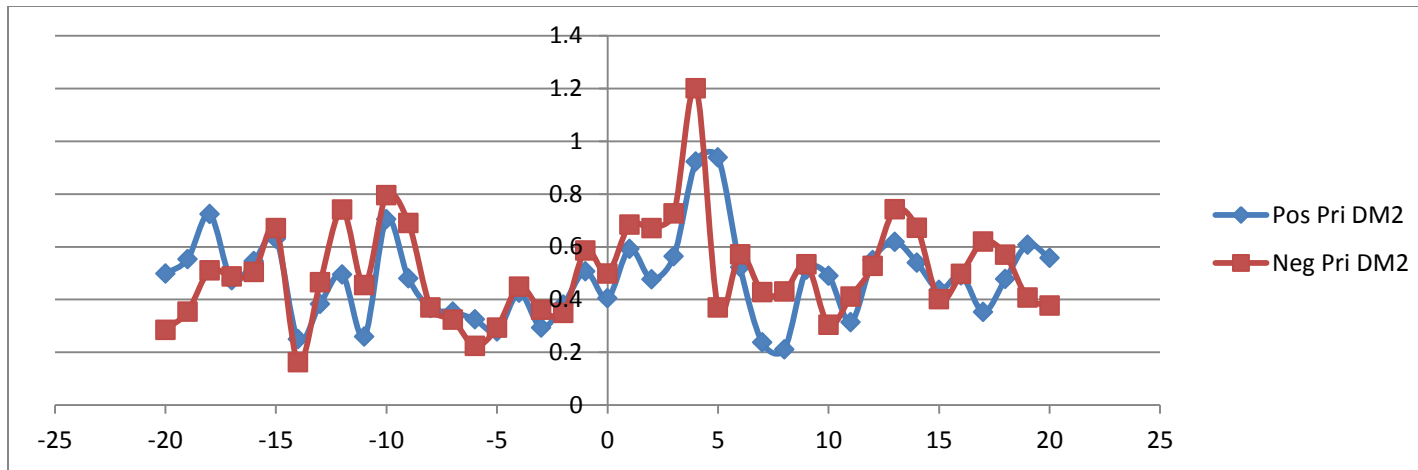| t-Test: Paired Two Sample for Means		
	Pos Pub DM2	*Neg Pub DM2*
Mean	1.824872423	1.810984095
Variance	0.211468451	0.201852183
Observations	41	41
Pearson Correlation	0.570424462	
Hypothesized Mean Difference	0	
df	40	
t Stat	0.211008793	
P(T<=t) one-tail	0.416975874	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.833951748	
t Critical two-tail	2.02107539	

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Figure 7: Positive-Private-Delay Measure II VS. Negative-Private-Delay Measure II

Table 8: t-Test for Positive-Private-Delay Measure II VS. Negative-Private-Delay Measure II

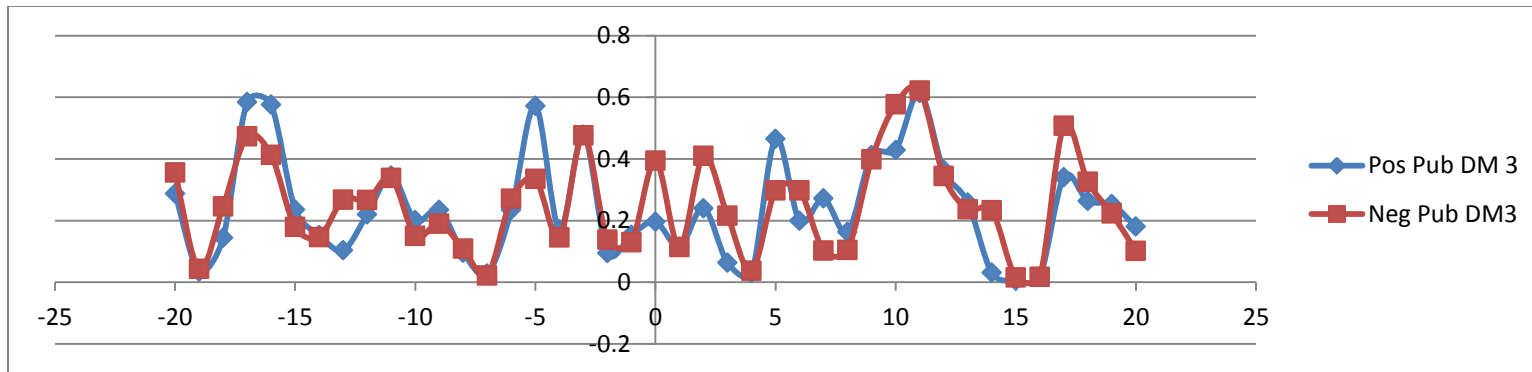| t-Test: Paired Two Sample for Means		
	Pos Pri DM2	*Neg Pri DM2*
Mean	0.481426653	0.505143779
Variance	0.026372069	0.035917109
Observations	41	41
Pearson Correlation	0.56600472	
Hypothesized Mean Difference	0	
df	40	
t Stat	-0.916612836	
P(T<=t) one-tail	0.182419553	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.364839105	
t Critical two-tail	2.02107539	

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Figure 8: Positive-Public-Delay Measure III VS. Negative-Public-Delay Measure III

Table 9: t-Test for Positive-Public-Delay Measure III VS. Negative-Public-Delay Measure III

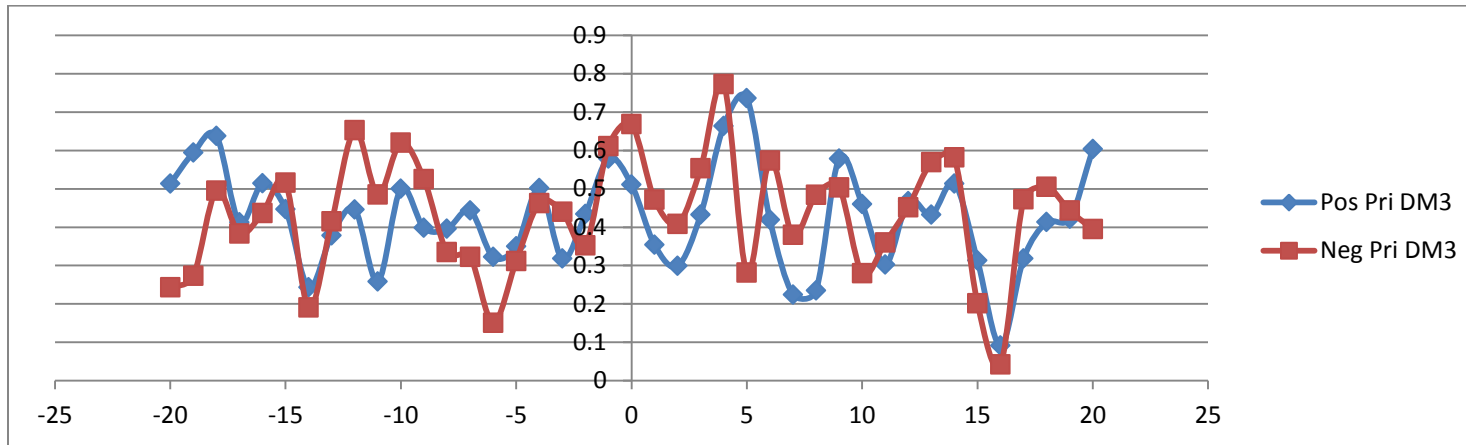| t-Test: Paired Two Sample for Means		
	Pos Pub DM 3	*Neg Pub DM3*
Mean	0.240503681	0.250533903
Variance	0.028145849	0.024383162
Observations	41	41
Pearson Correlation	0.806907789	
Hypothesized Mean Difference	0	
df	40	
t Stat	-0.634310547	
P(T<=t) one-tail	0.264744708	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.529489415	
t Critical two-tail	2.02107539	

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Figure 9: Positive-Private-Delay Measure III VS. Negative-Private- Delay Measure III

Table 10: t-Test for Positive-Private-Delay Measure III VS. Negative-Private- Delay Measure III

t-Test: Paired Two Sample for Means		
	Pos Pri DM3	*Neg Pri DM3*
Mean	0.426237474	0.429771278
Variance	0.017333176	0.022662301
Observations	41	41
Pearson Correlation	0.404981844	
Hypothesized Mean Difference	0	
df	40	
t Stat	-0.146234559	
P(T<=t) one-tail	0.442235365	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	0.88447073	
t Critical two-tail	2.02107539	

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Table 11: Summary Stats for Positive-Negative and Public-Private Information Group

	Average, Minimum and Maximum of Delay Measures											
	Pos Pub DM 1	Neg Pub DM 1	Pos Pub DM2	Neg Pub DM2	Pos Pub DM 3	Neg Pub DM3	Pos Pri DM 1	Neg Pri DM 1	Pos Pri DM2	Neg Pri DM2	Pos Pri DM3	Neg Pri DM3
Average	0.00189	0.00204	0.00215	0.00223	1.82487	1.81098	0.48143	0.50514	0.24050	0.25053	0.42624	0.42977
Min	0	0	0	0	0.43921	0.80497	0.21145	0.16214	0.00498	0.01523	0.09144	0.04242
Max	0.00794	0.00861	0.00667	0.00492	2.62304	2.63494	0.93838	1.19960	0.61376	0.62195	0.73578	0.77235

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Looking at our first set of results (Figure 1 through Figure 153) for Delay Measure I/II/III of Public –Private information group , we can see that for , the delay response for private information is always much faster than it is for public information.

Looking at our first set of results for Private Delay Measure I VS Public Delay Measure I in Figure 1 with corresponding Table we find that the Delay Measure I for Public information is on average 0.0883 which is higher than average of Delay Measure I of Private information. Same conclusion is obtained in Delay Measure II and III. Further, the averages of the delay measures are within Public –Private Information group are significantly different (results showed in Table1 through Table 3).

A comparison for Private and Public Delay Measures I, II, and III show a summary of the average, minimum, and maximum values are displayed on Table 4.

Looking at our second set of results for Positive Delay Measure I VS Negative Delay Measure I in Figure 1 4 through Figure 159 with corresponding Table through Table 10, we find that the delay measures for Positive information is no differ from Negative information for both Public and Private Information Group.

A comparison for Private/Public Negative/Positive Delay Measures I, II, and III show a summary of the average, minimum, and maximum values are displayed on Table .

Now we consider how efficient the market is when we have complementary derivative products in place. We consider derivatives products into our analysis as stocks that are comprised of stocks with Single Stock Futures (SSF) attached to the underlying asset.

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From what we hypothesize, if stocks have single stock futures, as previous studies have suggested, we can see that derivatives add information to the stock.

Let us take a closer look at the mechanics of this situation in further detail. Let us extend the scenario mentioned in the introduction to include a derivative for the stock being traded. Let us say, that the investors that are non-owners who are subscribed to the email and new cast methods of getting news, post negative information being released, still have orders in the market to buy, we know that most of them will also hedge their stocks by buying derivatives. Let's also say that sellers and non-owners of the stocks that have the SMS service, and have received the SMS message before the email and news, know that the stocks is overpriced and want to take advantage of the overpriced stocks by selling stocks that they do not own (assuming shorting is allowed), or sell futures of the stock if shorting is not allowed, they would do so by buying derivatives of the product. Thereafter, upon seeing that the stock price is creeping towards their bid price, they would believe that their order would likely be executed, and therefore buy derivatives to hedge their risk. However, because of supply and demand for the derivatives (hedging towards lower prices) the prices would have gone up substantially. This substantial increase in derivatives would signal to non-owners that there is something wrong, and this may lead them to think twice about buying the stock, and even make them withdraw their bid.

If we look at the differences between stocks that have, and stocks that do not have SSF, we can see from the analysis, that stocks without derivatives on average have a higher delay measure than stocks with; this means that stocks with derivatives are more efficient in reflecting information about the underlying asset.

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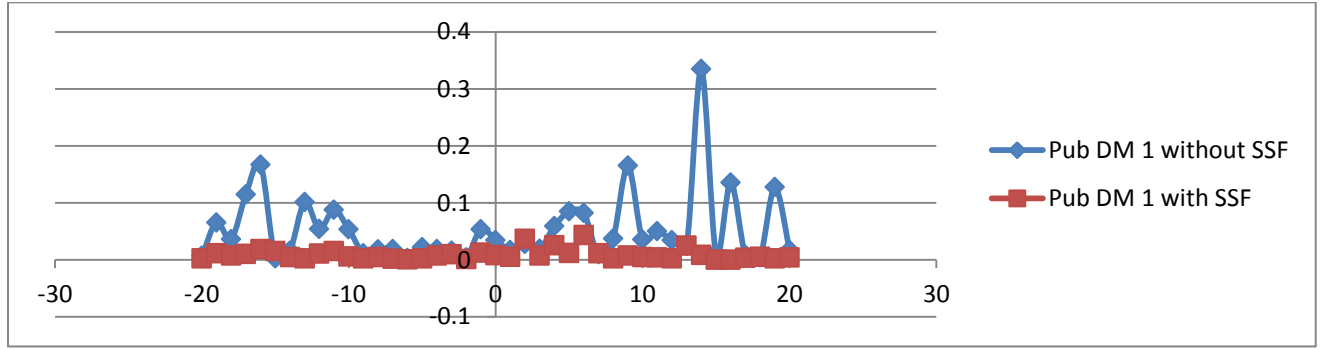Group C: With Derivatives VS. Without Derivatives (Single Stock Future)

Figure 10: Public--Without SSF-Delay Measure I VS. Public-With SSF -Delay Measure I

Table 12: t-Test for Public--Without SSF-Delay Measure I VS. Public-With SSF -Delay Measure I

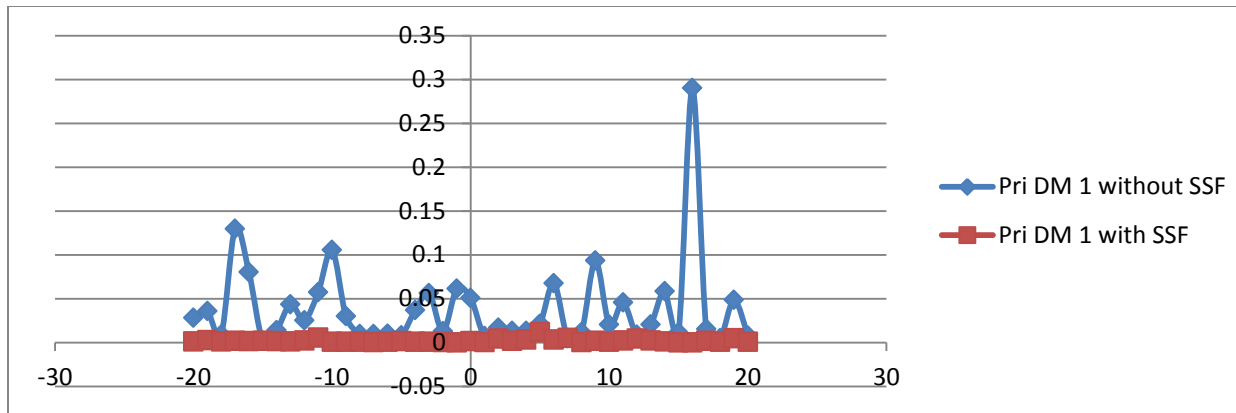| t-Test: Paired Two Sample for Means		
	Pub DM 1 without SSF	Pub DM 1 with SSF
Mean	0.053456484	0.008943805
Variance	0.004003507	8.76748E-05
Observations	41	41
Pearson Correlation	0.121872271	
Hypothesized Mean Difference	0	
df	40	
t Stat	4.536851707	
P(T<=t) one-tail	2.55573E-05	
t Critical one-tail	1.683851014	
P(T<=t) two-tail	5.11145E-05	
t Critical two-tail	2.02107537	

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Figure 11: Private- Without SSF- Delay Measure I VS. Private-With SSF-Delay Measure I

Table 13: t-Test for Private- Without SSF- Delay Measure I VS. Private-With SSF-Delay Measure I

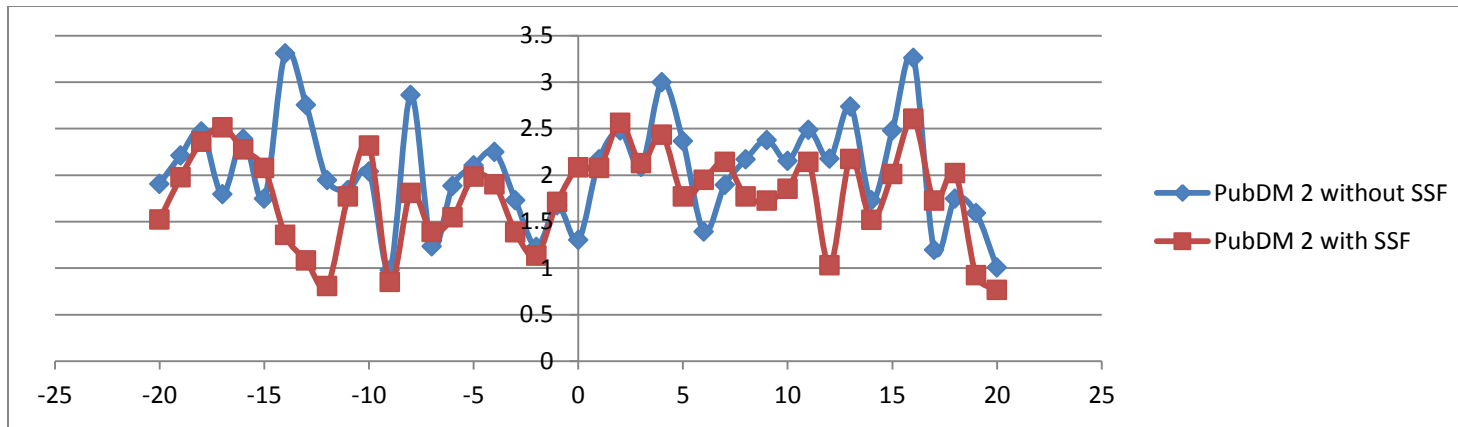| t-Test: Paired Two Sample for Means		
	Pri DM 1 without SSF	*Pri DM 1 with SSF*
Mean	0.038966499	0.001985993
Variance	0.002514183	4.44951E-06
Observations	41	41
Pearson Correlation	-0.123829764	
Hypothesized Mean Difference	0	
df	40	
t Stat	4.693919219	
P(T<=t) one-tail	1.56154E-05	
t Critical one-tail	1.683851014	
P(T<=t) two-tail	3.12308E-05	
t Critical two-tail	2.02107537	

35

Figure 12: Public-Without SSF-Delay Measure II VS. Public-With SSF-Delay Measure II

Table 14: t-Test for Public-Without SSF-Delay Measure II VS. Public-With SSF-Delay Measure II

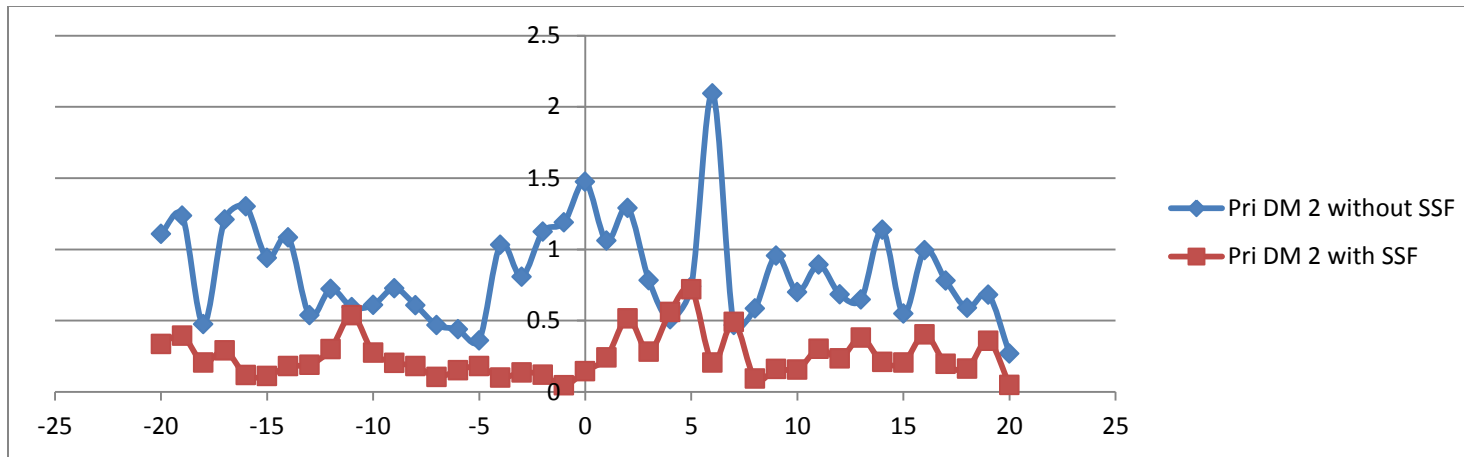| t-Test: Paired Two Sample for Means		
	PubDM 2 without SSF	*PubDM 2 with SSF*
Mean	2.051672795	1.784433372
Variance	0.324810086	0.247496368
Observations	41	41
Pearson Correlation	0.433155009	
Hypothesized Mean Difference	0	
df	40	
t Stat	2.993851061	
P(T<=t) one-tail	0.002353402	
t Critical one-tail	1.683851014	
P(T<=t) two-tail	0.004706804	
t Critical two-tail	2.02107537	

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Figure 13: Private-Without SSF-Delay Measure II VS. Private-With SSF-Delay Measure II

Table 15: t-Test for Private-Without SSF-Delay Measure II VS. Private-With SSF-Delay Measure II

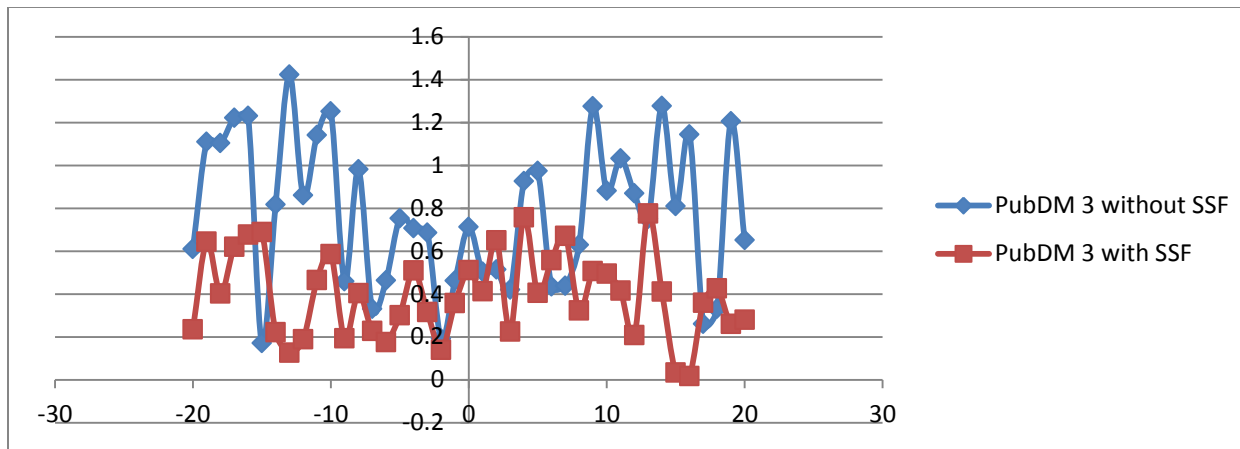| t-Test: Paired Two Sample for Means		
	Pri DM 2 without SSF	*Pri DM 2 with SSF*
Mean	0.840642463	0.250133711
Variance	0.127506266	0.022758665
Observations	41	41
Pearson Correlation	-0.049079056	
Hypothesized Mean Difference	0	
df	40	
t Stat	9.586931236	
P(T<=t) one-tail	3.2131E-12	
t Critical one-tail	1.683851013	
P(T<=t) two-tail	6.4262E-12	
t Critical two-tail	2.02107539	

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Figure 14: Public-Without SSF- Delay Measure III VS. Public-With SSF- Delay Measure III

Table 16: t-Test for Public-Without SSF- Delay Measure III VS. Public-With SSF- Delay Measure III

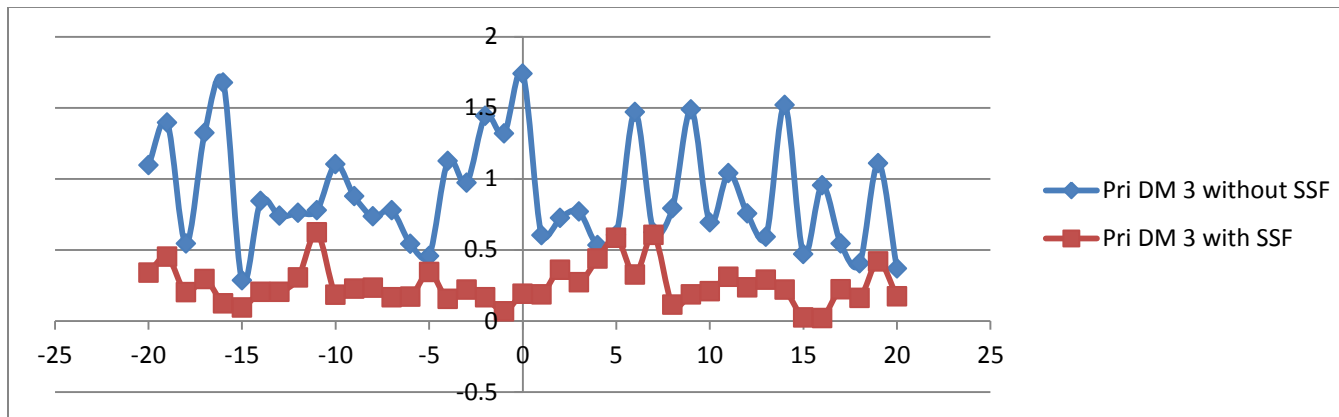| t-Test: Paired Two Sample for Means		
	PubDM 3 without SSF	*PubDM 3 with SSF*
Mean	0.780208761	0.39402972
Variance	0.116726402	0.03902261
Observations	41	41
Pearson Correlation	0.079507398	
Hypothesized Mean Difference	0	
df	40	
t Stat	6.49338474	
P(T<=t) one-tail	4.78924E-08	
t Critical one-tail	1.683851014	
P(T<=t) two-tail	9.57849E-08	
t Critical two-tail	2.02107537	

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Figure 15: Private- Without SSF- Delay Measure III VS. Private-With SSF-Delay Measure III

Table 17: t-Test for Private- Without SSF- Delay Measure III VS. Private-With SSF-Delay Measure III

t-Test: Paired Two Sample for Means		
	Pri DM 3 without SSF	Pri DM 3 with SSF
Mean	0.891968605	0.25148474
Variance	0.145730197	0.019831782
Observations	41	41
Pearson Correlation	-0.066328931	
Hypothesized Mean Difference	0	
df	40	
t Stat	9.868746467	
P(T<=t) one-tail	1.41154E-12	
t Critical one-tail	1.683851014	
P(T<=t) two-tail	2.82308E-12	
t Critical two-tail	2.02107537	

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Table 18: Summary of Basic Stats for SSF Group

	Average, Minimum and Maximum of Delay Measures											
	Pri DM 1 without SSF	Pri DM 1 with SSF	Pub DM 1 without SSF	Pub DM 1 with SSF	Pri DM 2 without SSF	Pri DM 2 with SSF	Pri DM 3 without SSF	Pri DM 3 with SSF	PubDM 2 without SSF	PubDM 2 with SSF	PubDM 3 without SSF	PubDM 3 with SSF
Average	0.0397	0.0020	0.0544	0.0091	0.8549	0.2552	0.9051	0.2535	2.0517	1.7844	0.7802	0.3940
Min	0.0019	0.0000	0.0024	0.0000	0.2687	0.0472	0.2847	0.0204	0.9784	0.7665	0.1706	0.0164
Max	0.2900	0.0116	0.3350	0.0433	2.0948	0.7210	1.7398	0.6220	3.3063	2.6056	1.4223	0.7755

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The results for delay measures of with derivatives and without derivatives group are showed in Figure 10 through Figure 15 with corresponding Table 12 though Table 17. For each Delay Measure I, II and III, stocks with the SSF are acting faster than the ones without SSF, regardless the information is public or private.

Let's compare Figure 12 (Public-Without SSF-Delay Measure II VS. Public-With SSF-Delay Measure II) and Figure 13 (Private-Without SSF-Delay Measure II VS. Private-With SSF-Delay Measure II). We noticed that in Figure 12, there is a lots overlapping area. As for Figure 13, the delay measure curves barely touches. We then can conclude that in the Private information group, the result is stronger than in the Public information.

A comparison for Private/Public with/without SSF with Delay Measures I, II, and III show a summary of the average, minimum, and maximum values are displayed on Table 18.

Conclusion

When trying to connect this puzzle of ours, we take a simple yet interesting story, and add to it the different players, and agents, to see how these different players and agents interact. We know that the element of time in our story is of essence, and that those with advanced knowledge of a situation, tend to exploit this information to gain an edge. If we look at both sides of the wall we can see that owners want prices to increase, and fear any price decrease. On the flip side, non-owners want to buy, but for a bargain price, as to eke out a profit as best they can. Yet, when we include short sellers in to the market, we can see that the entire situation changes. The notion of buy low to sell high in order to make a profit has transformed to sell high and buy low to make a profit. This interesting point of view is not natural, as one may believe, because it leads to the question of, how you can sell something that you do not own. This research looks at those individuals with the audacity to defy what

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is naturally believed to be the correct way to behave, and turn it on its head. Those who possess this audacity are what we consider sophisticated – having superior knowledge – informed traders. We specifically know that when assets are overpriced, those who bring down the price towards fundamentals are short sellers. If short sellers are informed traders, they possess private information that can be used to gain an advantage over others.

We shed light on the role of the derivatives market, and how the derivatives market behave in ways as to spread news and information about the underlying stocks that the complement. As derivatives behave as a source for protecting wealth, as a source of speculation, and a litmus test of sorts, guiding those who do not poses sophistication to question whether the investment choice they believe is good, is the actual correct one.

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Optimal International Portfolio Strategy:
Utilizing Different Caps Stocks in Emerging and Developed Countries

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Abstract

This research showed that the behavior of returns generated from Large- and Small- Cap stocks are different and should not be ignored by international portfolio investors. We found that Small-Cap markets indices have low correlations with both World market indices and among Small-Cap market indices themselves; while Large-Cap funds have high correlations including amongst each other. Investors can obtain additional gains from international diversification if they consider including Small-Cap stocks in their portfolio, especially in emerging countries.

Keywords: Portfolio, International diversification, Market correlation, Emerging market, Developed market

1. Introduction

With world markets becoming more and more interdependent, international portfolio managers are beginning to look for ways to better diversify away the correlated risk among these interdependent markets. Among many other reasons, portfolio managers prefer Large-Cap stocks as opposed to other smaller cap-sized stocks believing that Large-Cap stocks provide a greater defense against systematic risk. However, if managers believe that correlations between markets are best reduced by Large-Cap stocks, they may be mistaken. This research provides evidence to support the use of Small-Cap stocks for the purpose reducing the correlation between these interdependent markets. This research also finds that the degree of correlation also differ between emerging and developed markets.

1.1 Background

Classic studies of international portfolio diversification have documented that the gains from international diversification was based on the premise that the correlation was relatively lower among international securities than domestic securities Grubel (1968), Levy and Sarnat (1970), and Solnik (1974). Under the structure of international organization such like WTO (World Trade Organization) and NAFTA (North American Free Trade Agreement), international capital markets are integrated more than ever. Gradual liberalization of capital market of emerging countries and their increasing cross border investments and international trades made the global business integration even faster during recent decades. This phenomenon has lead to a dramatic change in correlations between these markets, where in the underpinnings of traditional international portfolio studies must be revised.

Recent studies have raised challenges that higher international correlations clearly throw doubt on the efficiency of international diversification argued by those classic international diversification studies. Longin and Solnik (1995) documented that international stock markets indices correlated among each other have increased between the period of 1960 to 1990. Goetzmann, Li, and Rouwenborst (2005) stated during periods of higher economic and financial integration period that international stock markets tend to have higher correlations than normal times.

Large-Cap stocks have received the lion's share from international investors' diversification portfolios. The bias of Large-Cap stocks was because investors naturally gravitated to stock securities, in particular ones with good reputation as well as large foreign companies that are well known and most likely multinational. Kang and Stulz (1997) in their study of foreigners' equity holdings in Japan found that foreign investors prefer large, export oriented, liquid, and U.S. cross-listed firms. Another study from Ferreira and Matos (2006) showed that institutional investors strongly prefer large and liquid stocks with good governance practices too. Moreover, the same study points out institutional investors who prefer stocks which are cross-listed in the U.S. market and members of the MSCI (Morgan Stanley Capital International) all-country world index. The other factor that reinforces the Large-Cap bias was that most of cross-listed stocks were the Large-Cap stocks, and they also act as a stimulation of international investment. Foerster and Karolyi (1999) documented that the cross-listings of shares were often used by companies in order to enhance the level of investor recognition and expand the shareholder base. In Huberman (2001), the Large-Cap bias mostly acts in accordance with the proposition that

familiarity breeds investment. Domestic institutional investors especially tend to track home stock market, which would build up the Large-Cap bias, since the national market indices are dominated by Large-Cap stocks also.

Returns from Large-Cap stocks are mainly affected by common international factors. On the other hand, returns from Small-Cap stocks are mainly affected by local and idiosyncratic factors. This phenomenon occurs because, Large-Cap companies are more likely to be the international companies with higher chance to be exposed to international customers and be driven by the global trend; while the Small-Cap companies tend to be more locally oriented and with more limited international exposure. Brooks and Del Negro (2006) recent study showed that an increase in the international component of a firm's sales will increase (decrease) the exposure of the firm to global (country-specific) shocks. This finding indicated that multinational firms were more subject to global shocks than locally oriented firms. The benefit of diversification of international portfolios with Large-Cap stocks can be modest since the returns of those companies are primarily affected by common global factors. However, the same result may not be applied to Small-Cap stocks since their returns are mainly affected by local and idiosyncratic factors. Hence, Small-Cap stocks become a potential factor and should be introduced into international portfolio in order to help investors gain more benefit from diversification.

Eun et al (2008) showed that the importance of diversification from Small-Cap stock to the international portfolio investors. On the other hand, from the practical business world point of view, many investment companies-such as Fidelity, ING, Lazard, Merrill Lynch, Morgan Stanley, Oppenheimer, and Templeton-currently offer Small-Cap oriented international mutual

funds in the U.S. In terms of geographical coverage, some funds are global as well as international, while others are regional and national. These recent introductions of international Small-Cap funds are highly instructive and also suggested the unique role that Small-Cap stocks can play in global risk diversification.

The primary purpose of this research is to show that the behavior of returns generated from Large- and Small-Cap stocks are different both in developed and emerging markets, moreover should not be ignored by international portfolio investors.

2. Data and Basic Statistics

In this study, we aim to access the potential benefits that can be gained from diversification of international portfolios if the investors include Small-Cap stocks and Large-Cap stocks.
We study from the perspective of U.S. investors who invest international portfolios with MSCI country or Large-Cap indices but desire to obtain the gain of including Small-Cap market indices from foreign countries.

We considered 7 developed countries: U.S., Canada, Japan, United Kingdom, Germany, France, and Italy, in addition, to 7 emerging countries: China, India, Taiwan, Brazil, Mexico, Russia, and South Africa. Our sample contains one country from Africa, two countries from North America, two from South America, four countries from Asia/Pacific and five from Europe.

We assumed that international investors do not face formal barriers to investing in stocks of these countries. In order to maintain analytical tractability and consistency with industry

practices, we examine the country indices and three market capitalization-based market indices, such as Large, Median and Small-Cap market indices from each country in our sample. In addition, we computed daily returns over most recent 5-year period from September 14, 2007-September 13, 2012. Our research contains two parts. First, we analyzed the difference of behaviors between returns that generated from country indices, Large, Median, and Small-Cap market indices, and we examined the correlation within each other plus their implications for diversification. Second, we applied the mean-variance analysis of international portfolio in introducing cap-based market indices.

From the data, we found that Small-Cap market returns have relatively low correlations with each other than Large-Cap market returns (Table 1: correlations). For example, during our sample period, the results showed that the correlation within the U.S. and U.K. Large-Cap market returns is 0.569 while the correlation between the Small-Cap market returns from those two countries is 0.509. All thirteen counties countries have lower correlations between Small-Cap market returns and U.S. Small-Cap market returns than Large-Cap market returns and U.S. Large-Cap market returns.

Further, the correlation between Large-Cap market returns with the World market returns is relatively higher than the correlation between Small-Cap market returns and the World market returns. For instance (Table 2: Basic Statistics), the correlation between the U.K. Large-Cap market returns with the World market returns is 0.8402, and the correlation between U.K. Small-Cap market returns with the World market returns is 0.7957. As a result, all fourteen countries have higher correlations between Large-Cap market returns and the World market returns than

the correlations between Small-Cap market returns and the World market returns. The same results also indicated for the U.S. Country market returns. From the prospective of U.S. investors, twelve out of thirteen other countries, except Japan, have lower correlations between Small-Cap market returns and U.S. Country market returns than Large-Cap market returns and U.S. Country market returns.

From above, our data result implies that Small-Cap market returns have lower correlations with the World market returns and U.S. Country market returns than Large-Cap and Mid-Cap market returns have with the World and U.S. Country market returns. This indicates that Small-Cap market returns are relatively less affected by global factors than Large and Mid-Cap affected by the same factors.

3. Preliminary Analysis

In order to compare the performance of these cap-base market indices, we obtained the daily MSCI stock market indices of the world and fourteen countries during the period January 2004 to December 2008. We then evaluated the daily return from the indices by using the following formula:

$$R_t = \frac{Index_t - Index_{t-1}}{Index_{t-1}}$$

We also assumed that in these fourteen countries we studied the investors would not have to face any interruptions such as government, politics, personal, or closed market.

We calculated the mean, standard deviation, skewness, and kurtosis of daily returns for each cap-based market indices and the correlation of cap-based market returns with U.S. Country market returns (corr us) and with World market returns (corr w). In the results showed in Table 2, we noticed that six out of seven developed countries, except Italy, have average returns from Large-Cap market higher than Small-Cap market.

As for the volatility, thirteen out of fourteen countries, except US, the Small-Cap market returns have lower volatility than the Large-Cap market returns. Among all the Large-Cap market returns, the lowest volatility is computed from the U.S. market indices. This is because that the U.S. has the largest stock market and the returns are usually computed in U.S. dollars terms. As for the Mid-Cap market returns, there is one developed countries, Japan, and none emerging countries that have lower volatility than the U.S. Mid-Cap market. Among the Small-Cap markets indices, four developed countries (Japan, UK, France, and Italy) and three emerging countries (China, Taiwan, and South Africa) that have lower volatility than U.S. Small-Cap market returns.

We also noticed that in most countries, the Large-Cap market returns have the highest correlation with the U.S. countries market indices (corr us), while the Mid-Cap next and the Small-Cap have the lowest correlation. Using Canada as an example, the correlation is 0.741 from Large-Cap market returns with U.S. country market returns, 0.681 from the Mid-Cap market returns and 0.634 from the Small-Cap market returns. One exception is Japan. The correlations between Japan and the U.S. country market indices are very low, regardless if it is from the Large-Cap market returns (0.006), Mid-Cap market returns (0.021), or Small-Cap market returns (0.006).

The correlations between US Country market returns and Small-Cap market returns of these two countries still have lower correlations with U.S. Country market returns than the Large-Cap market returns.

As for the correlations with the World market returns, we denoted as "corr W", a similar result appeared. Twelve out of fourteen countries, except the U.S. and Japan, have the highest correlation from Large-Cap market returns. We can conclude that all the countries, no matter developed or emerging countries, Small-Cap market returns have lower correlations with U.S. Country market returns or the World market returns than Large-Cap market returns, except Japan.

4. Methodology and Results

4.1 Mean-Variance Spanning Tests: Do Small-Caps Act Differently from Large-Caps?

We first constructed a hypothesis test to check if the Small-Cap market returns can be spanned by all MSCI country indices by three groups; first group contains seven developed countries, second group for seven emerging countries, and the last group contains all fourteen countries.

After the spanning test, we then examined the returns that generating from market-based indices and their risks affected by factors of global, local or Idiosyncratic.

Even though most countries with the Small-Cap market returns have lower correlations with U.S. Country market returns or World market returns compared with the Large-Cap market returns, the Small-Cap market returns may still be spanned by the countries market returns. If that is true, then the gain of diversification of introducing Small-Cap market returns into the

international portfolio will be less significant. On the other hand, if the spanning test has been rejected, then introducing Small-Cap market returns may improve the minimum-variance frontier base international portfolio.

Using the study by Huberman and Kandel (1987) and Kan and Zhou (2008), we constructed a spanning test to examine of Small-Cap market returns can be spanned by MSCI country indices or not. In order to do so, we built a regression model of the Small-Cap market returns ("new risk asset") on the MSCI countries indices ("benchmark assets") as following in three groups, seven developed countries, seven emerging countries, and all fourteen countries:

i. $\quad R_i = \alpha_i + \beta_i^{CA} MSCI^{CA} + \cdots + \beta_i^{US} MSCI^{US} + \varepsilon_i$

ii. $\quad R_i = \alpha_i + \beta_i^{BZ} MSCI^{BZ} + \cdots + \beta_i^{TW} MSCI^{TW} + \varepsilon_i$

iii. $\quad R_i = \alpha_i + \beta_i^{CA} MSCI^{CA} + \cdots + \beta_i^{TW} MSCI^{TW} + \varepsilon_i$

where R_i represent the return computed from Small-Cap market returns of the i-th country, $MSCI^{CA}$ ($MSCI^{BZ}$) denotes the return on the MSCI Canada (Brazil) country index, α_i represent the estimated regression intercept of the Small-Cap market returns, and β_i^{CA} (β_i^{BZ}) is the estimated regression coefficient associated with MSCI Canada (MSCI Brazil).

The null hypothesis of the spanning test is equivalent to the joint hypothesis that the regression intercept is equal to zero and the sum of all the regression coefficients is equal to one:

$$\alpha_i = 0, \quad and \sum_i \beta_i = 1$$

We assumed that the null hypothesis is true, $\sum_i \beta_i = 1$, then we constructed a reduced model by substituting the last beta by one subtract all the other betas. Then we can rewrite the model to become:

i. $R_i = \alpha_i + \beta_i^{CA} MSCI^{CA} + \cdots + (1 - \beta_i^{CA} - \cdots - \beta_i^{UK}) MSCI^{USA} + \varepsilon_i$

ii. $R_i = \alpha_i + \beta_i^{BZ} MSCI^{BZ} + \cdots + (1 - \beta_i^{BZ} - \cdots - \beta_i^{SA}) MSCI^{TW} + \varepsilon_i$

iii. $R_i = \alpha_i + \beta_i^{CA} MSCI^{CA} + \cdots + (1 - \beta_i^{CA} - \cdots - \beta_i^{SA}) MSCI^{TW} + \varepsilon_i$

After removed the parenthesis and combine the like terms, the model then become:

i. $R_i - MSCI^{US} = \alpha_i + \beta_i^{CA}(MSCI^{CA} - MSCI^{US}) + \cdots + \beta_i^{UK}(MSCI^{UK} - MSCI^{US}) + \varepsilon_i$

ii. $R_i - MSCI^{TW} = \alpha_i + \beta_i^{BZ}(MSCI^{BZ} - MSCI^{TW}) + \cdots + \beta_i^{SA}(MSCI^{SA} - MSCI^{TW}) + \varepsilon_i$

iii. $R_i - MSCI^{TW} = \alpha_i + \beta_i^{CA}(MSCI^{CA} - MSCI^{TW}) + \cdots + \beta_i^{SA}(MSCI^{SA} - MSCI^{TW}) + \varepsilon_i$

Since here we only considered one "new risk asset" which is the Small-Cap market returns, the test statistics of exact distribution of the Likelihood ratio test under the null hypothesis is as the following:

$$HK = \left(\frac{1}{V} - 1\right)\left(\frac{T - K - 1}{2}\right)$$

We let V denote the ratio of the determinant of the maximum likelihood estimator of the error covariance matrix for the unrestricted model (no spanning) to that of the restricted model (spanning). T is the number of observations and K is the number of benchmark assets. The test statistic follows an F distribution with (2, T-K-1) degree of freedom. Result showed in Table 3. To compute the V we used the formula as following:

$$V = \frac{\sum_{i=1}^{n}(residuals\ from\ the\ unrestricted\ model)^2}{\sum_{i=1}^{n}(residuals\ from\ the\ restricted\ model)^2}$$

.

We found that in the first group, we rejected the null hypothesizes of the spanning tests for six out of seven developed countries, except Germany, where the p-value is 0.58. Similar results appears in the second group; the p-values of the spanning test for all the seven emerging countries are all approximately approach zero. As for the third group, we then used all the fourteen countries market indices to be the benchmark assets. The results as we expected, like the combination of the first and the second group, we reject all the spanning tests except for Germany.

From previous discussion, we know that most countries have lower correlation between Small-Cap market returns and U.S. Country market returns or World market returns than Large-Cap market returns. And the result of spanning tests showed that the Small-Cap market returns cannot be spanned by the countries indices. If an investor chooses portfolios based on mean and variance, then the question becomes whether adding a new set of risky assets can allow the investor to improve the minimum-variance frontier from a given set of risky assets.

4.2 Return-Generating Mechanism for the Cap-based indices

In order to catch the behavior of the returns generated from the market based indices more precisely, we extended the research to factors of global, local, and idiosyncratic, which affect the cap-based market indices.

We constructed a two factor regression model to estimate the coefficients of global and the country indices for the Small-Cap market returns of each country as following:

$$R_i = \alpha_i + \beta_i^W R^W + \beta_i^C R_i^C + \varepsilon_i$$

We let R_i represent the daily return on the from the i-th country, R^W is the daily return on the MSCI the World market index, and R_i^C is the portion of the i-th country market index return that is uncorrelated to the return on the global market portfolio; which means that R_i^C is the residual from regressing the i-th country market index return on the MSCI World market index return. β_i^W and β_i^C in equation above denote the coefficients of global and orthogonalized country for the i-th country. In this model, we then can estimate the sensitivities of returns of the cap-based market indices to the global and country-specific factors. Once the coefficients of global and country have been measured, we then decomposed the variance of the cap-based market returns into the following three portions, the portion of the variance attributed to the global factor, the portion attributed to the country factor, and the idiosyncratic risk of the cap-based market returns, which is uncorrelated to either global or country factor. We computed the three proportions of the variance by the following formulas:

(i) Global factor proportion $= \dfrac{\left(\beta_i^W\right)^2 Var(R^W)}{Var(R_i)}$

(ii) Local factor proportion $= \dfrac{\left(\beta_i^C\right)^2 Var(R_i^C)}{Var(R_i)}$

(iii) Idiosyncratic factor proportion $= \dfrac{Var(\varepsilon_i)}{Var(R_i)}$

We showed the result of the two factor regressions in Table 4 including the estimate coefficients of the global and country factors and the portions of the variance of the cap-base market returns. We noticed that all the cap-based market returns in the sample have the statistically significant coefficients of World and country factor, which confirms that the global and the country factor do affect the cap-base market returns.

However, nine out of fourteen countries have highest coefficients from Large-Cap market returns; then followed by the coefficients from Mid-Cap market returns. The coefficients from Small-Cap market returns are the lowest. For example, Canada has the coefficients of the global (country) factor of 1.203 (1.013) for the Large-Cap market return, 1.098 (0.915) for the Mid-Cap market returns, and 1.139 (0.902) for the Small-Cap market returns. Five exceptions are U.K., U.S. Germany, Mexico and Taiwan. For U.S., the coefficients of the global (country) factor is 1.013 (0.995) for the Large-Cap market return, 1.170 (1.047) for the Mid-Cap market returns, and 1.181 (1.155) for the Small-Cap market returns. In the last three rows of the table, the sample average of the coefficient of the global (country) is 1.061 (1.014) for the Large-Cap market returns, 1.013 (0.887) for the Mid-Cap market returns, and 0.882 (0.780) for the Small-Cap market returns.

The result for variance decompositions, the proportions of the variance for the global, country, and the idiosyncratic factors, are things of noteworthy. Regardless of the country and the market-Cap categories, the idiosyncratic factors proportion is lowest compared with the global and country factors proportions. For example, U.S. Large-Cap (Small-Cap) market returns has the global factors proportion is 78.6% (72.1%), country factors proportion is 21.2% (19.4%), and the

idiosyncratic factors proportion 0.2% (8.5%). However, by comparing with the Large-Cap market returns within the same country, Small-Cap market returns have larger idiosyncratic factors proportion. From the data, we noticed that the Small-Cap market returns has the largest sample average of the proportion for the idiosyncratic factors, which is 18.4%, followed by the Mid-Cap market returns, 13%, and Large-Cap market returns has the lowest one, 0.3%, among these three market-Cap categories. We then conclude that the Small-Cap market returns are driven more by the idiosyncratic factors than the Large-Cap market returns.

The average global (country) factors proportion is 51.2% (48.5%) for Large-Cap market returns, 47.8% (39.2%) for the Mid-Cap market returns, and 45.6% (36.0%) for the Small-Cap market returns. T shows that among three market-Cap categories, both global and country factors have similar proportions. We also noticed an interesting phenomenon; if we divide the countries in our sample into two groups, developed and emerging countries, we found that in all developed countries in our sample, except Japan, the global factors proportion is higher than the country factors proportion. Using Canada Large-Cap market returns as an example, the global factors proportion is 72.1%, which is higher than the country factors proportion, 27.6%. However, only two out of seven developed countries have the higher global factors proportion than country factors proportion, which means that the cap-based market returns in emerging countries are not driven by the global trend as much as in developed countries. This result may occur because the companies in emerging countries are not exposed to international customers as much as the ones in developed countries.

4.3 Diversification of International Portfolio with Country Market Indices

In order to assess the benefit of diversification of international portfolio with Small-Cap market indices, it would be useful to examine the benchmark case of international portfolio with the country market indices. We used the data of the MSCI country stock market indices of two groups, developed countries and emerging countries, over 2008 to build a portfolio based on minimum variance frontier.

We can see the result in Table 5 that the highest of the correlations in the group of developed countries is 0.9587, from France and Italy, and the highest of the correlations in the group of emerging countries is 0.8482, from Mexico and Brazil. This reflects that the neighboring market tend to have high correlations with each other. Japan and U.S. have the correlation is -0.0022 which is the lowest in the developed group; this may be due to the insular economy of Japan.

During our 2008 sample period, the average for the sample mean of country market daily returns is 0.00264 for the developed countries group, 0.00379 for the emerging countries group, and the average of the standard deviation is 0.02745 and 0.03529 for developed and emerging countries. We can conclude that emerging countries markets are high-risk and high-return markets. The last two columns shows the optimal asset allocation of international portfolios contain the MSCI countries daily returns, developed and emerging countries. With short-sales, the developed (emerging) group have the portfolio expected return is 0.002 (0.002) and the standard deviation is 0.017 (0.018). This result suggests that investors should choose the international portfolio of the developed countries instead of the emerging countries. Without short-sales, the optimal portfolio for the developed countries consists of the investing 43.41% in the U.S., 47.48% in Japan, and 9.20% in Italy, with an expected return of 0.002 and the standard deviation of 0.017. As for the emerging countries, the optimal portfolio suggests to invest 10.55% in India, 59.53%

in Taiwan, and 29.92% in Mexico, with higher expected return of 0.003 and also a higher risk of 0.020.

4.4 The Optimal International Portfolio Allocation

In order to assess the potential gain of diversification by including the cap-base market returns, we build international portfolio with the MSCI country and Cap-based market daily returns in Markowitz model; results are presented in Table 6 (developed countries) and Table 7 (emerging countries). In Panel A of Table 6 and 7, we copy the result of the optimal portfolio of countries daily returns from previous section for comparison. Then, we compute the optimal global allocation with MSCI countries market daily returns and Small-Cap market daily returns, in Panel B. With short-sales not allowed in the developed countries group, the result suggests to invest 22.69% in U.S. Country market, 5.58% in U.S. Small-Cap market, 46.78% in Japan Small-Cap market, and 24.96% in Italy Small-Cap market. By comparing with the portfolio only contains countries market returns and the portfolio with the country and the Small-Cap market returns, we shift about 77% of the investment from the country market to the Small-Cap market to gain the benefit of reduction risk from 0.017 to 0.016. As for the emerging group, optimal portfolio consists of investing 15.9% in Taiwan Country market, 17.51% in China Small-Cap market, 5.11% in India Small-Cap market, 9.26% in Taiwan Small-Cap market, 27.49% in Mexico Small-Cap market, and 24.74% in Russia Small-Cap market. We enhance the expected return from 0.003 to 0.005, and reduce the risk from 0.020 to 0.017 by investing about 84% in the Small-Cap markets. In Panel C, with countries and Mid-Cap market returns, the optimal portfolio of developed countries consist of investing 27.45% in U.S. Country market and shift 40.07% to Japan Mid-Cap market and 30.48% to Italy Mid-Cap market to reduce the risk to

0.016. As for the emerging countries, we only invest 12.05% to India Mid-Cap markets; remain about 88% in country markets, 58.52% in Taiwan country market, 5% in Brazil country market, and 29.44% in Mexico country market. The expected return and risk are about the same as the portfolio of only country markets. This result implies that the portfolio of emerging countries introducing Small-Cap markets can improve the return and risk more than introducing the Mid-Cap markets. In Panel D, we include not only Small-Cap but also the Mid-Cap market returns in the portfolio along with the country market returns, the result for the developed countries showed that 19.43% in U.S. Country market, 29.02% in Italy Mid-Cap market, and more than 50% in the Small-Cap markets (5.12% in US Small-Cap and 46.44% in Japan Small-Cap). By this optimal portfolio, we can reduce the risk to 0.015. As for the emerging countries, optimal global allocation consists of investing 15.9% in Taiwan country market, 84.1% Small-Cap markets, and none of the Mid-Cap in the emerging countries be selected, which provides identical result to the portfolio that contain only country market returns and Small-Cap markets returns. The optimal allocation with short-sales, regardless of developed or emerging countries, Mid-Cap markets receive much more negative weight than Small-Cap markets. Also, by comparing the result for developed countries and emerging countries, Table 6 and Table 7, improvement level of introduction Small-Cap market into the portfolio for the emerging countries is higher than for the developed countries. In other words, the Small-Cap markets in emerging countries might be more independent of the global trend.

In order to observe the international market better, regardless of developing level, we then built an international portfolio, include all the developed countries, and all the emerging countries together. The result of optimal allocation is showed in Table 8. Without short sales, the

international portfolio with only country market indices, expect daily return is 0.002% while the risk is 0.014%. With the Small-Cap market in the portfolio as well, expect daily return can be improved to 0.003% and risk can be reduced to 0.009%, by shifting the 41% of weight to developed Small-Cap markets and 32% weight to emerging Small-Caps. The benefit of inducing the Mid-Cap markets into the portfolio is not as good as inducing Small-Cap markets. Expect return of the portfolio with Mid-Cap market returns remains the same as the basic portfolio with only countries markets; and risk only reduce from 0.017% to 0.016% by shifting 56% of weight to developed Mid-Cap markets and none for the emerging Mid-Cap markets. Similar result as we separated the developed and the emerging countries, included the more benefit can be gained by including Small-Cap markets than Mid-Cap markets or with the country market returns only.

5. Conclusion

World markets are becoming more and more globalized and interdependent, and this interdependence has increased the correlations between these markets. International portfolio managers seek to find ways to better diversify away the correlated risk among these interdependent markets. Small-Cap stocks that have limited international footprints tend to reflect local risks, and therefore share less of a correlation with Large-Cap stocks that share systemic ties to other international firms.

These results are particularly important to international portfolio managers as it provides an alternative investment strategy. Small-Cap stocks are relatively isolated from the broader market, and as such provide a damper to any systemic or systematic contingencies that diminish optimum portfolio performance. If international portfolio managers believe that correlations between

markets are best reduced by Large-Cap stocks, they may be mistaken. We examined the potential gain of introducing Small-Cap stocks as a vehicle for diversification of international portfolios. We found that Small-Cap markets have lower correlations not only with World market returns but also with each other. In contrast, Large-Cap funds tend to have relatively high correlations with World market returns and with each other, due to the common exposures to international investors. We also found that thirteen out of fourteen Small-Cap markets cannot be 'spanned' by country stock market indices that are dominated by Large-Cap stocks.

Our results also indicate that the optimal portfolio only contains country indices and Small-Cap markets. When short sales are allowed, Mid-Cap funds tend to receive negative weights, allowing extra positive investments in Small-Cap funds and selective country indices. Overall, our findings indicate that investors can obtain additional gains from international diversification if they consider including Small-Cap stocks, especially in emerging countries.

6. Discussion and Further Research

There are potential study issues in this area for future researchers: how Small-Cap stocks act in international diversification during financial crisis period and the characteristics/function changing of Small-Cap stocks in international portfolio during recent decade. It will be substantial importance for international investment study to further learn about the behavior of these Small-Cap stocks and build up a better return portfolio diversification by holding these Small-Cap stocks.

Table1: Correlations

Correlations within country market returns													
	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S. AFRICA	TAIWAN
CANADA	1.000	0.711	0.704	0.672	0.212	0.726	0.736	0.756	0.375	0.389	0.724	0.627	0.640	0.313
FRANCE	0.711	1.000	0.952	0.948	0.226	0.917	0.587	0.711	0.411	0.454	0.719	0.682	0.767	0.330
GERMANY	0.704	0.952	1.000	0.905	0.211	0.880	0.618	0.710	0.410	0.456	0.722	0.678	0.750	0.319
ITALY	0.672	0.948	0.905	1.000	0.210	0.857	0.547	0.651	0.362	0.434	0.669	0.642	0.719	0.284
JAPAN	0.212	0.226	0.211	0.210	1.000	0.240	0.008	0.144	0.527	0.252	0.104	0.287	0.312	0.516
UK	0.726	0.917	0.880	0.857	0.240	1.000	0.575	0.728	0.446	0.472	0.718	0.695	0.769	0.344
USA	0.736	0.587	0.618	0.547	0.008	0.575	1.000	0.701	0.246	0.320	0.742	0.450	0.421	0.161
BRAZIL	0.756	0.711	0.710	0.651	0.144	0.728	0.701	1.000	0.449	0.418	0.817	0.630	0.660	0.299
CHINA	0.375	0.411	0.410	0.362	0.527	0.446	0.246	0.449	1.000	0.586	0.414	0.499	0.504	0.630
INDIA	0.389	0.454	0.456	0.434	0.252	0.472	0.320	0.418	0.586	1.000	0.426	0.460	0.487	0.416
MEXICO	0.724	0.719	0.722	0.669	0.104	0.718	0.742	0.817	0.414	0.426	1.000	0.590	0.647	0.267
RUSSIA	0.627	0.682	0.678	0.642	0.287	0.695	0.450	0.630	0.499	0.460	0.590	1.000	0.719	0.404
S. AFRICA	0.640	0.767	0.750	0.719	0.312	0.769	0.421	0.660	0.504	0.487	0.647	0.719	1.000	0.414
TAIWAN	0.313	0.330	0.319	0.284	0.516	0.344	0.161	0.299	0.630	0.416	0.267	0.404	0.414	1.000

Correlations within Large Cap market returns													
	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S. AFRICA	TAIWAN
CANADA	1.000	0.699	0.691	0.666	0.207	0.717	0.733	0.749	0.367	0.382	0.716	0.618	0.631	0.305
FRANCE	0.699	1.000	0.945	0.947	0.219	0.911	0.581	0.704	0.402	0.448	0.708	0.674	0.755	0.325
GERMANY	0.691	0.945	1.000	0.897	0.204	0.868	0.614	0.700	0.402	0.449	0.711	0.668	0.734	0.311
ITALY	0.666	0.947	0.897	1.000	0.213	0.854	0.539	0.647	0.360	0.433	0.660	0.641	0.710	0.286
JAPAN	0.207	0.219	0.204	0.213	1.000	0.238	0.003	0.142	0.522	0.254	0.093	0.289	0.305	0.517
UK	0.717	0.911	0.868	0.854	0.238	1.000	0.569	0.723	0.442	0.468	0.706	0.688	0.758	0.340
USA	0.733	0.581	0.614	0.539	0.003	0.569	1.000	0.692	0.245	0.321	0.735	0.441	0.413	0.155
BRAZIL	0.749	0.704	0.700	0.647	0.142	0.723	0.692	1.000	0.450	0.416	0.811	0.625	0.655	0.299
CHINA	0.367	0.402	0.402	0.360	0.522	0.442	0.245	0.450	1.000	0.587	0.408	0.498	0.491	0.621
INDIA	0.382	0.448	0.449	0.433	0.254	0.468	0.321	0.416	0.587	1.000	0.425	0.459	0.480	0.418
MEXICO	0.716	0.708	0.711	0.660	0.093	0.706	0.735	0.811	0.408	0.425	1.000	0.581	0.636	0.264
RUSSIA	0.618	0.674	0.668	0.641	0.289	0.688	0.441	0.625	0.498	0.459	0.581	1.000	0.715	0.402
S. AFRICA	0.631	0.755	0.734	0.710	0.305	0.758	0.413	0.655	0.491	0.480	0.636	0.715	1.000	0.409
TAIWAN	0.305	0.325	0.311	0.286	0.517	0.340	0.155	0.299	0.621	0.418	0.264	0.402	0.409	1.000

Correlations within Mid-Cap market returns													
	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S. AFRICA	TAIWAN
CANADA	1.000	0.724	0.728	0.641	0.221	0.717	0.720	0.714	0.368	0.374	0.669	0.567	0.608	0.319
FRANCE	0.724	1.000	0.928	0.897	0.256	0.899	0.594	0.685	0.422	0.442	0.684	0.605	0.755	0.326
GERMANY	0.728	0.928	1.000	0.840	0.232	0.876	0.595	0.679	0.413	0.448	0.668	0.617	0.746	0.335
ITALY	0.641	0.897	0.840	1.000	0.174	0.799	0.548	0.608	0.323	0.396	0.623	0.529	0.668	0.237
JAPAN	0.221	0.256	0.232	0.174	1.000	0.237	0.030	0.144	0.496	0.230	0.161	0.241	0.304	0.471
UK	0.717	0.899	0.876	0.799	0.237	1.000	0.585	0.685	0.422	0.438	0.677	0.604	0.759	0.327
USA	0.720	0.594	0.595	0.548	0.030	0.585	1.000	0.682	0.215	0.279	0.666	0.455	0.425	0.171
BRAZIL	0.714	0.685	0.679	0.608	0.144	0.685	0.682	1.000	0.380	0.383	0.721	0.542	0.613	0.266
CHINA	0.368	0.422	0.413	0.323	0.496	0.422	0.215	0.380	1.000	0.498	0.381	0.449	0.491	0.618
INDIA	0.374	0.442	0.448	0.396	0.230	0.438	0.279	0.383	0.498	1.000	0.362	0.386	0.457	0.359
MEXICO	0.669	0.684	0.668	0.623	0.161	0.677	0.666	0.721	0.381	0.362	1.000	0.528	0.594	0.252
RUSSIA	0.567	0.605	0.617	0.529	0.241	0.604	0.455	0.542	0.449	0.386	0.528	1.000	0.588	0.366
S. AFRICA	0.608	0.755	0.746	0.668	0.304	0.759	0.425	0.613	0.491	0.457	0.594	0.588	1.000	0.373
TAIWAN	0.319	0.326	0.335	0.237	0.471	0.327	0.171	0.266	0.618	0.359	0.252	0.366	0.373	1.000

Correlations withinSmall-Cap market returns													
	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S. AFRICA	TAIWAN
CANADA	1.000	0.736	0.745	0.681	0.212	0.725	0.630	0.738	0.373	0.398	0.698	0.515	0.665	0.324
FRANCE	0.736	1.000	0.955	0.921	0.257	0.887	0.526	0.713	0.435	0.473	0.698	0.611	0.771	0.354
GERMANY	0.745	0.955	1.000	0.906	0.232	0.884	0.558	0.729	0.417	0.470	0.717	0.598	0.772	0.336
ITALY	0.681	0.921	0.906	1.000	0.203	0.829	0.501	0.675	0.359	0.442	0.678	0.582	0.727	0.293
JAPAN	0.212	0.257	0.232	0.203	1.000	0.233	-0.008	0.172	0.456	0.219	0.092	0.167	0.271	0.392
UK	0.725	0.887	0.884	0.829	0.233	1.000	0.509	0.702	0.427	0.459	0.680	0.617	0.759	0.343
USA	0.630	0.526	0.558	0.501	-0.008	0.509	1.000	0.579	0.160	0.257	0.673	0.345	0.392	0.154
BRAZIL	0.738	0.713	0.729	0.675	0.172	0.702	0.579	1.000	0.392	0.419	0.742	0.512	0.675	0.314
CHINA	0.373	0.435	0.417	0.359	0.456	0.427	0.160	0.392	1.000	0.508	0.367	0.408	0.456	0.600
INDIA	0.398	0.473	0.470	0.442	0.219	0.459	0.257	0.419	0.508	1.000	0.404	0.416	0.458	0.372
MEXICO	0.698	0.698	0.717	0.678	0.092	0.680	0.673	0.742	0.367	0.404	1.000	0.510	0.629	0.260
RUSSIA	0.515	0.611	0.598	0.582	0.167	0.617	0.345	0.512	0.408	0.416	0.510	1.000	0.562	0.368
S. AFRICA	0.665	0.771	0.772	0.727	0.271	0.759	0.392	0.675	0.456	0.458	0.629	0.562	1.000	0.358
TAIWAN	0.324	0.354	0.336	0.293	0.392	0.343	0.154	0.314	0.600	0.372	0.260	0.368	0.358	1.000

Table2: Basic Statistics and Correlations with World and Country Markets

	Mean	Variance	Skewness	Kurtosis	Corr World	Corr USA
CANADA Large Core	0.0001	0.0004	-0.4411	6.3502	0.84892	0.74093
FRANCE Large Core	-0.0001	0.0005	0.3548	4.7155	0.85053	0.58475
GERMANY Large Core	0.0000	0.0004	0.2762	4.3027	0.85298	0.61633
ITALY Large Core	-0.0004	0.0006	0.3025	4.0174	0.80112	0.54306
JAPAN Large Core	-0.0002	0.0003	0.0810	5.6264	0.27552	0.00554
UK Large Core	0.0000	0.0004	0.2270	6.8691	0.84021	0.57201
USA Large Core	0.0001	0.0003	0.0025	7.6896	0.88681	0.9992
BRAZIL Large Core	0.0003	0.0007	0.1162	7.8772	0.80309	0.69892
CHINA Large Core	0.0001	0.0005	0.3698	5.9265	0.46094	0.24832
INDIA Large Core	0.0001	0.0005	0.6303	9.2557	0.47874	0.32375
MEXICO Large Core	0.0003	0.0004	0.3146	7.0648	0.81613	0.74017
RUSSIA Large Core	0.0002	0.0009	0.2820	13.5729	0.66046	0.44683
S. AFRICA Large Core	0.0004	0.0005	0.0763	3.6848	0.68341	0.41887
TAIWAN Large Core	0.0001	0.0003	0.0168	2.2225	0.36232	0.16176

	Mean	Variance	Skewness	Kurtosis	Corr World	Corr USA
CANADA Mid Core	0.0003	0.0004	-0.3885	4.3422	0.8213	0.6806
FRANCE Mid Core	0.0000	0.0004	-0.1217	2.5456	0.8442	0.5799
GERMANY Mid Core	-0.0002	0.0006	-0.1166	4.7917	0.8280	0.5745
ITALY Mid Core	-0.0005	0.0004	0.0083	1.7524	0.7683	0.5400
JAPAN Mid Core	-0.0001	0.0002	0.0087	6.1142	0.2769	0.0217
UK Mid Core	0.0000	0.0004	0.0116	3.4571	0.8303	0.5677
USA Mid Core	0.0002	0.0003	-0.2056	5.2427	0.8870	0.9816
BRAZIL Mid Core	0.0003	0.0006	-0.0122	8.9072	0.7769	0.6734
CHINA Mid Core	-0.0002	0.0004	-0.2713	3.8779	0.4198	0.1983
INDIA Mid Core	0.0003	0.0005	0.2138	7.0326	0.4245	0.2732
MEXICO Mid Core	0.0004	0.0006	-0.1724	10.2644	0.7618	0.6540
RUSSIA Mid Core	0.0001	0.0010	0.5144	10.5074	0.6073	0.4360
S. AFRICA Mid Core	0.0003	0.0004	-0.2882	4.7644	0.6766	0.4095
TAIWAN Mid Core	-0.0001	0.0004	-0.2705	1.7687	0.3372	0.1478

	Mean	Variance	Skewness	Kurtosis	Corr World	Corr USA
CANADA Small Core	0.0002	0.0004	-0.3740	4.4471	0.8034	0.6339
FRANCE Small Core	0.0000	0.0004	-0.2106	2.3915	0.8162	0.5367
GERMANY Small Core	0.0001	0.0004	0.0615	3.2979	0.8349	0.5684
ITALY Small Core	-0.0006	0.0004	-0.0725	1.5438	0.7731	0.5129
JAPAN Small Core	0.0000	0.0002	-0.2199	6.8838	0.2352	0.0064
UK Small Core	0.0001	0.0003	-0.2165	2.6610	0.7957	0.5210
USA Small Core	0.0003	0.0004	-0.2072	3.5722	0.8490	0.9567
BRAZIL Small Core	0.0005	0.0005	-0.5426	8.5110	0.7660	0.6091
CHINA Small Core	-0.0001	0.0003	-0.5348	3.1627	0.3762	0.1613
INDIA Small Core	-0.0001	0.0004	-0.1266	5.5423	0.4265	0.2749
MEXICO Small Core	0.0000	0.0004	-0.5322	5.5053	0.7867	0.6843
RUSSIA Small Core	-0.0004	0.0005	-0.4425	4.1952	0.5232	0.3260
S. AFRICA Small Core	0.0002	0.0003	-0.4270	5.2475	0.6774	0.3943
TAIWAN Small Core	0.0000	0.0003	-0.4335	2.1066	0.3225	0.1474

Table 3: Spanning Test Results

estimated beta	Constant	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	HK	P-values
CANADA SM	0.0001296	**0.90941**	0.05228	0.01962	0.01186	**0.02671**	0.08051	**-0.14957**	4.2497	**0.0144**
FRANCE SM	0.0001156	**0.09269**	**0.57699**	**0.18633**	0.04757	**0.11289**	-0.0282	**-0.06824**	12.1865	**0.0000**
GERMANY SM	0.0002009	**0.08223**	**0.43945**	**0.30969**	0.04149	**0.08828**	0.0833	-0.02581	0.5512	0.5759
ITALY SM	-0.0003248	**0.03718**	**0.1325**	**0.17991**	**0.53186**	0.05667	**-0.072**	**-0.04398**	50.6414	**0.0000**
JAPAN SM	0.0000784	-0.00503	0.03459	**0.05264**	-0.07751	**0.846434**	-0.05165	0.02967	84.7137	**0.0000**
UK SM	0.0001081	**0.04925**	0.03874	0.05187	0.02015	**0.08196**	**0.72613**	-0.04435	10.3944	**0.0000**
USA SM	0.0001977	**0.05096**	0.06624	**-0.0804**	**0.05295**	-0.01525	-0.0849	**1.12555**	34.8080	**0.0000**

estimated beta	Constant	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S.AFRICA	TAIWAN	HK	P-values
BRAZIL SM	0.0002904	**0.62633**	-0.0062	**0.03371**	0.01682	**0.03107**	0.09936	0.02882	48.9755	**0.0000**
CHINA SM	-0.0001003	-0.02663	**0.5801**	0.00916	0.00859	-0.01851	-0.00092	**0.16346**	138.3800	**0.0000**
INDIA SM	-0.0001956	0.00318	**0.04119**	**0.83972**	0.00571	0.02264	**-0.06206**	-0.00658	41.0005	**0.0000**
MEXICO SM	-0.0002248	0.00457	-0.01073	**0.03309**	**0.77364**	**0.02393**	0.0174	**0.03597**	27.2445	**0.0000**
RUSSIA SM	-0.0005269	**-0.06745**	**-0.08151**	0.10493	0.07013	**0.54288**	0.01243	**0.14974**	41.5982	**0.0000**
S.AFRICA SM	0.0000098	-0.01593	**0.03289**	**0.026**	**0.05315**	0.010588	**0.62714**	0.02798	174.4330	**0.0000**
TAIWAN SM	-0.0000027	0.02855	-0.01523	0.02249	-0.02665	**0.02903**	-0.05657	**0.93268**	13.5728	**0.0000**

estimated beta	Constant	CANADA	FRANCE	GERMANY	ITALY	JAPAN	UK	USA	BRAZIL	CHINA	INDIA	MEXICO	RUSSIA	S.Africa	TAIWAN	HK	P-values
CANADA SM	0.000	**0.862**	0.021	-0.004	0.030	0.013	0.025	**-0.195**	**0.081**	-0.024	**0.041**	0.033	-0.002	0.028	**0.039**	4.098	**0.017**
FRANCE SM	0.000	**0.068**	**0.568**	**0.157**	**0.055**	**0.074**	**-0.075**	**-0.077**	0.005	0.000	**0.059**	0.022	**0.020**	0.020	**0.044**	5.947	**0.003**
GERMANY SM	0.000	**0.054**	**0.424**	**0.273**	0.050	**0.044**	0.025	-0.038	-0.007	0.016	**0.054**	**0.050**	0.014	**0.048**	**0.031**	2.068	0.126
ITALY SM	0.000	0.018	**0.127**	**0.157**	**0.530**	**0.044**	**-0.110**	**-0.068**	-0.002	-0.019	**0.059**	**0.054**	0.014	0.014	0.018	35.499	**0.000**
JAPAN SM	0.000	-0.005	0.029	**0.065**	-0.079	**0.881**	-0.043	0.002	**0.034**	**-0.021**	-0.005	0.020	**-0.029**	-0.003	**-0.027**	82.405	**0.000**
UK SM	0.000	0.026	0.030	0.018	0.020	**0.043**	**0.684**	-0.035	**-0.041**	-0.020	**0.048**	0.043	0.045	**0.032**	0.062	3.056	**0.047**
USA SM	0.000	**0.036**	0.047	**-0.088**	0.058	-0.026	-0.095	**1.116**	-0.013	**-0.035**	-0.001	0.048	0.013	0.011	**0.064**	41.713	**0.000**
BRAZIL SM	0.000	**-0.046**	-0.007	-0.004	**0.077**	0.039	0.078	**-0.083**	**0.643**	-0.018	**0.030**	0.036	0.020	0.036	0.023	28.910	**0.000**
CHINA SM	0.000	**0.059**	0.056	-0.030	0.061	**0.049**	-0.046	**-0.093**	-0.023	**0.570**	0.012	0.028	**-0.029**	**-0.048**	**0.146**	77.909	**0.000**
INDIA SM	0.000	0.040	-0.020	**0.114**	-0.022	**0.048**	-0.052	**-0.080**	0.010	0.025	**0.846**	0.028	0.017	**-0.089**	-0.022	22.606	**0.000**
MEXICO SM	0.000	0.022	-0.011	0.017	**0.102**	-0.013	0.019	0.024	-0.020	0.010	0.019	**0.722**	0.004	-0.028	**0.038**	9.159	**0.000**
RUSSIA SM	0.000	-0.024	-0.142	**0.317**	**0.137**	**-0.071**	-0.089	**-0.129**	-0.056	-0.050	**0.086**	0.053	**0.520**	-0.074	**0.176**	38.925	**0.000**
S.AFRICA SM	0.000	0.013	0.002	0.044	**0.077**	**0.027**	0.008	**-0.088**	-0.012	**0.031**	0.021	**0.057**	-0.006	**0.561**	0.021	105.602	**0.000**
TAIWAN SM	0.000	0.027	0.009	0.038	0.008	0.002	-0.049	-0.019	0.026	-0.013	0.022	-0.030	**0.025**	-0.066	**0.930**	7.896	**0.000**

Significant p-value at 1 percent based on a two tailed test apear in bold, 5 percent apear in underline and 10 percent in italic.

Table 4: Regression and Proportion of Global and Country Factors

	Cap	World bata	P-value	Country beta	P-value	Global	Country	Idosyncratic
	Large	1.20386	0	1.01377	0	72.1%	27.6%	0.3%
CANADA	Mid	1.09774	0	0.91486	0	67.4%	25.3%	7.2%
	Small	1.13922	0	0.90229	0	64.6%	21.9%	13.6%
	Large	1.33378	0	1.03129	0	72.3%	27.5%	0.2%
FRANCE	Mid	1.16757	0	0.79639	0	71.3%	21.1%	7.6%
	Small	1.11120	0	0.76330	0	66.6%	20.0%	13.4%
	Large	1.26905	0	1.01014	0	72.8%	27.1%	0.2%
GERMANY	Mid	1.43320	0	0.86877	0	68.6%	14.8%	16.6%
	Small	1.23409	0	0.74053	0	69.7%	14.7%	15.6%
	Large	1.36274	0	1.02899	0	64.2%	35.6%	0.2%
ITALY	Mid	1.14262	0	0.81821	0	59.0%	29.4%	11.5%
	Small	1.05497	0	0.69383	0	59.8%	25.1%	15.1%
	Large	0.32316	0	1.01678	0	7.6%	92.2%	0.2%
JAPAN	Mid	0.30405	0	0.92664	0	7.7%	87.3%	5.0%
	Small	0.24311	0	0.83805	0	5.5%	80.6%	13.9%
	Large	1.14213	0	1.01323	0	70.6%	29.2%	0.2%
UK	Mid	1.14654	0	0.92445	0	68.9%	23.5%	7.5%
	Small	1.01732	0	0.81846	0	63.3%	21.5%	15.2%
	Large	1.01310	0	0.99048	0	78.6%	21.2%	0.2%
USA	Mid	1.16988	0	1.04659	0	78.7%	17.8%	3.6%
	Small	1.18119	0	1.15503	0	72.1%	19.4%	8.5%
	Large	1.55275	0	1.02493	0	64.5%	35.3%	0.2%
BRAZIL	Mid	1.33962	0	0.81669	0	60.4%	28.2%	11.4%
	Small	1.16565	0	0.66367	0	58.7%	23.9%	17.4%
	Large	0.75425	0	1.02272	0	21.2%	78.5%	0.3%
CHINA	Mid	0.61727	0	0.85398	0	17.6%	67.7%	14.6%
	Small	0.45157	0	0.64627	0	14.2%	58.2%	27.6%
	Large	0.74515	0	1.00192	0	22.9%	76.7%	0.3%
INDIA	Mid	0.67782	0	0.98804	0	18.0%	70.9%	11.1%
	Small	0.61985	0	0.85187	0	18.2%	63.6%	18.2%
	Large	1.18796	0	1.01264	0	66.6%	33.1%	0.3%
MEXICO	Mid	1.27746	0	0.89357	0	58.0%	19.4%	22.5%
	Small	1.05865	0	0.71073	0	61.9%	19.1%	19.0%
	Large	1.40997	0	1.01053	0	43.6%	56.3%	0.0%
RUSSIA	Mid	1.33898	0	0.62877	0	36.9%	20.4%	42.7%
	Small	0.85284	0	0.55744	0	27.4%	29.4%	43.2%
	Large	1.12158	0	1.03571	0	46.7%	52.7%	0.6%
S.AFRICA	Mid	1.00742	0	0.85963	0	45.8%	44.1%	10.1%
	Small	0.81154	0	0.65191	0	45.9%	39.2%	14.9%
	Large	0.42953	0	0.98386	0	13.1%	86.2%	0.6%
TAIWAN	Mid	0.45818	0	1.07641	0	11.4%	78.6%	10.1%
	Small	0.40615	0	0.92532	0	10.4%	67.6%	22.0%
	Large	1.06064		1.01407		51.2%	48.5%	0.3%
Average	Mid	1.01274		0.88664		47.8%	39.2%	13.0%
	Small	0.88195		0.77991		45.6%	36.0%	18.4%

Table 5: Correlations and Optimal Portfolio of Country Market

	USA	CANADA	JAPAN	UK	GERMANY	FRANCE	ITALY	Mean	s.d.	with short sales	without short sales
Correlations of Developed Countries in 2008											
USA	1	0.7041	-0.0022	0.5088	0.5424	0.4834	0.4246	0.00218	0.02545	57.90%	43.31%
CANADA	0.7041	1	0.3085	0.6925	0.653	0.6708	0.6348	0.00287	0.03095	-24.78%	0.00%
JAPAN	-0.0022	0.3085	1	0.3321	0.2865	0.3194	0.3398	0.00169	0.02454	49.89%	47.48%
UNITED KINGDOM	0.5088	0.6925	0.321	1	0.8929	0.9483	0.9121	0.00309	0.02827	-4.98%	0.00%
GERMANY	0.5424	0.653	0.2865	0.8929	1	0.9317	0.8883	0.0028	0.02686	8.78%	0.00%
FRANCE	0.4834	0.6708	0.3194	0.9483	0.9317	1	0.9587	0.00268	0.02847	-23.07%	0.00%
ITALY	0.4246	0.6348	0.3398	0.9121	0.8883	0.9587	1	0.00319	0.02764	36.26%	9.20%
							Average	0.00264	0.02745		
							Portfolio Expected Returns			0.002	0.002
							Portfolio Standard Deviation			0.017	0.017

	CHINA	INDIA	TAIWAN	BRAZIL	MEXICO	RUSSIA	SA	Mean	s.d.	with short sales	without short sales
Correlations of Emerging Countries in 2008											
CHINA	1	0.6288	0.601	0.4496	0.4096	5493	0.5539	0.00344	0.03586	-11.03%	0.00%
INDIA	0.6288	1	0.4272	0.3949	0.383	0.4587	0.4819	0.00458	0.0317	16.73%	10.55%
TAIWAN	0.601	0.4272	1	0.2676	0.2048	0.4573	0.4589	0.00283	0.0235	63.66%	59.53%
BRAZIL	0.4496	0.3943	0.2676	1	0.8482	0.6053	0.6598	0.00423	0.04394	-21.33%	0.00%
MEXICO	0.4096	0.383	0.2048	0.8482	1	0.5572	0.6226	0.00268	0.03057	56.08%	29.92%
RUSSIA	0.5493	0.4587	0.4573	0.6053	0.5572	1	0.7254	0.0063	0.04812	-12.63%	0.00%
SA	0.5539	0.4819	0.4589	0.6598	0.6226	0.7254	1	0.0025	0.03332	8.25%	0.00%
							Average	0.00379	0.03529		
							Portfolio Expected Returns			0.002	0.003
							Portfolio Standard Deviation			0.018	0.02

Table 6: Optimal Portfolio Allocation of Developed Countries

	Panel A		Panel B		Panel C		Panel D	
	Country		Country+Small Cap		Country+Mid Cap		Country+Small+Mid	
	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales
USA	57.90%	43.31%	45.19%	22.69%	81.18%	27.45%	79.86%	19.43%
CANADA	-24.78%	0.00%	-26.60%	0.00%	-55.58%	0.00%	-45.93%	0.00%
JAPAN	49.89%	47.48%	-21.73%	0.00%	-2.41%	0.00%	6.04%	0.00%
UK	-4.98%	0.00%	-21.94%	0.00%	0.72%	0.00%	-5.57%	0.00%
GERMANY	8.78%	0.00%	-9.79%	0.00%	-1.18%	0.00%	-3.47%	0.00%
FRANCE	-23.07%	0.00%	-5.27%	0.00%	-13.31%	0.00%	2.36%	0.00%
ITALY	36.26%	9.20%	10.57%	0.00%	-20.68%	0.00%	-14.22%	0.00%
USA Mid					-50.08%	0.00%	-72.46%	0.00%
CANADA Mid					57.12%	0.00%	43.06%	0.00%
JAPAN Mid					30.36%	40.07%	-36.34%	0.00%
UK Mid					11.48%	0.00%	-20.13%	0.00%
GERMANY Mid					-40.76%	0.00%	-32.50%	0.00%
FRANCE Mid					17.81%	0.00%	-0.91%	0.00%
ITALY Mid					85.35%	32.48%	55.24%	29.02%
USA Small			-3.48%	5.58%			22.81%	5.12%
CANADA Small			11.68%	0.00%			3.68%	0.00%
JAPAN Small			57.93%	46.78%			55.81%	46.44%
UK Small			34.67%	0.00%			46.05%	0.00%
GERMANY Small			-74.69%	0.00%			-27.24%	0.00%
FRANCE Small			15.16%	0.00%			17.47%	0.00%
ITALY Small			88.30%	24.96%			26.42%	0.00%
Expected Returns	0.002	0.002	0.002	0.002	0.001	0.002	0.002	0.002
Standard Deviation	0.017	0.017	0.012	0.016	0.012	0.016	0.011	0.015

Table 7: Optimal Portfolio Allocation of Emerging Countries

	Country		Country+Small Cap		Country+Mid Cap		Country+Small+Mid	
	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales
CHINA	-11.03%	0.00%	-22.41%	0.00%	-42.95%	0.00%	-10.95%	0.00%
INDIA	16.73%	10.55%	3.04%	0.00%	-8.01%	0.00%	17.64%	0.00%
TAIWAN	63.66%	59.53%	12.21%	15.90%	67.83%	58.52%	43.76%	15.90%
BRAZIL	-21.33%	0.00%	-4.82%	0.00%	-44.26%	5.00%	-19.35%	0.00%
MEXICO	56.08%	29.92%	16.77%	0.00%	66.33%	29.44%	21.72%	0.00%
RUSSIA	-12.36%	0.00%	-22.23%	0.00%	-11.57%	0.00%	-20.18%	0.00%
SA	8.25%	0.00%	-14.00%	0.00%	17.49%	0.00%	-0.44%	0.00%
CHINA Mid					42.98%	0.00%	-16.79%	0.00%
INDIA Mid					24.10%	12.05%	-25.81%	0.00%
TAIWAN Mid					-13.99%	0.00%	-78.33%	0.00%
BRAZIL Mid					32.12%	0.00%	20.19%	0.00%
MEXICO Mid					-20.45%	0.00%	-27.86%	0.00%
RUSSIA Mid					-0.23%	0.00%	2.85%	0.00%
SA Mid					-9.39%	0.00%	-32.28%	0.00%
CHINA Small			29.61%	17.51%			36.18%	17.51%
INDIA Small			5.58%	5.11%			17.24%	5.11%
TAIWAN Small			10.36%	9.26%			59.83%	9.26%
BRAZIL Small			-5.92%	0.00%			-4.03%	0.00%
MEXICO Small			17.78%	27.49%			33.32%	27.49%
RUSSIA Small			38.32%	24.74%			26.40%	24.74%
SA Small			35.71%	0.00%			56.98%	0.00%
Expected Returns	0.002	0.003	0.004	0.005	0.002	0.003	0.003	0.005
Standard Deviation	0.018	0.02	0.013	0.017	0.017	0.02	0.011	0.017

Table 8: Optimal Portfolio Allocation of Developed and Emerging Countries

	Panel A		Panel B		Panel C	
	Country		Country+Small Cap		Country+Mid Cap	
	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales	With Short Sales	Without Short Sales
USA	46.72%	38.76%	54.79%	27.12%	76.61%	25.56%
CANADA	-15.74%	0.00%	-15.84%	0.00%	-49.31%	0.00%
JAPAN	36.75%	31.00%	-20.27%	0.00%	-1.24%	0.00%
UK	6.08%	0.00%	2.54%	0.00%	26.89%	0.00%
GERMANY	11.14%	0.00%	-12.06%	0.00%	-6.35%	0.00%
FRANCE	-18.61%	0.00%	-6.14%	0.00%	-16.85%	0.00%
ITALY	22.88%	4.69%	-9.22%	0.00%	-18.52%	0.00%
CHINA	-16.51%	0.00%	-14.92%	0.00%	-26.10%	0.00%
INDIA	5.65%	0.13%	4.83%	0.00%	1.69%	0.00%
TAIWAN	28.77%	25.42%	-0.62%	0.00%	20.24%	18.99%
BRAZIL	-16.86%	0.00%	-2.51%	0.00%	-7.08%	0.00%
MEXICO	13.85%	0.00%	-4.76%	0.00%	25.88%	0.00%
RUSSIA	-8.73%	0.00%	-14.73%	0.00%	-1.29%	0.00%
SA	4.62%	0.00%	-7.30%	0.00%	7.05%	0.00%
USA Mid					-44.58%	0.00%
CANADA Mid					48.29%	0.00%
JAPAN Mid					23.59%	28.31%
UK Mid					-9.76%	0.00%
GERMANY Mid					-30.78%	0.00%
FRANCE Mid					21.65%	0.00%
ITALY Mid					7303.00%	21.15%
CHINA Mid					21.72%	0.00%
INDIA Mid					-1.13%	0.00%
TAIWAN Mid					-2.80%	0.00%
BRAZIL Mid					-3.57%	0.00%
MEXICO Mid					-20.66%	0.00%
RUSSIA Mid					-0.52%	0.00%
SA Mid					-6.40%	0.00%
USA Small			-14.72%	0.00%		
CANADA Small			9.21%	0.00%		
JAPAN Small			40.02%	34.11%		
UK Small			8.38%	0.00%		
GERMANY Small			-23.81%	0.00%		
FRANCE Small			2.89%	0.00%		
ITALY Small			52.03%	6.41%		
CHINA Small			17.21%	4.43%		
INDIA Small			-7.04%	0.00%		
TAIWAN Small			6.57%	7.01%		
BRAZIL Small			-9.20%	0.00%		
MEXICO Small			4.40%	0.00%		
RUSSIA Small			27.95%	20.92%		
SA Small			32.30%	0.00%		
Expected Returns	0.002	0.002	0.003	0.003	0.001	0.002
Standard Deviation	0.014	0.017	0.009	0.015	0.01	0.016

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BENCHMARKING THRIFT AND MORTGAGE FINANCE COMPANIES

Abstract

This study uses data envelopment analysis (DEA) approach to benchmark the performance of thirteen thrifts and mortgage finance companies against one another for the period 2008 to 2011. We cover the period of start of the economic crisis and the consequent passing to new law to regulate the financial services industry. We find that, at the height of the economic crisis in 2008, only five companies out of thirteen were efficient and the number of efficient companies actually declined to four only in 2010. In 2011, the number of efficient companies increased to eleven. We illustrate the use of data envelopment analysis (DEA), an operations research technique, to evaluate the relative financial strength of thirteen thrift and mortgage firms by benchmarking them on the basis of four variables against their peers. DEA clearly brings out the firms that are operating more efficiently in comparison to other firms in the industry, and points out the areas in which poorly performing firms need to improve.

I.   INTRODUCTION

Given the significance of financial institutions in economic growth, financial institutions including banks, thrifts, and mortgage companies are considered private companies with a public purpose. They seek to create value for all the stakeholders and maximize shareholder wealth subject to the constraints of risk, market competition, social, and the legal/regulatory framework. The private nature of these institutions requires them to be viable through profitability and the public nature of these institutions emphasizes safety and soundness of their operations. Profitability is important for the viability of a financial institution, but safety and security is also critical for the survival of the financial system. Financial institutions make a trade-off between

the profitability level they strive to achieve and the risks they are willing to take. If a bank achieves loan growth and, consequently, higher profitability by engaging in excessively risky lending, it may be vulnerable to high loan defaults that would hurt its earnings or even threaten its survival over time as the world saw under the current economic crisis. Since 2008, the US mortgage industry has clearly been in a state of duress due to an overwhelming number of nonperforming home loans and as a result it had a severe negative impact on the profitability and viability of the financial system in the United States.

On July 21, 2010, President Obama signed into law an act of Congress entitled the "Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010" (H.R. 4173), (hereafter, "Dodd-Frank"). This act is intended to curb excessive risk by banks by making them responsible lenders.

The new law makes provisions for better risk monitoring and capital requirements to build a cushion to prevent future banking crisis of the magnitude that hit the United States in 2008. Under the new act, financial institutions will be discouraged from engaging in predatory lending activities.

The act also poses a special challenge to the long-term viability of thrifts and thrift holding companies through a direct or indirect impact on the income or cost of doing business for the thrift and banking industry. Profit margins for all financial institutions are expected to decline under the new regulations. For example, larger institutions will no longer be able to generate profits from risky bets using their own money and will have to rely more on the traditional low-margin banking business.

In addition, the cost of doing business in the banking industry will go up, because smaller banks will be required to increase staff levels in their credit departments and compliance functions as the rules will apply to the same extent to both large and small institutions.

The objective of this paper is to benchmark the performance of thirteen thrifts and mortgage finance companies against one another for the period 2008 to 2011. In this paper, we use data envelopment analysis (DEA), an operations research technique, to benchmark these thirteen thrift and mortgage companies. DEA clearly brings out the companies that are operating more efficiently in comparison to other firms in the industry. DEA also points out the areas in which poorly performing firms need to improve. By using the existing good companies as a "role model," DEA not only helps differentiate well performing (efficient) firms from poorly performing (inefficient) firms, but also brings out the reasons why a company may be underperforming. This helps investors and creditors justify their decisions to invest or not to invest their funds in a particular company. This will also help regulators identify areas of weakness for a thrift or mortgage firm so that management plans can focus on plugging the weaknesses or taking steps to counter the weaknesses.

The rest of the paper is organized along the following lines. In section II, we provide a review of previous studies. Section III discusses the model that we use in this study. Section IV provides empirical analysis of our results. Section V summarizes and concludes our study.

II.   **LITERATURE REVIEW**

Use of data envelopment analysis in analyzing the efficiency of banks and banking industry are well documented in previous studies. According to Thanassoulis (1999), data envelopment analysis, a linear-programming technique, is increasingly being used to assess performance in the banking industry. The unit of assessment is normally the bank branch. Studies are mostly

centered on deriving a summary measure of the efficiency of each unit, on estimating targets of performance for the unit, and on identifying role-model units of good operating practice. Additional uses for DEA in banking include the measurement of efficiency in light of resource and output prices, the estimation of operating budgets that are conducive to efficiency, the assessment of financial risk at the bank-branch level, and the measurement of the impact of managerial change initiatives on productivity.

Previous studies that use data envelopment analysis in the context of the banking industry can be broadly classified into three categories:

- Studies that focus on benchmarking banks against each other in a particular country;

- Studies that focus on analyzing the branch efficiencies; and

- Studies that focus on economies of scale in the banking industry.

Malhotra, Poteau, and Malhotra (2012) developed a multidimensional framework using data envelopment analysis to benchmark the performance of 35 commercial banks in India on the basis of eight performance variables. Kao and Liu (2004) computed efficiency scores based on the data contained in the financial statements of Taiwanese banks. They used this data to make advanced predictions of the performances of 24 commercial banks in Taiwan. Pille and Paradi (2002) analyzed the financial performance of Ontario credit unions. They developed models to detect weaknesses in Credit Unions in Ontario, Canada. Halkos and Salamouis (2004) explored the efficiency of Greek banks with the use of a number of suggested financial efficiency ratios for the time period 1997-1999. They showed that data envelopment analysis could be used as either an alternative or complement to ratio analysis for the evaluation of an organization's performance. The study found that the higher the size of total assets the higher the efficiency. Neal (2004) investigated X-efficiency and

productivity change in Australian banking between 1995 and 1999 using data envelopment analysis and Malmquist productivity indexes. The study differed from earlier studies by examining efficiency by bank type, and found that regional banks were less efficient than other bank types. The study concluded that diseconomies of scale set in very early, and hence are not a sufficient basis on which to allow mergers between large banks to proceed. Paradi and Schaffnit (2004) evaluated the performance of the commercial branches of a large Canadian bank using data envelopment analysis. Chen, Sun, and Peng (2005) studied the efficiency and productivity growth of commercial banks in Taiwan before and after financial holding corporations' establishment. They employed a data envelopment analysis approach to generate efficiency indices as well as Malmquist productivity growth indices for each bank.

Howland and Rowse (2006) assessed the efficiency of branches of a major Canadian bank by benchmarking them against the DEA model of American bank branch efficiency. Sufian (2007) used the DEA approach to evaluate trends in the efficiency of the Singapore banking sector and to distinguish between technical, pure technical and scale efficiencies. Fisher (2005) evaluated the operating performance of a bank branch relative to peer branches of the same bank in Southern California.

Sanjeev (2007) evaluated the efficiency of the public sector banks operating in India for a period of five years (1997-2001) using DEA. The study also investigated if there is any relationship between the efficiency and size of the banks. The results of the study suggested that no conclusive relationship could be established between the efficiency and size of the banks. Lin, Shu, and Hsiao (2007) studied the relative efficiency of management in the Taiwanese banking system through DEA. The goal was to estimate the competitiveness of each bank and managerial efficiency is to show the efficiency variation of each bank through

Malmquist index. Bergendahl and Lindblom (2008) developed principles for an evaluation

of the efficiency of a savings bank using data envelopment analysis as a method to consider

the service orientation of savings banks. They determined the number of Swedish savings

banks being "service efficient" as well as the average degree of service efficiency in this

industry.

No study has specifically analyzed the thrifts and mortgage companies in the United

States. This study extends previous literature by analyzing the performance of the thrifts and

mortgage industry at a point in time when the industry is going through much turmoil.

III.   MODEL

The Data Envelopment Analysis Model[1]

Data envelopment analysis (DEA) is a linear programming technique that was developed

by Charnes Cooper (1978) to assess the relative performance of homogenous organizational

units. Further, this generalized optimization technique measures the relative performance of

different decision-making entities (called decision-making units or DMUs) that have multiple

objectives (outputs) and multiple inputs structure. Since, in this study, we analyze thirteen

thrift and mortgage companies, these companies are the DMUs. DEA measures the

efficiency with which a DMU uses the resources available (inputs) to generate a given set of

outputs. The DEA methodology defines efficiency as a ratio of total outputs to total inputs

and uses this to evaluate the relative performance of a DMU. Further, the DEA model

estimates relative efficiency, which is with reference to the best performing DMU or DMUs

(in case multiple DMUs are most efficient). The DEA allocates an efficiency score of unity

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[1] The main sources of the DEA Model description are Ramanathan (2003) and Zhu (2003).

or 100 percent to the most efficient unit. The low-performing DMUs' efficiency can vary between 0 and 100 percent in comparison to the best performance.

To develop a DEA model, we consider "n" Decision-making units (DMUs). Further, we define the following variables:

j = 1, 2,…, n (DMU variable).

i = 1, 2,…, m (inputs variable).

r = 1, 2,……, s (outputs variable).

Therefore, each DMU_j, j = 1, 2,…, n, uses the following variable factors:

x_{ij} – amount of input i for the unit j, i =1,2,……,m and j =1,2,….,n.

y_{rj} – amount of output r for the unit j, r = 1, 2,….., s and j = 1, 2,….,n.

u_r – weight assigned to the output r, r = 1,2,…..,s

v_i – weight assigned to the input i, i =1,2,……,m.

Further, for each DMU, we form the virtual input and output using the weights (to be determined) v_i and u_r:

Virtual input = $\sum_{i=1}^{m} v_i x_{ij}$

Virtual output = $\sum_{r=1}^{s} u_r y_{rj}$

Where j= 1,2, …., n (DMU variable). We want to determine the weights, using linear programming so as to maximize the ratio

$$\frac{Virtual\ Output}{Virtual\ Input}$$

The DEA methodology gives a measure of efficiency that is defined as the ratio of weighted outputs to weighted inputs. The most important issue in this method is the assessment of the weights. Charnes et. al., define the efficiency measure by assigning to each unit the most favorable weights. In general, the weights will not be the same for different units. Further, if a unit happens to be inefficient, relative to the others, when most favorable weights are chosen, then it is inefficient, independent of the choice of weights. Thus, given a set of weights, we define the efficiency with which a DMU processes the inputs to produce outputs as the ratio of the weighted sum of outputs to the weighted sum of inputs.

$$\text{Efficiency} = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \tag{1}$$

IV. DATA AND METHODOLOGY

We used the data available from the financial statements of thirteen thrift and mortgage companies for the period 2008 to 2011. The data is from *Mergent Online.* Thirteen financial services firms that we include in our study are: Aastoria Financial Corporation, Bank Mutual Corporation, Brookline Bancorp Inc., Dime Community Bancshares, Hudson City Bancorp Inc., New York Cmnty Bancorp Inc., Northwest Bancshares Inc., Oritani Financial Corporation, People's United Finl Inc., Provident Financial Svcs Inc., Trustco Bank Corp/Ny, Viewpoint Financial Group, and Washington Federal Inc. These thrift and mortgage companies have been identified as competitors by Standard & Poor's Netadvantage. Therefore, in order to benchmark the performance of thirteen thrifts and mortgage companies, we consider the following four broad sets of ratios that capture the private-public nature of banking:

- Efficiency ratio

- Net Interest Margin

- Return on Assets

- Loan Loss Reserve Ratio

Efficiency ratio is based on noninterest expenses divided by operating revenue. Noninterest expenses include operational expenses such as personnel and occupancy costs (salaries, technology, building, supplies, and administrative expenses). Operating revenue includes net interest income (interest revenue less interest expense) plus fees income. Efficiency ratio measures costs required to generate each dollar of revenue and reflects the productivity of a bank. If the costs required to generate every dollar of revenue are low, it means lower operational costs. Lower operational costs translate into greater operational efficiency.

Net interest margin (NIM): The NIM is calculated by dividing the net interest income by the earning assets. For Indian banks, it is measured by net interest income divided by total funds.

Return on assets (ROA): Return on assets is computed by dividing bank's net income by its total assets. In general, the higher the ROA the better it is, provided it is not the result of excessive risk-taking. Banks will typically have a relatively low ROA in comparison to industrial organizations mainly because banks are highly leveraged.

Loan Loss Reserve Ratio is computed by dividing the loan loss reserves by the total non-performing assets of the institution. Higher ratio means that the bank has enough funds to cover the loan losses and the institution will remain sound. It is a measure of the safety of a thrift and mortgage firm.

Table 1 illustrates the pooled data of the thirteen companies used for analysis.

<Insert Table 1 about here>

In this paper, we have one input variable in the form of the efficiency ratio that needs to be minimized and three output measures in the form of the loan loss reserve ratio, net interest margin, and return on assets that need to be maximized. Since the number of output variables exceeds the number of input variables, we used the input oriented model.

Finally, the choice of the DEA model is also an important consideration. We should select the appropriate DEA model with options such as input maximizing or output minimizing, multiplier or envelopment, and constant or variable returns to scale. DEA applications that involve inflexible inputs or not fully under control inputs should use output-based formulations. On the contrary, for an application with outputs that are an outcome of managerial goals, input-based DEA formulations are more appropriate. In addition, for an application that emphasizes inputs and outputs, we should use the multiplier version. Similarly, for an application that considers relations among DMUs, envelopment models are more suitable. Furthermore, the characteristics of the application dictate the use of constant or variable returns to scale. If the performance of DMUs depends heavily on the scale of operation, constant returns to scale (CRS) is more applicable, otherwise variable returns to scale is a more appropriate assumption.

In our study, the comparative evaluation among the companies is an important consideration. Therefore, we select the envelopment models for our analysis. In addition, the outputs are an outcome of managerial goals. Therefore, input-based formulation is recommended for our study. The objective of the analysis is to suggest a benchmark for the thrift and mortgage firms. Furthermore, to investigate the effect of scale of operations, if any, among the thirteen companies, we consider both variable returns to scale and constant returns to scale DEA models. Also, the structure of the DEA model (in envelopment form) uses an equation and separate

calculation for every input and output. Therefore, all the input and output variables can be used simultaneously and measured in their own units.   In this study, we use the Input-Oriented Variables Return to Scale (VRS) to evaluate the efficiency of thirteen thrifts and mortgage companies for the period 2008 to 2011.

V.   EMPIRICAL ANALYSIS

Using the DEA methodology, we compute an efficiency score for the thirteen companies on a scale of 1 to 100 on the basis of the financial data for each year for the period 2008 to 2011. Table 2 illustrates the efficiency scores for thirteen companies. Further, we also study the peers (model companies) for inefficient companies.

<Insert Table 2 about here>

Table 2 shows the relative performance of the financial services companies benchmarked against each other. Table 2 also shows that five out of thirteen companies were ranked as efficient based on the data for the years 2008 and 2009. In 2010, only four companies were 100% efficient, and in 2011, the number of 100% efficient companies went up to six. Here is summary of our findings:

- Only Hudson City Bancorp is 100% efficient throughout the sample period of 2008 to 2011.

- Astoria Financial, Bank Mutual, Provident Financial Services, and Viewpoint Financial Group are not 100% efficient in any year during the period of 2008 to 2011.

- Northwest Bancshares is 100% efficient in the years 2008 and 2009 only,

- Peoples United Financial is 100% efficient in 2008 and 2011,

- Trustco is 100% efficient in 2008 only,

- Washington Federal is 100% efficient in 2008, 2009, and 2011 only,

- Brookline Bancorp is 100% in 2009, 2010, and 2011.

- DME Community Bancshares is 100% efficient in the years 2010 and 2011

- New York Community Bancorp is 100% efficient in the years 2009 and 2010

- In the years 2008 and 2009, Astoria Financial is the least efficient company with an efficiency score of 64% and 69%, respectively

- In 2010 and 2011, the least efficient company is Bank Mutual Corporation with an efficiency score of 40% and 68%, respectively.

- The 100% efficient companies (blue dots) are on the efficiency frontier, whereas the inefficient companies (red dots) are inside the efficiency frontier. The DEA Analyzer calculates the level of inefficiency by measuring the distance between the efficiency frontier and the inefficient companies. Therefore, a financial analyst can use this efficiency frontier to assess the relative efficiency of the firm in the industry. The DEA model compares the net interest margin, return on assets, loan loss reserves, and efficiency ratios.

<Insert Table 3 about here>

Table 3 shows that DIME Community Bancorp serves as a peer for Astoria Financial Corporation, New York Community Bancorp, Northwest Banc Shares, Provident Financial Services, Trustco Bank Corporation, Viewpoint Financial Group, and Viewpoint Financial

Group. People's United Financial Services Company serves as a peer for Bank Mutual Corporation, Northwest Bancshares, Provident Financial Services, and Trustco Bank Corporation. Brookline Bankcorp is the peer for Trustco Bank Corporation. The efficient peer companies have a similar mix of input-output levels compared to that of the corresponding inefficient company, but at more absolute levels. The efficient companies generally have higher output levels relative to the company in question. The features of efficient peer companies make them very useful as role models that inefficient companies can emulate to improve their performance. Furthermore, DIME Community Bancop is the immediate efficient peer for six companies in 2011, so its frequency of use as an efficient-peer, expressed as a percentage of the number of Pareto-inefficient companies, is more than 50%. Thus, we have enhanced confidence that DIME Community Bancorp is genuinely well-performing company as it outperforms all the other companies. Furthermore, these companies are more likely to be a better role model for less efficient companies to emulate as their operating practices and environment match the majority of the other companies quite closely.

After calculating the efficiency of a company and identifying the efficient peers, the next step in DEA analysis is the feasible expansion of the output or contraction of the input levels of a company within the possible set of input-output levels. The DEA efficiency measure tells us whether or not a given company can improve its performance relative to the set of companies to which it is being compared. Therefore, after minimizing the input efficiency, the next stage involves calculating the optimal set of slack values with an assurance that input efficiency will not decrease at the expense of slack values of the input and output factors. Once the input efficiency factor has been minimized, the model does seek the maximum sum of the input and output slacks. If any of these values is positive at the optimal solution to the DEA model, it

implies that the corresponding output of the company (DMU) can improve further after its output

levels have been raised by the efficiency factor, without the need for additional input. If the

efficiency is 100% and the slack variables are zero, then the output levels of a company cannot

be expanded jointly or individually without raising its input level. Further, its input level cannot

be lowered given its output levels. Thus, the companies are Pareto-efficient with technical output

efficiency of 1. If the company is 100% efficient but one slack value is positive at the optimal

solution then the DEA model has identified a point on the efficiency frontier that offers the same

level on one of the outputs as company A in question, but it offers in excess of the company A

on the output corresponding to the positive slack. Thus, company A is not Pareto-efficient, but

with radial efficiency of 1 as its output cannot be expanded jointly. Finally, if the company A is

not efficient (<100%) or the efficiency factor is less than 1, then the company in question is not

Pareto-efficient and efficiency factor is the maximum factor by which both its observed input

levels can be reduced without changing its output. If at the optimal solution, we have not only

input efficiency < 1, but also some positive slack, then the output of company A corresponding

to the positive slack can be raised by more than the factor's output efficiency, without the need

for additional input. The potential additional output at company A is not reflected in its

efficiency measure because the additional output does not apply across all output dimensions.

Table 4 shows the slack variables for thrift and mortgage companies for the year 2011 only.

<Insert Table 4 about here>

The slack variables for 100% efficient companies are zerio. Therefore, Brookline Bancorp,

DIME Community Bancshares, Hudson City Bancorp, Oritani Financial Corporation, Peoples

United Financial, and Washington Federal are Pareto-efficient as the DEA model has been unable to identify some feasible production point which can improve on some other input or output level. On the other hand, Astoria Financial Corporation needs to improve its efficiency ratio by reducing it by 0.11 units, loan loss reserve ratio and net interest margin by increasing them by 0.11 units and 0.49 units, respectively. Bank Mutual Corporation needs to improve its efficiency ratio by decreasing it by 0.04 units and improve its loan loss reserve ratio, and return on asset by increasing them by 0.13 units and 2.63 units, respectively. Similarly, Net York Community Bancorp needs to improve its efficiency ratio, loan loss reserve ratio, and net interest margin relative to its efficient peers. Also, Provident Financial Services needs to improve its efficiency ratio and loan loss reserve ratio, while Viewpoint Financial Corporation needs to improve its efficiency ratio and net interest margin relative to their 100% efficient peers. On the other hand, Northwest Bancshares and Trustco Bank Corporation need to improve its efficiency ratio (by minimizing nonoperating expense relative to operating revenue) only.

VI.   SUMMARY AND CONCLUSIONS

The housing mortgage loans are being blamed for the current economic crisis. Since 2008, the US mortgage industry has clearly been in a state of duress due to an overwhelming number of nonperforming home loans; millions of homeowners owing more than their homes are worth, depressed home sales, and the ineffectiveness of mortgage modification and refinancing programs. As a result, the government introduced new legislation, Dodd-Frank Act, to regular the financial industry so that there is no repeat of the 2008 economic crisis. New regulation will have an impact on the financial performance of the entire financial industry. In this study, we

evaluated the relative performance of thirteen thrift and mortgage firms by benchmarking them against one another through the operations research technique of data envelopment analysis.

DEA employs relative efficiency, a concept enabling comparison of companies with a pool of known efficient companies. The DEA model compares a firm with the pool of efficient companies by creating an 'efficiency frontier' of good firms – a tolerance boundary created by establishing the efficiency of firms in terms of several sets of financial ratios. Companies lying beyond this boundary can improve one of the input values without worsening the others. We found that Hudson City Bancorp was the only company that was100% efficient throughout the sample period of 2008 to 2011. On the other hand, Astoria Financial Corporation, Bank Mutual Corporation, Provident Financial Services, and Viewpoint Financial Group were inefficient for each year of the sample period of 2008 to 2011. We also illustrate the areas in which inefficient companies are lagging behind efficient firms.

This study also provides an insight into the benefits of DEA methodology in analyzing financial statements of firms. The DSS stores the company's historical data, competitive firm's data and other industry specific data and uses the DEA methodology to analyze a firm's performance. Moreover, DEA modeling does not require prescription of the functional forms between inputs and outputs. DEA uses techniques such as mathematical programming that can handle a large number of variables and constraints. As DEA does not impose a limit on the number of input and output variables to be used in calculating the desired evaluation measures, it's easier for the analyst to deal with complex problems and other considerations they are likely to confront. However, DEA does have certain limitations. As DEA is an extreme point technique, errors in measurements can lead to deviations in results. DEA efficiencies are very sensitive to even small errors, making sensitivity analysis an important component of the DEA-

procedure. In addition, as DEA is a non-parametric technique, statistical hypothesis tests are difficult. Further, DEA has been designed to compute efficiency scores only when one or more inputs and one or more outputs are used for the analysis. Finally, the application of DEA requires solving a separate linear program for each DMU. Hence the application of DEA to cases with a large number of DMUs can be computationally intensive. However, with the modern computing capacity, this is not a serious issue.

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Table 1. Summary statistics of the data used in this study

Variables	Efficiency Ratio				Loan Loss Reserve Ratio				Net Interest Margin				Return on Assets			
	2011	2010	2009	2008	2011	2010	2009	2008	2011	2010	2009	2008	2011	2010	2009	2008
Mean	0.41	0.39	0.35	0.30	0.70	0.65	0.71	1.41	3.25	3.04	2.86	2.77	0.49	0.52	0.36	0.58
Median	0.45	0.41	0.32	0.30	0.55	0.63	0.54	1.00	3.40	3.45	2.96	2.78	0.82	0.73	0.44	0.64
Maximum	0.64	0.72	0.63	0.54	2.00	1.88	2.21	5.67	4.10	3.71	3.56	3.62	1.17	1.30	1.07	0.99
Minimum	0.15	0.10	0.09	0.07	0.26	0.26	0.21	0.21	1.90	1.47	2.09	1.91	-1.87	-2.38	-1.82	-0.14
Std. Deviat	0.14	0.15	0.15	0.13	0.49	0.42	0.60	1.45	0.62	0.71	0.47	0.54	0.97	0.91	0.71	0.30

Table 2. A summary of the relative efficiencies of thirteen mortgage and thrift companies for the period 2008 to 2011.								
	2008.00		2009.00		2010.00		2011.00	
Company	efficiency	Percenta	efficiency	Percentage Efficien	efficiency	Percenta	efficiency	Percenta
ASTORIA FINANCIAL CORP	1.57	0.64	1.44	0.69	1.30	0.77	1.35	0.74
BANK MUTUAL CORP	1.44	0.69	1.30	0.77	2.52	0.40	1.46	0.68
BROOKLINE BANCORP INC	1.06	0.94	1.00	1.00	1.00	1.00	1.00	1.00
DIME COMMUNITY BANCSHARES	1.08	0.92	1.01	0.99	1.00	1.00	1.00	1.00
HUDSON CITY BANCORP INC	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NEW YORK CMNTY BANCORP INC	1.24	0.81	1.00	1.00	1.00	1.00	1.01	0.99
NORTHWEST BANCSHARES INC	1.00	1.00	1.00	1.00	1.05	0.95	1.05	0.95
ORITANI FINANCIAL CORP	1.09	0.92	1.19	0.84	1.14	0.88	1.00	1.00
PEOPLE'S UNITED FINL INC	1.00	1.00	1.07	0.94	1.01	0.99	1.00	1.00
PROVIDENT FINANCIAL SVCS INC	1.13	0.89	1.15	0.87	1.08	0.93	1.08	0.93
TRUSTCO BANK CORP/NY	1.00	1.00	1.01	0.99	1.06	0.94	1.09	0.92
VIEWPOINT FINANCIAL GROUP	1.24	0.80	1.26	0.80	1.17	0.85	1.11	0.90
WASHINGTON FEDERAL INC	1.00	1.00	1.00	1.00	1.10	0.91	1.00	1.00

Table 3 illustrates the peer group for the inefficient companies for the year 2011.

Company	Percentage Efficiency	ASTORIA	BANK MUT	BROOKLINE BANCORP IN	DIME COMMUNITY BANK	HUDSON C	NEW YORK	NORTHWE	ORITANI FI	PEOPLE'S	PROVIDEN	TRUSTCO	VIEWPOIN	WASHINGT
Table 3. Peers for inefficient companies														
ASTORIA FINANCIAL CORP	74%	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BANK MUTUAL CORP	68%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
BROOKLINE BANCORP INC	100%	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIME COMMUNITY BANCSHARES	100%	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HUDSON CITY BANCORP INC	100%	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NEW YORK CMNTY BANCORP INC	99%	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NORTHWEST BANCSHARES INC	95%	0.00	0.00	0.01	0.42	0.00	0.00	0.00	0.00	0.57	0.00	0.00	0.00	0.00
ORITANI FINANCIAL CORP	100%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
PEOPLE'S UNITED FINL INC	100%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
PROVIDENT FINANCIAL SVCS INC	93%	0.00	0.00	0.00	0.66	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.00	0.00
TRUSTCO BANK CORP/NY	92%	0.00	0.00	0.25	0.62	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0
VIEWPOINT FINANCIAL GROUP	90%	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0
WASHINGTON FEDERAL INC	100%	0	0	0	0	0.00	0	0	0	0	0	0	0	1

Company	Efficiency	Loan Lo	Net Inte	Return on Asset
Table 4. Slack values for input and output factors for the year 2011				
ASTORIA FINANCIAL CORP	0.1112	0.1099	0.4924	0.0000
BANK MUTUAL CORP	0.0383	0.1289	0.0000	2.6300
BROOKLINE BANCORP INC	0.0000	0.0000	0.0000	0.0000
DIME COMMUNITY BANCSHARES	0.0000	0.0000	0.0000	0.0000
HUDSON CITY BANCORP INC	0.0000	0.0000	0.0000	0.0000
NEW YORK CMNTY BANCORP INC	0.0372	0.2468	0.0768	0.0000
NORTHWEST BANCSHARES INC	0.0114	0.0000	0.0000	0.0000
ORITANI FINANCIAL CORP	0.0000	0.0000	0.0000	0.0000
PEOPLE'S UNITED FINL INC	0.0000	0.0000	0.0000	0.0000
PROVIDENT FINANCIAL SVCS INC	0.0661	0.0334	0.0000	0.0000
TRUSTCO BANK CORP/NY	0.1319	0.0000	0.0000	0.0000
VIEWPOINT FINANCIAL GROUP	0.2139	0.0000	0.3520	0.0000
WASHINGTON FEDERAL INC	0.0000	0.0000	0.0000	0.0000

Appendix A: List of Thrifts and Mortgage Companies in this Study

THRIFTS & MORTGAGE FINANCE‡

AF	ASTORIA FINANCIAL CORP
BKMU	BANK MUTUAL CORP
BRKL	BROOKLINE BANCORP INC
DCOM	DIME COMMUNITY BANCSHARES
HCBK	HUDSON CITY BANCORP INC
NYB	NEW YORK CMNTY BANCORP INC
NWBI	NORTHWEST BANCSHARES INC
ORIT	ORITANI FINANCIAL CORP
PBCT	PEOPLE'S UNITED FINL INC
PFS	PROVIDENT FINANCIAL SVCS INC
TRST	TRUSTCO BANK CORP/NY
VPFG	VIEWPOINT FINANCIAL GROUP
WAFD	WASHINGTON FEDERAL INC

A SECURE MULTIMATCHER SYSTEM FOR FINGERPRINT VERIFICATION

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ABSTRACT

In this work we propose a multimatcher system for fingerprint verification for obtaining a system that is almost comparable with the state-of-the-art commercial matchers. One of the main problems in fingerprint identification, given the frequency of low quality images, is to adjust, as optimally as possible, the alignment of two fingerprints for comparison. In this paper we describe a multimatcher system that varies the preprocessing method using different wavelet decompositions of the original fingerprint image. After the alignment step, we also propose some variants of the widely used TICO method that utilize different descriptors (minutiae-based, correlation-based, and texture-based methods) for describing the area around the minutiae. Moreover, since our alignment method is based on texture features describing the appearance of the fingerprint pattern in a broad region around the minutia, we find that we can also couple it with Biohashing for obtaining a more secure fingerprint authentication approach. Results are validated on all four FVC2004 DBs and on the easier FVC2002 DB2. We also investigate the fusion among the proposed methods with the competitor systems in the FVC2004 competition. The MATLAB code used in our experiments is freely available for download at http://www.dei.unipd.it/wdyn/?IDsezione= 3314& IDgruppo_pass=124&preview=".

Keywords: fingerprint identification; texture descriptors; minutiae; biohashing; multimatcher.

1. INTRODUCTION

Biometrics is the science of measuring and discovering universal physical, biological, or behavioral characteristics that are unique to individuals. Popular biometrics utilized by contemporary biometric systems includes facial appearance, iris patterns, and fingerprints. Biometric recognition is based on the automatic recognition or identification of an individual based on one or more biometric patterns. Advances in biometric technology are focused on producing better recognition accuracy, security, and cost effectiveness. Basing security on

biometrics is a much more reliable and viable solution to contemporary security problems than basing it on passwords, badges, and USB keys, all of which can be forgotten or lost, recorded or cloned, shared, and stolen. Because biometric authentication is directly dependent on physiological or behavioral aspects possessed by a given subject, biometrics represents the only form of authentication that directly authenticates a user. As the need increases for organizations to secure critical systems, ad hoc networks [26], and sensitive data, biometric technology will continue to grow in importance. Moreover, it is extremely important to begin securing biometric systems since an individual's biometric information lasts a life-time and usually cannot be changed.

Fingerprints are one of the oldest and most frequently used biometrics [6], mainly because fingerprints are easy to acquire, unique, and immutable. As a result, fingerprint recognition systems are the focus of much research [15] [30]. These systems must deal with several problems, including the variable quality of acquired fingerprints, distortions and degradations in the fingerprints themselves (due to cuts, bruises, and calluses), impersonation, and fraud detection. It is very difficult to extract characteristic features in the fingerprint that offer the most relevant and secure information.

In general, fingerprint systems can be classified into three categories based on the type of features and methods used in classification. The first category is based on extracting minutiae points (points where ridges end or are split into two ridges) from fingerprint images. Minutia-based systems match prints by seeking out the best alignment among two sets of minutiae [29]. The second category is correlation-based. This approach estimates the degree of similarity between a sample and a template by calculating the spatial correlation between corresponding pixels, without using specific features [1]. The third category is image-based. This approach extracts local or global texture features from the fingerprint pattern and uses a distance metric or a classifier to make a matching decision [9].

Minutiae-based approaches have been widely studied and are used in many commercial fingerprint matching systems. Minutia-based methods are oftentimes favored because they are analogous to the way forensic experts compare fingerprints. As a result, minutia-based methods have legal standing in many countries. Machine learning systems that use minutiae are evaluated based on the accuracy of the minutiae extracted and on the efficacy of a point pattern matching model. Spurious and missing minutiae are common problems in low quality fingerprints and can introduce errors in minutiae correspondence. Thanks to their high level of uniqueness and practicality in comparison with other types of fingerprint features (e.g., ridge orientation and skin pores) approaches based on minutiae typically provide the best classification results [9] [24].

Correlation and image-based methods are gaining in popularity. Correlation-based matching involves superimposing two fingerprint images and then calculating a pixel-wise correlation for different displacements and rotations [8] [11]. Correlation-based methods provide good classification rates but require accurate alignment.

Image-based approaches use powerful methods for extracting relevant features from images, such as Local Binary Patterns (LBP) [21] [20] [27] [10] and Gabor filters [23], both widely used in texture recognition. The advantage of using texture features is that they can be represented as fixed length vectors that can be used for indexing purposes (e.g., multidimensional index [7]) or as couples in some protection strategy, such as in Biohashing [12] [18]. The recognition performance of image-based approaches, however, is not

comparable with minutiae-based methods, but recent experiments have demonstrated that the fusion of image-based and minutiae-based methods outperforms the best stand-alone approaches [15] [24].

Another drawback of image-based systems is the need for precise alignment among images. Both core alignment and minutiae alignment have been proposed in the literature [15] [18]. In core alignment, each fingerprint is aligned to a template by considering a reference point, called the core point. FingerCode [9] and its variants [25] [28] [31] use Gabor filters or other texture descriptors in the area around the core point. Unfortunately, it is very hard to find a reliable reference point in low quality images. In minutiae alignment [24] [2], a fingerprint is aligned to a template considering its minutiae sets [19] [19] [18]. Minutiae alignment is more robust than core alignment [24] but requires a reliable minutiae extraction method. Two excellent recent methods based on minutiae alignment use, in the one case, LBP combined with Gabor descriptors [20] and, in the other case, local Gabor filters extracted starting from the minutiae localizations and orientations [2].

In this paper, we start with the well-defined literature on hybrid/multimatcher approaches for fingerprint authentication by proposing a system that performs comparatively well to other systems but that is also able to be linked with biohashing for secure biometric verification. The good performance of the proposed method is validated using several benchmark datasets: all four FVC2004 datasets and DB2 of FVC2002. An additional experiment shows that the fusion between our approach and the competitor systems of the FVC2004 competition outperforms the winner of FVC2004.

Since the main problem in fingerprint authentication is the alignment of the two fingerprints to be compared, we have modified the well-known TICO method [29] by changing the descriptors used for describing the area around the minutiae. We combine different TICO-based approaches (each based on a different minutiae descriptor and a different preprocessing method) for minimizing the number of erroneously aligned couples of fingerprints. Moreover, different descriptors are extracted from the image after the alignment step. Each descriptor is then used to build a different texture-based matcher, and the matchers are combined by sum rule. We highlight the fact that our proposed system can be coupled with a Biohashing technique [5], since both the descriptors used for describing the area around the minutiae in the TICO approach and the texture features used for matching are fixed-length vectors. Finally, we want to stress that our proposed approach is not a heavily parameterized system in need of fine-tuning for each dataset. It works out of the box. In all reported results, we used the same parameters across all five datasets.

The remainder of this paper is organized as follows. In section 2 we discuss the fingerprint matching approach examined and proposed in this study. In section 3 we report the experimental results obtained using the FVC2004 and FVC2002 datasets. Finally, in section 4, we draw some conclusions and mention directions for future research.

2. FINGERPRINT MATCHING SYSTEM

A complete system for fingerprint verification is usually broadly composed of the following three steps: 1) an enhancement step used to improve the quality of the input image; 2) a feature extraction step; and 3) a matching step based on a distance evaluation and/or classification method. In this section, we explain the steps of our fingerprint matching system, designed according to the structure depicted in figure 1.

Our algorithm can be broken down into the following steps:

STEP 1: ENHANCEMENT. The fingerprint image is enhanced by the approach proposed by Chikkerur et al. [4]: it is based on the Fourier analysis for estimating the local ridge orientation and the frequency information.

STEP 2: MINUTIAE EXTRACTION. In this work we perform minutiae extraction with the main aim of aligning the image, since we do not use a pure minutiae-based matcher. The minutiae are extracted using the CUBS toolbox [4].

STEP 3: PREPROCESSING (WAVELET IMAGE TRANSFORMATION). Each image is projected onto a transformed space by two-level wavelet decomposition [16]. This step is motivated by [13], where performance was boosted in an image-based fingerprint matcher by designing an ensemble of matchers based on the perturbation of the preprocessing step (i.e., by performing different image transformations, with each used to train a different matcher). In this work we use such a method to choose the Haar wavelet decompositions (horizontal and vertical details at the first level of decomposition are used). An example of Haar wavelet decomposition is shown in figure 2.
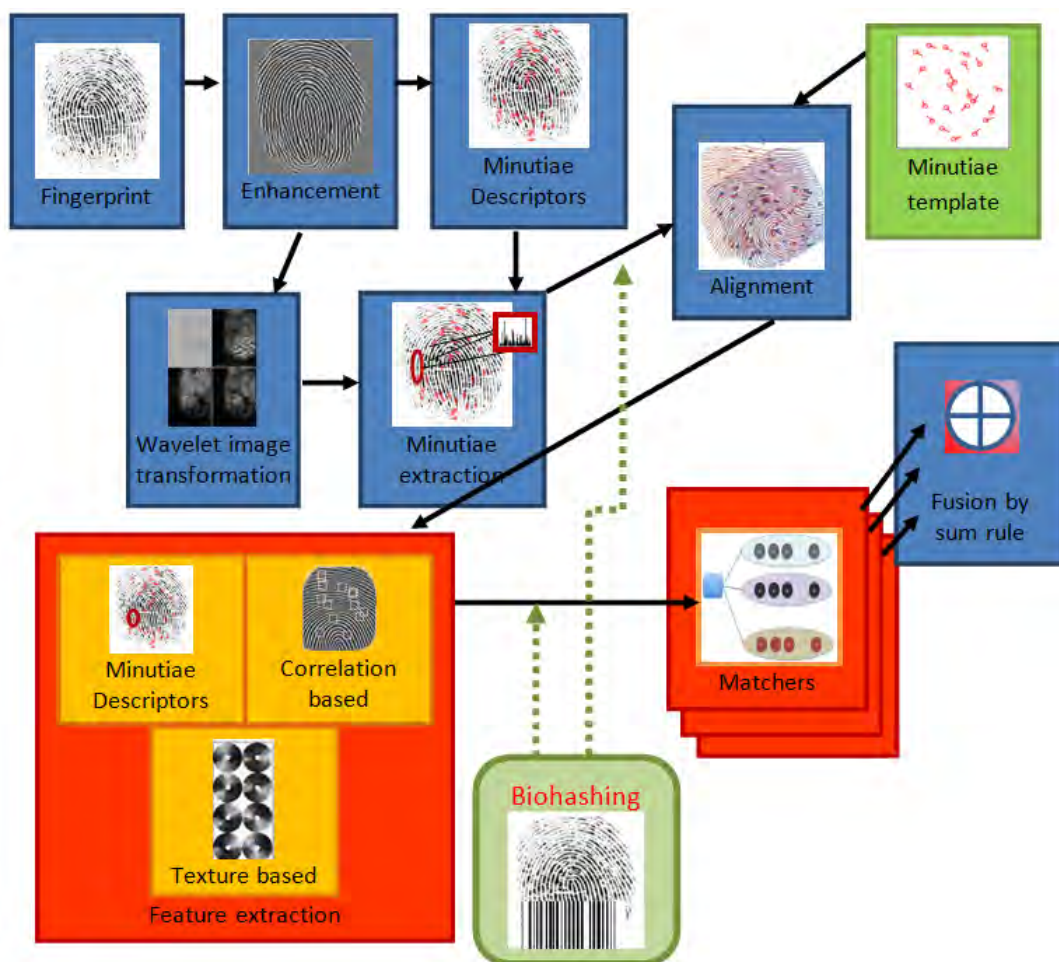
Figure 1. Schema of the proposed approach.

STEP 4: MINUTIAE DESCRIPTORS. According to the original idea proposed in [29] (the TICO approach), we extract local descriptors from a small region around each minutia: this additional information is used to improve the alignment procedure. The descriptor proposed in [29] captures information in a region of the fingerprint by surrounding a minutia position by concentric rings, and using the minutia direction as the reference point for ordering the rings in a counterclockwise direction. In this way, the descriptor becomes invariant to rotation and translation. Differently from [29], we have tested several texture based descriptors for describing the area around the minutia. In our final system, we have combined different minutiae descriptors for minimizing the number of erroneously aligned couples: the original TICO descriptors (TD), LBP [21], with two different radii, and histogram of gradients [18]. These four matchers (one for each descriptor) are combined by weighted sum rule, where the weight of TD is 3 and the weight of the other three matchers is one.

STEP 5: FINGERPRINT ALIGNMENT. A minutiae-based matcher is used in our system to evaluate the best roto-translational movement for aligning the input fingerprint to the template. In this work the matcher is a modified version of [29], designed to deal with the texture descriptors used in *STEP 4*.

STEP 6: FEATURE EXTRACTION AND MATCHING. Our system is a composition of matchers from different categories, divided according to the taxonomy proposed in [15], namely, into correlation-based, image-based, and minutiae-based matchers. A detailed description of these three matchers is provided separately below.

STEP 7: BIOHASHING (OPTIONAL). Biohashing is an encryption technique for providing more secure fingerprint authentication [17]. BioHashing and its variants can be considered a feature transformation that calculates a vector of bits, commonly called the BioHash code, from a biometric feature vector and a Hash key, or seed. In this work, we use BioHashing both in the minutiae descriptors (*STEP 4*) and in the texture descriptors (*STEP 6*), both of which are fixed-length vectors. The correlation-based matcher cannot be coupled with the Biohashing module, since it requires the gray-level image. Using Biohashing, a biometric descriptor is reduced to a bit vector of size m, and compared to the template by the Hamming Distance. In this work, we use the improved algorithm for generating the BioHash code [17].

Figure 2. On the left an enhanced fingerprint, on the right its one-level decomposition by Haar wavelet (the selected bands are highlighted).

STEP 8: FUSION. The scores from different matchers (*STEP 6*) are combined using the sum rule, i.e., by summing the scores of a pool of classifiers that belong to an ensemble for the final score. It is important to note that before fusion, the scores are normalized to a mean of 0 and a standard deviation of 1.

In the remainder of this section, we describe the three types of matchers used in *STEP 6*.

2.1 Correlation-based matchers (COR)

COR estimates the degree of similarity between two fingerprints by calculating the spatial correlation between corresponding pixels [1]; therefore, to be accurate, alignment is important. In this work we propose a "local" correlation-based matcher, which, instead of calculating a global correlation, performs an image tessellation in overlapping square regions of dimension 50×50 (*overlap*=50%). We use the normalized 2-D cross-correlation for comparing two regions.

To reduce the computation time, we use only the alignment obtained considering TD and LBP with (R=3, P=24) (see section 2.3, below). We thus have six correlation matchers: two different alignments and three different preprocessing methods of the image (original image; Haar wavelet, first level of decomposition, horizontal details coefficients; and Haar wavelet, first level of decomposition, vertical details coefficients). These matchers are combined by the weighted sum rule. The weight of TD coupled with original image is two; otherwise, the weight is always one.

2.2 Texture-based matchers (TEX)

TEX is a matcher that exploits the information in the fingerprint pattern. In this work we test several texture descriptors to represent the image patterns, but only report the results obtained by the best approaches: two descriptors based on Local Phase Quantization (LPQ) [22], obtained by varying the method used for local frequency estimation (STFT with uniform window and Gaussian derivative quadrature filter pair), extracted from the image filtered by Gabor filters.

In TEX, first, the image is decomposed into overlapping square cells of dimension 50×50 (overlap=50%). Each cell is then resized to dimension of 25×25 (to reduce the computation time) and convolved, as in [18], with a bank of 2 Gabor filters at different scales and orientations (i.e., the two LPQ descriptors are extracted from two different filtered images). Before the convolution, each subwindow is normalized using the method as in [18]. The two Gabor filters are 1) scale $\sigma=2$, angle $\theta = 90°$, fixing the frequency to $\nu=1/3$ and 2) scale $\sigma=1$, angle $\theta = 135°$, fixing the frequency to $\nu=1/3$.

The matching value between two fingerprints (previously aligned) is calculated separately for each descriptor, and the two distances are combined by sum rule according to the City block distance function, which calculates the distance between descriptors x_r and x as follows

$$dist_{CB}(x_r, x_s) = \sum_{j=1}^{n} |x_r(j) - x_s(j)| \qquad EQ: 1.$$

In all TEX experiments, we use three descriptors: 1) LPQ (STFT with uniform window) extracted from the original image; 2) LPQ (STFT with uniform window) extracted from the Gabor filtered image (angle $\theta = 135°$); and 3) LPQ (Gaussian derivative quadrature filter pair) extracted from the Gabor filtered image (angle $\theta = 90°$).

To reduce computation time, we use only the alignment obtained considering TD and LBP with (R=3, P=24) (see section 2.3 below). Thus, we have eighteen TEX matchers: two with different alignments, three with different preprocessing methods of the image (original image; Haar wavelet, first level of decomposition, horizontal details coefficients; and Haar wavelet, first level of decomposition, vertical details coefficients), and three different descriptors. These matchers are combined by weighted sum rule. The weight of TD, coupled with original image, is two; otherwise, the weight is always one.

2.3   Minutiae-based matchers (MIN)

In this work we do not use a pure minutiae-based matcher, but rather a matcher based on descriptors that capture information in the region of the fingerprint surrounding a minutiae position with concentric rings (as described in *STEP 4*). The matching score returned by the MIN matcher is the average distance among each couple of mated minutiae obtained in the alignment step. The distance between each couple of minutiae is evaluated according to the selected descriptor. The minutiae descriptors are the original TICO descriptors [29], LBP [21], with different radii, and the histogram of gradients (HOG) [18].

LBP is a powerful texture descriptor based on the occurrence histogram of the LBP operator. The LBP operator is rotation invariant and evaluates the binary difference between the gray value of a pixel **x** and the gray values of P neighboring pixels on a circle of radius R around **x**. The final descriptors are obtained with ($R=2$, $P=16$) and ($R=3$, $P=24$).

For HOG, each image in our experiments is divided into a grid with 3 rows and 3 columns (9 cells total). The orientation and magnitude of each pixel is calculated. The absolute orientation is divided into 9 equally sized bins, which results in a 9-bin histogram per each of the 9 cells.

3. EXPERIMENTAL RESULTS

In order to evaluate the proposed system, several experiments have been carried out on the most used benchmarks for fingerprint recognition: the four databases of FVC2004 [14], considered very difficult, and the easier FVC2002 DB2 (named "2002" in the tables below). All the experiments follow the well-known FVC testing protocol [14], which include the following matching attempts:
1. Genuine recognition attempts, where the template of each impression is matched against the remaining impressions of the same user;
2. Impostor recognition attempts, where the template of the first impression is matched against the first impressions of the remaining fingers.

The system performance is measured according to the Equal Error Rate (EER) [15] performance indicator. In the following tables, the label **AV** is related to the average EER of the given approach in all the tested datasets.

The first experiment evaluates the performance of a minutiae-based system, which can be considered a baseline for results. In Table 1 the performance of some matchers obtained by varying steps *3* and *4* are compared, i.e., a simple minutiae-based matcher is coupled with different wavelet preprocessing approaches and/or descriptors.

The following approaches are compared in Table 1:
- *TICO* is the original method proposed in [29]. This is a system where *STEP 4* is performed using the original TICO descriptors, and *STEP 3* is not performed;
- *MINw* is an ensemble of minutiae-based matchers, each evaluated starting from a different preprocessing method (*STEP 3*) of the image [13] (original image; Haar wavelet, first level of decomposition, horizontal details coefficients; and Haar wavelet, first level of decomposition, vertical details coefficients) combined by sum rule. This is a system where the *STEP 4* is performed using the original TICO descriptors;
- *MINm* is an ensemble of minutiae-based matchers (as described in section 2.3), with each based on a different minutiae descriptor (without the preprocessing step), combined by sum rule. This is a system where *STEP 3* is not performed;
- *MINmw* is an ensemble of minutiae-based matchers with different preprocessing steps. This is a system where both *STEP 3* and *STEP 4* are performed, as described in section 2.

	DB1	DB2	DB3	DB4	2002	AV
TICO	14.66	7.93	10.10	7.81	2.57	8.61
MINm	13.62	7.78	8.24	6.24	2.45	7.68
MINw	12.60	7.24	8.74	7.03	2.20	7.46
MINmw	12.45	7.11	7.32	5.98	2.10	6.99

Table 1. EERs obtained by different minutia based's approaches.

From the results reported in table 1, it is clear that combining different minutiae-based matchers provides a performance improvement with respect to the stand-alone approach. In our opinion, this is due to the fact that the use of an ensemble of alignments (*STEP 3* and *STEP 4*) improves the quality of the alignment.

The second experiment is aimed at evaluating the performance of the other two matchers described in sections 2.1 (COR) and 2.2 (TEX), coupled with different wavelet alignments:
- *{COR, TEX}*, the matchers based on a stand-alone alignment by the original TICO approach;
- *{CORmw, TEXmw}*, ensemble of matchers where alignment is performed as in *MINmw* and as described in section 2.

	DB1	DB2	DB3	DB4	2002	AV
COR	12.72	4.60	6.49	3.53	1.47	5.76
CORmw	11.81	4.89	6.42	2.77	1.63	5.50
TEX	10.89	4.75	4.86	4.49	2.40	5.48
TEXmw	10.06	5.07	4.56	4.42	2.38	5.29

Table 2. EERs obtained using different matchers and their version based on different alignments.

The results in table 2 show that using an ensemble of alignments (*STEP 3* and *STEP 4*) with these two matchers does not provide the same gain as was the case with the minutiae-based matcher. This could be due to the fact that the wavelet selection optimized the minutiae-matcher and thus could be descriptor dependent.

The third experiment is aimed at evaluating our complete system, as described in section 2, and comparing it with two other approaches.

In table 3 we report the performance of the following systems:
- *MCT* is the system proposed in this paper, that is a the combination by the sum rule among *MINmw, CORmw,* and *TEXmw*;
- *HFM* is the system proposed in [3] based on a combination of different enhancement techniques and matchers;
- *LFE*, a minutiae-based matcher recently proposed in [5] obtained by coupling the complete NIST FIS2 matcher (the bozorth3 package) with different enhancement methods;
- *ENH* combines the ideas in this paper with [3], i.e., the creation of a multimatcher based on the variation of the enhancement step. The multimatcher tested in this work is the fusion by the sum rule of *MINmw*, *Chikkerur approach*+TEX, *ROM approach*+MIN, *Yang approach* (with the segmentation step)+*MIN*. See [3] for a detailed description of the enhancement procedures. Their MATLAB code is available in the toolbox for this paper.

	DB1	DB2	DB3	DB4	2002	AV
MCT	9.60	4.31	4.40	2.64	1.63	4.51
ENH	8.84	3.92	3.49	2.31	1.10	3.93
HFM [3]	9.59	4.30	2.92	2.83	1.26	4.18
LFE [5]	12.00	8.20	5.00	7.00	---	---

Table 3. Comparison among different free approaches.

The multimatcher approach proposed in [3] obtains a lower EER with respect to *MCT*, but the use of different enhancement techniques requires higher computational cost. The idea of our approach gains a performance improvement if coupled with different enhancement methods (*ENH*) and obtains a lower EER, but at the cost of higher complexity. In [5], the best EERs were obtained by coupling the complete NIST FIS2 matcher (the bozorth3 package) with different enhancement methods. The NIST matcher is very old but still very widely used by researchers as a baseline method, primarily because it is freely available. Our proposed multimatcher (*MCT*) outperforms these free toolboxes.

The fourth experiment, reported in Table 5, gives the EER obtained by combining our multimatcher (ENH) with the best performing systems in the FVC2004 competition (according to the average EER in the four datasets), with the aim of determining whether the fusion of *ENH* with commercial state-of-the-art approaches improves performance. The results in Table 5 demonstrate that coupling *ENH* with the FVC2004 competitors often improves performance.

	DB1	DB2	DB3	DB4	AV
P101	2.72	3.56	1.19	0.79	2.07
P101+ENH	2.53	1.96	0.89	0.58	1.49
P047	1.97	3.49	1.18	1.76	2.1
P047+ENH	2.45	2.77	1.21	1.38	1.95
P071	4.37	2.58	1.63	0.6	2.3
P071+ENH	4.6	2.49	1.42	0.63	2.28
P004	4.1	2.78	1.88	1	2.45
P004+ENH	4.1	2.17	1.31	0.89	2.11
P039	7.17	1.58	1.78	1.07	2.9
P039+ENH	6.9	1.6	1.19	0.91	2.65

Table 5. Fusions among the best competitors of FVC2004 and *ENH*.

3.1 Biohashing

The fifth experiment is addressed at evaluating BioHashing applied to the novel feature vector based on texture-based features. Because the BioHashing approach requires a fixed length feature vector, it cannot be applied so easily to minutiae-based methods. In the experiments reported in Table 6, the performance is obtained by improving the BioHashing matcher in [17] related to 1) the worst test case when an "impostor" always steals the hash key and 2) the best case when the key is not stolen (the original method in [17] is also reported for comparison). As can easily be seen, in the best and most probable case when the hash key is not stolen, the BioHashing approach gives excellent results, even on the difficult FVC2004 datasets.

	DB1	DB2	DB3	DB4	2002	AV
MCT	9.60	4.31	4.40	2.64	1.63	4.51
Worst	12.20	5.68	5.12	2.95	2.24	5.63
Best	3.25	0.45	0.52	0	0	0.84

Table 6. EER obtained by BioHashing matcher in the two testing protocol.

4. CONCLUSION AND DISCUSSION

One of the main problems in fingerprint identification is to align the two fingerprints that should be compared. To obtain at least one good alignment, given a couple of low quality fingerprints, we propose some variants of the widely used TICO method of changing the descriptor used for describing the area around the minutiae by performing a wavelet-base preprocessing step. After the alignment, several matchers of different types are fused: some correlation-based, some texture-based, and some minutiae-based. Moreover, since our alignment method is based on texture features describing the appearance of the fingerprint pattern in a broad region around the minutia, we couple it with Biohashing to obtain a more secure fingerprint authentication approach.

Our experiments show that the proposed multimatcher approach works well on all the FVC2004 datasets as well as the FVC2002-DB2 dataset without parameter fine tuning for each dataset. Our results show a significant improvement over the baseline TICO matching algorithm. Results are superior to those reported by several academic systems, and our system is nearly comparable to the commercial competitors of FVC2004.

The application of the Biohashing procedure to our approach provides secure storage and transmission of biometric data. In particular, we highlight the fact that the minutiae-based alignment needs only the position of the minutiae, not the type, for the fingerprint image around the minutiae to be secured by Biohashing. Similarly the matching procedure is secured by Biohashing. Thus, the only information that can be stolen is the position and angle of the minutiae, which has been proven to be insufficient to synthetically reconstruct a fingerprint that can spoof a texture-based system [18].

Our MATLAB toolbox is freely available and can be used to verify or compare the results of our system. We also hope that it will serve as the foundation for further explorations in the field.

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HETEROGENEOUS ENSEMBLES FOR THE MISSING FEATURE PROBLEM

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ABSTRACT

Missing values are ubiquitous in real-world datasets. In this work, we show how to handle them with heterogeneous ensembles of classifiers that outperform state-of-the-art solutions. Several approaches are compared using several different datasets. Some state-of-the-art classifiers, e.g., SVM and RotBoost, are tested first and coupled with the Expectation-Maximization (EM) imputation method. The classifiers are then combined to build ensembles. Using the Wilcoxon signed-rank test (reject the null hypothesis, level of significance 0.05), we show that our best heterogeneous ensembles, obtained by combining a forest of decision trees (a method that does not require any dataset-specific tuning) with a cluster-based imputation method, outperforms two dataset-tuned solutions: a stand-alone SVM classifier and a random subspace of SVMs, both based on LibSVM, the most widely used SVM toolbox in the world. Our heterogeneous ensembles also exhibit better performance than a recent cluster-based imputation method for handling missing values (a method which has been shown to outperform several other state-of-the-art imputation approaches) when both the training set and the testing set contain 10% missing values. The MATLAB code of several tested descriptors, along with the datasets used in our experiments, is available at http://www.dei.unipd.it/wdyn/?IDsezione=3314&IDgruppo_pass=124& preview=.

Keywords: missing values; imputation methods; support vector machine; decision tree; ensemble of classifiers.

1. INTRODUCTION

Whether in business or in other domains, real data are rarely perfect. In most cases they are incomplete, vague, and inaccurate: survey questions are riddled with random or missing answers, images are often out of focus, sensors fail, and equipment malfunctions. These and other circumstances, such as extreme noise and accidental deletions and errors, can introduce values in datasets that bias estimation and prediction [24].

Of the various problems encountered in data sources, missing data is one of the most common [17]. Methods for handling missing values depend on the severity of the problem. In general, a missing data rate lower than 1% is not significant, while rates between 1% and 5% are considered manageable. Missing data rates between 5% and 15%, however, require sophisticated imputation

methods for treating the missing values, and rates greater than 15% are generally considered to have a severe impact on results. Missing values can be measured in the simplest case by searching for null values, but there are other forms of missing values that are more difficult to detect, such as outliers and values that that lie outside predetermined ranges [22].

Missing values are particularly problematic when working with machine learning algorithms. In neural networks and K-Nearest neighbor algorithms, for instance, missing values can result in variance underestimation, distribution distortion, and correlation depression. In some cases, the algorithms are unable to handle missing data. Unfortunately, the most common method for dealing with the problem in machine learning is essentially to ignore it [13] by using a technique commonly referred to as "filtering." This method for handling missing values works sufficiently well when missing data rates are below 5%, but becomes increasingly unsatisfactory when rates are higher. In some application areas, e.g., in epistatic miniarray profiling (E-MAP) [21], which is used for the analysis of genetic-interaction maps in the form of symmetric matrices, missing data rates can exceed 30%. In this case, discarding all genes that contain missing values would result in removing more than 90% of the data in the E-MAP matrix. Filtering in these cases greatly compromises the value of such studies.

In cases where missing values exceed 5%, there are a number of statistical models that could be used to assess the impact of missing values and to determine the best imputation method for treatment. According to Little and Rubin [17], models of missing data randomness can be divided into three classes: MCAR (**M**issing **C**ompletely **A**t **R**andom), where the probability for a random variable X is independent of the actual value of X or the values of the other features; 2) MAR (**M**issing **A**t **R**andom), where the missing probability is independent of the value of X after controlling the other features; and 3) NMAR (**N**ot **M**issing **A**t **R**andom), where the probability that X is missing might depend on the value of X itself. MCAR is usually the model of choice, but in many real-world applications MAR is a more realistic assumption [18].

Typical methods for data imputation essentially replace a missing value with one which has the greatest similarity to others in the dataset, as in *hot-deck* imputation [11], where new values for a feature are computed as the mean of that feature across the training set or across *k*-nearest neighbors. Robust statistical approaches have also been developed. A popular choice is multiple imputation (MI) [26], which replaces missing values by their $m > 1$ simulated versions (*m* typically small). Each of the simulated datasets is analyzed using standard methods, and the results are combined to produce estimates and confidence intervals that incorporate the uncertainty introduced by the missing data. For recent surveys on imputation methods, see [6] [23] [8].

The last ten years have witnessed the development of powerful machine learning imputation methods that fill in missing values by constructing a predictive model to estimate the values that are lacking from information in the dataset. These investigations have examined the application of some well-known stand-alone classifiers, such as the Multi-Layer Perceptron (MLP), K-nearest neighbors (KNN), self-organizing maps (SOM) and decision trees (DT) [28]. Bayesian networks have also produced some good results [9] [12]. In [12], for example, two Bayesian methods for imputation are proposed that are based on the construction of Bayesian networks for each feature with missing values.

A number of excellent studies of various imputation methods compared with or combined with machine learning algorithms have also recently appeared. In [28] single imputation, likelihood-based multiple imputation (MI), probabilistic split, and surrogate split are compared for coping with missing values in decision trees. Using real datasets, comparisons show MI to be the top performer. In [4], an iterative boosting method is proposed for improving the quality of the imputed features,

and, in [5], the same authors investigate the influence of imputation on classification error for five methods. These studies conclude that imputation is usually beneficial for the classification of instances with missing values. In [7], a comparison of imputation methods that includes some commercial methods for MI (such as Amelia II, WinMICE, and SAS) reports that only machine learning algorithms (the study considers three: MLP, KNN and SOM) significantly improves the classification results in the presence of missing values. Moreover, all three machine learning algorithms are shown to perform equally well.

A slightly different machine learning solution is proposed in [23], which investigates a novel random subspace (RS) approach dubbed Learn++.MF. This approach makes two assumptions: 1) the feature set is partially redundant and 2) the redundancy is distributed randomly over the feature set. Learn++.MF is based on the distribution update concepts of Learn++, with the random feature selection of RS. When an instance with missing values is introduced, only those classifiers trained with the features that are presently available in that test pattern are used for classification. In their study, the authors compare Learn++.MF with the one-class approach [14], the expectation-maximization (EM) approach [27], and another RS-based approach where the mean imputation is used for the missing values before the RS ensemble classification. They show that Learn++.MF outperforms these other methods across several datasets.

In this work, EM is used as the base imputation method, and we boost performance in the presence of missing values using a heterogeneous ensemble built on SVM classifiers as well as other ensembles. We compare our ensemble approach with other state-of-the-art classification methods using several datasets. Our best approach outperforms both a stand-alone SVM (even when the SVM kernel and the various SVM parameters are carefully fine-tuned for each dataset) and a recently-proposed ensemble [20], which has already been shown to outperform several other state-of-the-art methods for handling missing values.

2. PROPOSED APPROACH

The heterogeneous ensembles we propose are based on the fusion by sum rule [15] of different state-of-the-art classifiers, which in turn may be ensembles of classifiers themselves (e.g., a random subspace of RotBoost). In our opinion, the main value of such *ensembles of ensembles* is that they offer the most feasible way of coping with the "no free lunch" theorems, which state that any two optimization algorithms in a suitable class exhibit the same performance when results are averaged across all possible problem sets (see, e.g., [29]). In other words, heterogeneous ensembles may be one of the best performing methods across various classification problems in the presence of missing values. Different ensembles are tested in this paper. In the remainder of this section, we describe the building blocks composing these ensembles.

2.1 Expectation-Maximization (EM) [1]

EM [27], first proposed in 1977 [2], is an iterative method for parameter estimation that uses maximum likelihood criteria. In this work we use EM as the core method to fill in missing values before training the classifiers in our ensembles.

EM formalizes an intuitive method to manage missing values and can be outlined as follows:
1. Estimate initial parameters using complete data.
2. Use parameters to estimate and evaluate missing data.

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[1] Details and MATLAB code: http://www.gps.caltech.edu/~tapio/imputation/ (accessed: 18 October 2012).

3. Use the *new* estimated data to reevaluate parameters.
4. Repeat steps 2 and 3 until convergence.

Formally, let a dataset, given as a data matrix $\mathbf{X} \in R^{n \times p}$ with n patterns and p features, contain some rows (patterns) with missing values. For each pattern x_i let a be the portion of the row for which values are available (p_a columns) and m the portion where values are missing ($p_m = p - p_a$ columns). Let us define $\mathbf{\mu}$ and $\mathbf{\Sigma}$ as the mean and the covariance matrices of the dataset, which are correspondingly partitioned between available and missing values for a given row. The goal of EM is to replace the missing values with values that are consistent with the available data. The missing values are assumed to be randomly scattered according to a normal distribution.

For each row x_i the relation between the available and the missing portions is modeled by a linear regression:

$$\mathbf{x}_m - \mathbf{\mu}_m = (\mathbf{x}_a - \mathbf{\mu}_a)\mathbf{B} + e, \qquad \text{EQ. 1}$$

where e is the imputation error, with zero mean and unknown covariance matrix $\mathbf{C}$, and $\mathbf{B}$ is the regression coefficients matrix. EM estimates $\mathbf{\mu}$, $\mathbf{\Sigma}$, $\mathbf{B}$, and $\mathbf{C}$ (for details see [27]). Using the estimated parameters, the missing values are filled in and new estimates of $\mathbf{\mu}$ and $\mathbf{\Sigma}$ are calculated. The whole process is repeated until values for estimated data are stable.

2.2 Random Subspace (RS)

RS [10] is an ensemble combining technique that is used in some our ensemble experiments. Consider a training set $\mathbf{X}$ formed by n vectors $\mathbf{x}_i = (x_{i1}, x_{i2}, \dots, x_{ip})$ with p features each. RS randomly selects $r < p$ features from the original feature space and creates a new training set $\mathbf{X}^r$. Each vector $\mathbf{x}_i \in \mathbf{X}^r$ is thus r-dimensional. A classifier is built using the new training set $\mathbf{X}^r$, i.e., using a reduced feature space. This process is repeated b times, so that b random feature subsets and b classifiers are created. The final classification is obtained by combining the scores of the b classifiers.

An outline of the RS algorithm is the following:
1. **For** i=1 **to** b **do:**
   a. Select an r-dimensional random subspace $\mathbf{X}^r$
      from the original p-dimensional feature space
   b. Train a classifier $C_i(x)$ on $\mathbf{X}^r$
   Endfor
2. Combine classifiers $C_i(x)\ i = 1, \dots, b$ by a simple combination method. The sum rule is used in this paper:

$$score_{RSM} = \frac{1}{b} \sum_i score_{C_i(x)} \qquad \text{EQ. 2}$$

2.3 Support Vector Machine (SVM)

SVM [1] is a linear binary classifier. In our work we use SVMs as core classifiers in several of our ensembles. An SVM performs classification by cutting the n-dimensional space, with n being the number of features, into two regions associated with two distinct classes which are often referred to as the *positive class* and the *negative class*. The regions are separated by an n-dimensional hyperplane that has the largest possible distance d from the training vectors of the two classes. To

formally define an SVM, consider a set of training vectors $(x_1, y_1), (x_2, y_2), \ldots, (x_p, y_p)\ldots$, where $x_i \in R^n$ denotes the i-th input vector and $y_i \in \{+1, -1\}$ is the corresponding label. If there are unequal misclassification costs, the optimization problem becomes:

$$\text{minimize } \frac{1}{2}\|w\|^2 + C_+ \sum_{i:y_i=1} \xi_i + C_- \sum_{j:y_j=-1} \xi_j$$

$$\text{Subject to } y_k(w \cdot x_k + b) \geq 1 - \xi_k, \quad \xi_k \geq 0,$$

EQ. 3

where w is a vector normal to the hyperplane, $|b|/\|w\|$ is the distance of the hyperplane from the origin, $\|w\|$ is the Euclidean norm of w, C_+/C_- are classification costs that enable a tradeoff between training errors (C_+ for positive training patterns and C_- for the negative patterns) and the margin d. The slack variable ξ_i allows for errors in classification.

To handle classes that are not linearly separable, kernel functions are used that remap the training vectors into a higher k-dimensional space ($k \gg n$) where examples become separable. With the inclusion of kernel functions and Lagrange multipliers α_i, the dual optimization problem can be formulated as:

$$\text{maximize } w(\alpha) \sum_{i=1}^{l} \alpha_i - \sum_{i=1;j=1}^{l} \alpha_i y_i \alpha_j y_j K(x_i \cdot x_j)$$

$$C \geq \alpha_i \geq 0 \ \forall i \ \sum_{i=1}^{l} \alpha_i y_i = 0.$$

EQ. 4

Training examples with a nonzero α are called Support Vectors (SVs). The hyperplane is completely defined by the SVs, which denote the training points lying at minimum distance from the hyperplane itself. The solution of the classification problem becomes a decision function:

$$f(x) = sign\left(\sum_{i=1}^{N_{SV}} \alpha_i y_i K(s_i, x) + b\right),$$

EQ. 5

where x is a vector to be classified, the s_i's are the support vectors (N_{SV} in total), and $K(s_i, x)$ is the kernel function.

2.4   Random subspace of RotBoost with NPE (RSR)

Rotation Boosting [30], or RotBoost, combines two ensemble techniques: AdaBoost and Rotation Forest. Experimental results reported in [30] show that RotBoost outperforms several variants of AdaBoost and Rotation Forest.

Starting from the original code shared by the authors of [30], in this paper the RotBoost method is improved by combining it with RS. Moreover, the Rotation Forest part of the method adopts the neighborhood preserving embedding (NPE) feature transform in lieu of PCA. Our choice is motivated by [19], which shows that RotBoost coupled with NPE outperforms standard RotBoost. RotBoost and NPE are described in detail below.

2.4.1   Rotation Boosting (RotBoost)

RotBoost [30] is an ensemble classifier technique obtained from a combination of AdaBoost and Rotation Forest. AdaBoost [32] is a sequential ensemble algorithm where a new classifier is built

each iteration by taking into account the performance obtained by the classifier created in the previous iteration. A weight is associated with each training pattern. At the beginning of an iteration, the weights of patterns that were misclassified by the previous classifier are increased, and the weights of correctly classified instances are decreased. In this way, the method focuses on difficult instances, since in each step the goal is to correctly classify instances that were misclassified in the previous iteration.

RotationForest [31] is an ensemble technique that builds each classifier on a training set that is modified by applying PCA. The primary heuristic is to exploit a feature transform method and then reconstruct a full feature set for each classifier included in the ensemble. This is performed in the following way: the feature set is randomly split into K subsets, or parameters, and PCA is applied separately to each subset. By pooling all principal components, a new set of *n* features is obtained. In this way data are linearly mapped into the new feature space, and classifiers are trained using them. The goal is to promote diversity through feature extraction while preserving accuracy by keeping all the extracted principal components.

The RotBoost algorithm is a simple combination of AdaBoost and Rotation Forest. PCA is applied first as in RotationForest, and a Rotation Matrix is obtained that maps data into a new feature space. Base classifiers are then built by applying the AdaBoost technique. As demonstrated in [30], RotBoost exhibits significantly lower misclassification errors with respect to both AdaBoost and RotationForest.

2.4.2 Neighborhood Preserving Embedding (NPE)

Neighborhood Preserving Embedding (NPE) [33] is an algorithm that solves the general problem of dimensionality reduction.[2] Given a set of points $x_1, x_2, \ldots, x_m \in R^m$, the idea is to find a transformation matrix **A** that maps these points into another set $y_1, y_2, \ldots y_m \in R^d$ where $d \ll m$. In this way, $y_i = A^T x_i$ represents x_i in a space with significantly less dimensions.

NPE begins by building a weight matrix to describe the relationships between data points: each point is described as a weighted combination of its neighbors. An optimal embedding is sought such that the neighborhood structure is preserved in the reduced space.

The algorithm can be formalized in three steps:
1) *Build an adjacency graph.* Define a graph **G** with *m* nodes. The *i*-th node represents the point x_i. There is an edge between *i* and *j* iff x_j is one of the K nearest neighbors of x_i;
2) *Compute weights.* In this step weights on edges are calculated. **W** is the weight matrix and W_{ij} is the weight of the edge from node *i* to node *j*. The matrix can be computed by minimizing the objective function:

$$\min \sum_i^m \left\| x_i - \sum_j^m W_{ij} x_j \right\|^2 \qquad \textbf{EQ. 6}$$

Subject to: $\sum_j^m W_{ij} = 1, j = 1,2, \ldots, m;$

3) *Compute the Projection.* In this step the linear projection is computed. The following eigenvector problem is solved: $XMX^T \mathbf{a} = \lambda XX^T \mathbf{a}.$ The local manifold structure is then preserved using the following transformation matrix **A** that maps x_i to y_i:

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[2] MATLAB code available from http://www.cad.zju.edu.cn/home/dengcai/Data/DimensionReduction.html.

$$y_i = A^T x_i \,, \text{ where } \mathbf{A} = (\mathbf{a}_0, \mathbf{a}_1, \dots, \mathbf{a}_{d-1}).$$ **EQ. 7**

2.5   Cluster-Based Imputation (CBor_EM)

Cluster-based imputation (*CBor_EM*) [20] is an ensemble built using a multiple imputation approach. First the missing features are calculated using EM, then the training patterns are clustered into *CN* groups (*CN*=5, in this paper). For each group a separate EM imputation is performed, and the resulting training set is used to build a classifier, which is a random subspace of SVMs. Finally, the *CN* classifiers are combined by sum rule. Moreover, in the original algorithm the multiple imputation method is coupled, by sum rule, with a random subspace of SVMs trained using the whole dataset and EM (based on the whole dataset) as imputation method (see [20] for details). The experiments in [20] show that the multiple imputation outperforms other state-of-the-art imputation approaches (CBor_EM is compared with a number of recent methods using more than 10 datasets). In this paper we test the original method based on EM using the original parameters (i.e., the same number of imputations and parameters of the clustering procedure) without any fine-tuning. We also examine a variant of the method where random subspaces are built before the clustering and imputation step. This method is referred to as *CBI* in the experimental section. This variant should work better with correlated features since random subspace is performed before the other steps.

Pseudocode for CBI can be written as follows:

   TRAINING
     1. NORMALIZATION
        `1.1`   Normalize the original training patterns (OTR) and the testing patterns to the $0 \div 1$ interval. Replace the missing values in the training set using the EM imputation, thus obtaining a new training set called ETR.
     For k = 1 to *50* **do**:
     2. RANDOM SUBSPACE
        Extract from OTR and ETR two random subspaces, OTR_k and ETR_k, that retain 50% of the set of original features
     3. CLUSTERING
        `3.1`   Use the fuzzy-based clustering method to cluster the patterns of ETR_k into *CN* groups (we simply set *CN* =10)
     For t = 1 **to** *CN* **do**:
        `3.2`   Let IDX be the indices of training patterns in ETR_k that have a similarity to the *t*-th cluster greater than *TH* (we fix *TH*=0.25 as in [20]). Let D_t be a subset of OTR_k built using the patterns whose indices belong to IDX
        `3.3`   **While** D_t contains less than 25 patterns **or** there exists a feature whose value is missing in all the patterns that belong to D_t:
          assign to D_t a random subset of 25% of all the training patterns
     4. EM IMPUTATION
        `4.1`   Fill in the missing values of OTR_k by performing a new EM imputation that uses only the training patterns in D_t. Let $ETR_{k,t}$ be the training set built using M_t
     5. CLASSIFICATION
        `5.1`   Train a support vector machine using $ETR_{k,t}$ and classify the test patterns
     Endfor
    Endfor
     6. FUSION
        `6.1`   Combine the scores obtained by the different SVMs by sum rule

3. EXPERIMENTAL RESULTS

To compare our system with other state-of-the-art approaches, we report results obtained using the *Datasets with induced missing values* from the KEEL Repository.[3] Table 1 shows the main characteristics of the datasets in terms of the number of features, examples, and classes. A detailed description of these databases is available on the UCI machine learning website.[4]

In the KEEL datasets only the training partitions are affected by missing values: to be precise, the datasets have been built by randomly removing 10% of the values. We have also modified the datasets to introduce 10% or 25% of missing values in the test partitions for performing further tests. The features in each dataset are linearly normalized to the 0÷1 interval before using them to train the classifiers.

DATASET	Abbreviation	#Features	#Examples	#Classes
Iris	IR	4	150	3
Pima	PI	8	768	2
Wine	WI	13	178	3
Australian	AU	14	690	2
Newthyroid	NT	5	215	3
Ecoli	EC	7	336	8
German	GE	20	1000	2
Magic	MA	10	1902	2
Shuttle	SH	9	2175	7
Satimage	SA	36	6435	7

Table 1. Characteristics of the datasets used in the experiments: number of features, number of examples, and number of classes.

A 10-fold cross-validation protocol is used in all experiments. For comparison purposes, it is possible to download the 10-fold cross-validation partitions from the KEEL Repository.

The error area under the ROC curve (EUC) [3, 25] is used as the performance metric. The ROC curve is a plot of the sensitivity versus false positives (1 - specificity). The error area under the ROC curve can be interpreted as the probability that the classifier will assign a lower score to a randomly chosen positive sample than it would to a randomly chosen negative sample. When a multiclass dataset is used, the one-versus-all area under ROC curve is used as the performance indicator [16]. In this case, the final EUC value is obtained by averaging all class values. The area under the ROC curve is considered one of the most reliable performance metrics [25] since it is based on both sensitivity and specificity.

Table 2 shows the results of the following classifiers when the original KEEL datasets (where only the training sets contain missing values) are used:
- **SVM**: stand-alone SVM (see Section 2.3) with kernel and parameters tuned separately for each dataset.
- **RSS**: random subspace of SVMs (see Section 2.2).
- **RSR**: random subspace of RotBoost with NPE (see Section 2.4).
- **CBor_EM**: cluster-based imputation (see Section 2.5) as proposed in [20]. The number of subspaces is set to 50.

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[3] http://sci2s.ugr.es/keel/missing.php#sub2b (accessed: 8 October 2012).
[4] http://archive.ics.uci.edu/ml/ (accessed: 8 October 2012).

- **CBI**: variant of cluster-based imputation (see Section 2.5). The number of subspaces is also 50.
- **CBI+RSS**: CBI coupled with RSS.
- **SVM+RSR**: sum rule between SVM and RSR.
- **XSVM+RSR**: weighted sum rule between SVM and RSR. The weight of SVM is *X* while that of RSR is one.
- **XCBor+RSR**: weighted sum rule between CBor_EM and RSR. The weight of SVM is *X* while that of RSR is one.

The implementation of SVM used in all our experiments is the one provided by the popular LibSVM library.

The outcome of the comparison is summarized in Table 2. The column named *Av* is the average rank and reports the relative position of a classifier against the others (if a given classifier is consistently the best in all datasets, then its rank would be 1).

DATASET	AU	EC	GE	IR	MA	NT	PI	SA	SH	WI	Av
SVM	6.94	3.89	24.68	0.20	15.92	0.12	17.05	1.09	0.49	0.04	7.9
RSS	7.37	4.17	23.04	0.53	15.45	0.22	17.00	0.94	0.69	0.04	9.1
RSR	7.02	4.65	21.26	0.27	12.77	0.10	17.27	1.00	**0.01**	**0.00**	6.0
CBor_EM	7.31	4.13	22.29	0.27	14.02	0.12	16.69	0.94	0.06	0.04	7.7
CBI	7.66	5.21	23.14	1.93	16.40	3.38	18.47	1.18	1.16	**0.00**	10.9
CBI+RSS	7.46	4.34	22.93	0.93	15.57	0.48	17.46	1.05	0.84	**0.00**	9.6
1SVM+RSR	6.81	3.88	21.81	**0.13**	13.11	**0.06**	16.50	0.83	0.03	**0.00**	**3.0**
2SVM+RSR	6.81	3.81	22.55	**0.13**	13.48	**0.06**	16.55	0.86	0.06	0.04	4.8
3SVM+RSR	**6.75**	**3.71**	22.96	**0.13**	13.82	0.15	16.59	0.89	0.09	0.04	6.1
1CBor +RSR	6.81	4.07	**20.53**	0.20	**11.75**	**0.06**	16.06	**0.80**	0.02	**0.00**	3.1
2CBor +RSR	6.94	4.01	20.84	0.27	11.86	**0.06**	15.97	0.83	0.03	**0.00**	4.3
3CBor +RSR	7.06	4.09	21.06	0.20	11.99	**0.06**	**15.90**	0.86	0.04	0.04	5.5

Table 2. EUC obtained for the different datasets and classification methods under consideration. Best results for each dataset are marked in bold.

Several interesting observations can be made from the reported results:
- A random subspace of SVMs (RSS) does not outperform a stand-alone SVM. This can be explained by observing that the datasets have few features; hence, on average, there is no correlation problem. RSS works best when there is either the curse of dimensionality and/or a correlation problem [23]. Probably for this reason the performance of CBI and CBI+RSS is lower than that obtained by the original CBor_EM method proposed in [20].
- The best results are obtained by the sum rule between SVM and RSR (i.e., 1SVM+RSR and 1CBor +RSR). In our opinion, it is very interesting that our heterogeneous ensembles outperform the most widely used SVM library (LibSVM) even when SVM is finely tuned for each dataset. As our ensembles work significantly better than LibSVM, we are making our MATLAB code publicly available for others to use.

The differences in performance between 1SVM+RSR (or 1CBor+RSR), the highest-ranking ensemble, and SVM, RSS, and CBor_EM are all statistically significant, as demonstrated by applying the Wilcoxon signed-rank test [3]. In each of these cases, the *p*-value of rejecting the null hypothesis (which assumes 1SVM+RSR exhibit the same EUC as the other classifier) was found to be less than 0.05. While the performance of 1SVM+RSR and 1CBor+RSR are similar.

The datasets in Table 1 have also been used in the literature (see [18]) for the evaluation of a different set of classifiers that operate with missing values. In [18], accuracy was selected as the measure of performance. In Table 3, we compare the accuracy of our best ensemble with the results reported for the same datasets in [18]. In both our results and in [18], the same 10-fold cross-validation partitions are adopted. It is clear that our approach exhibits superior performance across the line.

DATASET	AU	EC	GE	IR	MA	NT	PI	SH	WI
SVM+RSR	**87.68**	**88.40**	**76.50**	**96.67**	**81.81**	**96.30**	**77.23**	**99.45**	**98.30**
[18]	85.71	67.70	72.26	95.73	77.13	92.13	72.49	97.57	96.52

Table 3. Comparison using accuracy as the performance metric with the methods in [18].

DATASET	AU	EC	GE	IR	MA	NT	PI	SA	SH	WI	Av
SVM	10.96	5.37	24.61	**0.67**	16.55	1.49	16.72	1.15	0.37	0.13	8.3
RSS	9.17	6.45	23.29	0.73	15.37	1.62	16.70	0.98	0.21	0.08	8.0
RSR	**7.69**	6.51	**21.38**	0.80	13.02	0.70	18.58	1.03	0.02	0.09	6.1
CBor_EM	8.77	6.05	23.11	**0.67**	14.21	0.83	16.98	**0.80**	0.11	0.05	6.5
CBI	7.98	8.13	23.99	2.27	21.30	2.70	19.49	1.23	4.47	0.17	10.8
CBI+RSS	7.98	6.67	24.44	1.40	17.97	0.74	17.75	1.08	1.57	0.08	9.5
1SVM+RSR	8.49	**5.37**	21.83	**0.67**	13.42	0.58	16.86	0.87	0.04	**0.04**	**3.9**
2SVM+RSR	8.85	6.45	22.63	0.73	14.02	0.58	16.65	0.92	0.04	**0.04**	5.4
3SVM+RSR	9.25	6.51	23.09	0.73	14.47	0.62	**16.51**	0.95	0.11	**0.04**	6.9
1CBor +RSR	8.06	5.68	21.57	0.73	**12.95**	**0.45**	17.00	0.82	**0.02**	**0.04**	**3.9**
2CBor +RSR	8.19	5.83	21.77	**0.67**	13.15	0.48	16.88	0.79	0.04	**0.04**	4.0
3CBor +RSR	8.29	5.91	21.99	**0.67**	13.24	0.58	16.71	0.77	0.05	**0.04**	4.7

Table 4. EUC obtained using the datasets where both training/testing partitions contain 10% of missing values. Best results for each dataset are marked in bold.

DATASET	AU	EC	GE	IR	MA	NT	PI	SA	SH	WI	Av
SVM	10.69	6.46	26.57	1.53	19.01	4.96	18.60	1.31	0.69	0.27	8.5
RSS	10.16	7.22	26.07	2.33	18.49	4.80	18.69	1.07	0.43	0.24	8.6
RSR	8.68	6.35	**23.24**	2.33	**15.47**	2.36	19.74	1.15	0.42	0.40	6.2
CBor_EM	9.01	6.97	25.65	1.60	17.40	2.65	18.52	0.86	0.35	**0.13**	5.7
1SVM+RSR	9.11	**5.36**	23.91	1.67	15.71	2.24	18.25	0.96	0.18	0.28	4.3
2SVM+RSR	9.45	5.40	24.61	1.60	16.18	2.94	18.38	1.02	0.25	0.29	5.8
3SVM+RSR	9.76	5.53	25.01	**1.40**	16.58	3.36	18.41	1.05	0.30	0.22	5.7
1CBor +RSR	**8.46**	6.14	23.30	1.67	15.56	**1.83**	18.30	0.90	**0.14**	0.24	3.2
2CBor +RSR	8.55	6.37	23.55	1.53	15.78	1.89	**18.07**	0.86	0.18	0.19	**3.0**
3CBor +RSR	8.69	6.40	23.80	1.67	15.99	2.01	18.15	**0.85**	0.20	0.15	4.0

Table 5. EUC obtained using the datasets where both training/testing partitions contain 25% of missing values. Best results for each dataset are marked in bold.

As a last experiment, we compare the classifiers using our modified datasets that introduce 10% and 25% missing values both in the training patterns and in the testing patterns. In table 4 we report the results obtained using the datasets with 10% of missing values, while in Table 5 we report the results with 25% of missing values.

In these tests, both 1SVM+RSR and 1CBor +RSR do not perform better than CBor_EM with p-value < 0.05 but with p < 0.10. However, considering that in the previous test 1SVM+RSR/1CBor+RSR outperformed CBor_EM, we can conclude that they are more consistent in providing a high level of performance. To corroborate this observation, further tests should be performed with different percentages of missing values. We also note that both 1SVM+RSR and 1CBor+RSR continue to perform better than the two SVM-based approaches (i.e., SVM and RSS), as confirmed by the Wilcoxon test: the *p*-value of rejecting the null hypothesis is, again, found to be less than 0.05.

Finally, we remark that the additional tests with an increased number of missing values do not allow us to discriminate the performance of the two best ensembles, 1SVM+RSR and 1CBor+RSR. With 10% of missing values in the test set, the two ensembles obtain the same performance; with 25% of missing values, 1CBor+RSR outperforms 1SVM+RSR but with too high a p-value (i.e., 0.25) for a solid conclusion. All in all, our experiments in this paper point out 1CBor+RSR is the best performing ensemble. However, further datasets should definitely be considered to assess the performance difference, if any, between 1CBor+RSR and 1SVM+RSR.

4. CONCLUSION

In this paper we experimentally compare several classifiers and heterogeneous ensembles of classifiers to assess their performance in the presence of missing values. Ten different datasets are considered, addressing a wide spectrum of diverse problems. We test three versions of the datasets. In the first version, only the training data contains missing values (10%). In the second and third versions, both the training and testing patterns contain missing values (10%/25%, respectively).

We identify an *ensemble of ensembles*, which we call *1CBor+RSR*, that outperforms two prominent solutions:
1. The most widely used SVM library (LibSVM), even when SVM is finely tuned for each dataset. We remark that our result is not trivial since, as we showed in Section 3, a simple ensemble of SVMs is not enough to boost performance.
2. The original method for missing imputation proposed in [27], which in turn has already been shown to exhibit better performance than several state-of-the-art imputation approaches.

The superior performance of our ensemble is confirmed by the Wilcoxon signed-rank test.

In future work, we plan to investigate further the validity of our heterogeneous ensembles by applying them to a wider selection of datasets exhibiting several different characteristics of patterns.

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AUTOMATED CROWD DETECTION IN STADIUM ARENAS

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ABSTRACT

In this paper, we present an approach for crowd detection based on an ensemble of classifiers which employ several feature representation schemes of crowd images, including, local ternary patterns, local binary patterns, and features based on the spatial gray level dependency matrix. A Support Vector Machine classifier is trained on each of these feature vectors. Classifier predictions are then combined by sum rule. Experiments are performed on a large dataset that contains challenging sequences of actual football matches recorded at a stadium arena. Experimental results confirm that the different feature representations give complementary information which is exploited by fusion rules. The method proposed in this paper is shown to outperform previous methods tested on the same dataset. MATLAB code using the different descriptors is available at http://www.dei. unipd.it/wdyn/?IDsezione=3314&IDgruppo_pass=124&preview=".

Keywords: crowd detection, local ternary patterns, spatial gray level dependency matrix, local binary patterns.

1. INTRODUCTION

Video surveillance is an active area of research. Technology has reached the stage where mounting cameras is cheap. Cities throughout the world continue to amass extensive networks of camera surveillance systems. This has led to something of a monitoring crisis. Despite the ample volume of available video data, little accountable information is being retrieved. Human monitoring is tiring, expensive, and ineffective. It is estimated, for instance, that monitoring 25 cameras 24/7 costs an average of $150K per year, and experiments at Sandia National Laboratories for the US Department of Energy showed that human attention to video monitors deteriorates to unacceptable levels after only 20 minutes of viewing [11]. A practical solution would automate the monitoring process, freeing personnel to further evaluate and respond to detected events. Some key technologies motivating research along these lines include video-based detection and tracking, video-based person identification, and large-scale surveillance systems [16]. The desirability of such research is reflected in governmental funding, such as the EU Chromatica and Prismatical programs, the U.S. Combat Zones [5] project, and the older U.S. program VSAM (Video Surveillance and Monitoring) [4] [18], which greatly promoted research in these areas as they relate to both the battlefield and the commercial sector [26] [13] [15].

A number of computer vision technologies that deal with automated video surveillance have also recently found significant commercial success [20] [28]. Much of the focus of this technology has been on building physical security applications, but other issues being addressed involve event detection and face recognition at a distance. Yet, despite the many recent advances, these state-of-

the-art systems tend to fail at critical points when the environmental assumptions on which they were built no longer apply. One common environmental change that often results in system failure is crowding. Isolating events and actors in crowds is complicated by such things as background motion [19] and high levels of occlusion where only a small portion of the human shape is visible [30].

 In recent years, algorithms for crowd detection have been gaining strong interest. There are several reasons motivating this research. Crowded environments are very difficult to monitor by human observers, whether live or via video surveillance, because the visual patterns are highly repetitive and the complexity of the movement characterizing the scene is often overwhelming. Moreover, crowds can form and grow quickly and unexpectedly turn violent. Crowd detection systems and the automated analysis of higher level crowd characteristics, such as crowd configuration [2], flow [29], and violence [14], hold out the promise of offering invaluable assistance to safety personnel in targeting areas of emerging threat. Crowd algorithms are also valuable because they enable intelligent video surveillance systems to analyze a wider range of scenarios, extending outside common intrusion detection and patrolling tasks [10], and crowd detection algorithms work well with existing camera networks, as the perimeter defining a crowd often spans distances lying outside the range of a single camera. Crowd detection is especially important in the context of intelligent and automated video surveillance systems intended for large venues and public events, such as football games and concerts, as well as for such common environments as city streets and underground train stations during peak hours.

The development of crowd detection algorithms is rather recent. One of the earliest works describing a system for detecting a crowd dates in the mid 90s [7]. In that early paper, the authors provided a high level description of crowds inspired by gas dynamics along with a low level machine vision solution. Other approaches developed over the years include methods based on motion analysis and texture analysis. In [23], for example, a motion based system is proposed that assumes particles are evenly spaced; these are then displaced according to optical flow. In [17], motion heat maps, together with a set of indicators for measuring motion entropy, are used to detect crowds. Finally, in [2], a motion-based system is proposed that detects the precise contours of a crowd from still images.

Texture analysis works especially well when the task is focused on measuring the entropy of an image rather than on finding objects characterized by precise shapes that can be geometrically described. In crowd detection, the main approach used in texture-based methods is based on evaluating the gray level dependency matrix (GLDM), a method of feature representation that dates back to the 1970s [12]. This feature set is very large. However, in algorithms using it for crowd detection, only a few features are retained. In [22], for example, four features (labeled contrast, homogeneity, energy, and entropy) are used as the inputs for a neural network that classifies crowd density. In [10], a novel set of features based on GLDM are proposed that provide a richer description of the co-occurrence matrix for analyzing smaller segments of images. Aside from GLDM, other systems have used the Histogram of Oriented Gradients (HOG) descriptor [9] and SIFT feature density [2]. Finally, of note is [21], where a number of texture-based methods are compared and evaluated for crowd detection.

In this paper, we present a novel texture-based approach for crowd detection using an ensemble of classifiers that employ several descriptors, or feature representation schemes, of crowd images, including, local ternary patterns (LTP), local binary patterns (LBP), and a feature set based on GLDM. A Support Vector Machine classifier is trained on each of these feature vectors. Classifier predictions are then combined by sum rule. Experiments are performed on a large dataset that contains challenging sequences recorded during real football matches at a stadium arena. In our

experiments, a fusion approach obtains the best average result. Our experiments demonstrate that it is possible to develop crowd detection systems composed of different simple methods that perform competitively with more complex state-of-the-art systems. This is useful since combining *n* independent approaches lends itself easily to parallelization (for instance, a different descriptor can be given to each core in a system with a multicore processor) making the system suitable for real time applications without the need for hardcode optimization.

The remainder of this paper is organized as follows. In section 2, we provide a detailed description of the texture descriptors used in our experiments. In section 3, we outline and explain our proposed approach. In section 4, we describe the dataset and several experimental results for validating our approach. Finally, in section 4, we summarize our results and give suggestions for further research.

2. TEXTURE DESCRIPTORS

Automated crowd localization and classification is a difficult machine classification problem that we believe is best handled by combining multiple descriptors to boost performance. Good descriptors are invariant to image rotation and scale. In addition, they are robust in terms of variations in illumination. By combining descriptors, a system can utilize the best properties of each. The remainder of this section describes the various texture descriptors used in our proposed ensemble method.

2.1 Invariant Local Binary Patterns (LBP) [24]

LBP is an extensively studied local texture operator that possesses several excellent properties: low computational complexity, rotation invariance, and robustness in terms of illumination variations. LBP is a histogram that is based on a statistical operator that is calculated by examining the joint distribution of gray scale values of a circularly symmetric neighbor set of P pixels around a pixel $\mathbf{x}$ on a circle of radius R. In this study we use a multiresolution descriptor that is obtained by concatenating two histograms calculated using the uniform bins with the following parameters: ($P=8$; $R=1$) and ($P=16$; $R=2$).

2.2 Local Ternary Patterns (LTP) [27]

A generalization of LBP is LTP, which represents gray-scale differences between the pixels using a ternary rather than a binary value. The difference between the gray value of a pixel $\mathbf{x}$ from the gray values in one of its neighborhood $\mathbf{u}$ is represented by three values, which are determined by the application of the threshold τ: 1 if $\mathbf{u} \geq \mathbf{x} + \tau$; -1 if $\mathbf{u} \leq \mathbf{x} - \tau$; else 0. This provides a more discriminant descriptor that is also less sensitive to noise. To reduce computational complexity, the ternary pattern is divided into two binary patterns by considering both the positive and the negative components. The histograms computed from these two patterns are then concatenated. In our system, two different parameter configurations are evaluated: ($P=8$; $R=1$) and ($P=16$; $R=2$).

2.3 Histogram of oriented gradients (HOG) [6]

HOG calculates intensity gradients from pixel to pixel and selects a corresponding histogram bin for each pixel based on the gradient direction. The HOG features extracted in our experiments use a 2×2 version of the HOG. The HOG features were extracted on a regular grid at steps of 8 pixels and stacked together considering sets of 2×2 neighbors to form a longer descriptor with more descriptive power.

2.4 Haralick texture features [12]

The Haralick texture features descriptor was proposed nearly 30 years ago to classify different categories of rock, but it is widely used today to classify many types of images. It is based on the SGLD, or the co-occurrence matrix.

Given an image with N gray levels, the SGLD matrix at angle θ is a matrix of size $N{\times}N$. Each element in the matrix is a count of the total number of pairs of gray levels i and j at a distance d along the direction θ.

Thirteen features are calculated from a SGLD matrix at a fixed angle θ: energy, correlation, inertia, entropy, inverse difference moment, sum average, sum variance, sum entropy, difference average, difference variance, difference entropy, and two information measures of correlation (Implemented as in Haralick Texture Features Matlab Toolbox v0.1b www.bme.utexas.edu/reasearch/informatics). In this work we test the features set extracted using Haralick's method, which concatenates the features extracted by considering four angles (0°, 45°, 135° and 90°), with d=1.

2.5 Shape analysis [10]

The SGLD is capable of measuring texture by analyzing the transitions (i.e., the differences between the gray levels) between couples of pixels, and organizing them to form a histogram. Deeper studies reveal that this matrix contains a great deal of information that is only partially extracted by features commonly used in the literature [10]. For this reason, it is worth investigating novel features and methods in order to extract more information in a given framed scene.

The SGLD can be seen as a two-dimensional histogram that is created by setting up a grid of 256 x 256 locations (in the common case of 8-bit image depth), one for each grayscale value. Once the whole image has been scanned and each pixel couple considered, the SGLD represents how pixels change. If only smooth variations can be found in the image, the SGLD will be concentrated towards the diagonal, while abrupt changes will lead to peaks that have a certain distance from the diagonal. Information about where such transitions occur, however, is lost, since all contributions are summed up irrespective of the region they were observed.

To obtain a better characterization of SGLD, a set of new features was developed in [10], with the idea of describing the shape of the histogram in more detail. From a detailed shape description, it is then possible to obtain much more data than that provided by commonly used indicators.

One way to extract more information is to analyze the 3D shape of the histogram by considering several height values. Each level curve is then analyzed by approximating it with an ellipse. On each ellipse a number of parameters are measured, and, finally, the amount these parameters change over the different ellipses is measured. This leads to a number of useful indicators, the first one being the decrease of the axes of the ellipses, and how it fits with a linear model. The maximum and minimum of the axes is also valuable. Yet another parameter of interest measures the volume under the highest contour level, with its dual parameter (the volume of the SGLD over the same contour level) also considered. A further important parameter is the eccentricity of the ellipses, which measures the amount of strong pixel variations: an ellipse which is thin around the main diagonal indicates that the number of strong variations is negligible, and vice-versa. Further parameters that we consider in this work are the surface of the smallest ellipse that describes how smooth the upper part of the SGLD is, and its ratio with the widest ellipse. Finally, the number of SGLD locations that have zero height is measured.

3. PROPOSED APPROACH

In this paper we not only combine different texture descriptors but also different color constancy approaches (the color constancy approaches estimate the unknown light of a scene and try to normalize it to a standard light) as well as the contrast limited adaptive histogram equalization[1] (AH), using the function *adapthisteq.m* in MATLAB 7, as a preprocessing method to reduce the illumination problem [8]. The following color constancy approaches are tested: Grey-World (*GW*), max-RGB (*MR*), Shades of Grey (*SG*), and Grey-Edge (*GE*).

The system we propose in this paper classifies a given image in a given crowd density into two categories: *no crowd and low* (where less than 4 persons appear in an image) and *med and high crowd* (where 4 or more persons appear in the image). The number of persons in each image in our database was manually tabulated, and each image was labeled accordingly. Experiments were then performed that combined the different descriptors using the sum rule. In Table 1 we list the features tested in this paper.

Descriptor	Short name	Dimension
Local Ternary Pattern	*LTP*	604
Local Binary pattern	*LBP*	302
Haralick texture features	*HAR*	52
Histogram of gradients	*HOG*	81
Shape analysis	*SA*	36

Table 1. Descriptors used in the proposed system.

The original video resolution was set to 640×480 pixels (for more details on the dataset, see section 4.1). In our system, the images were divided into either four or sixteen regions. As seen in section 4, the performance of our best ensemble depends on how the full image is divided. Moreover, whereas the best stand-alone descriptor in both cases is LTP, the other approaches perform quite differently in the two cases.

4. EXPERIMENTAL RESULTS

The dataset chosen for training and testing the classifier was acquired in a small stadium during a football match. Inside the stadium, a number of Pan-Tilt-Zoom (PTZ) cameras, capable of framing every part of the venue, was installed. A subset of four cameras installed in different positions (one framing outside the venue) was then chosen as a source for the recordings, which started one hour before the match was scheduled to begin and ended half an hour after the match ended. The recorded images are the same images that the security officers observed while keeping the venue under control. In this way, we are assured the images include salient events since the actions of security professionals (they controlled the tilt/pan/zoom mechanisms of the cameras) determined which scenes were recorded.

Recorded sequences include scenes in which the public or the game appear alone, scenes where both are present in the same image, and other scenes that include people queuing up at a kiosk during the game break. Flows of people getting into and out of the stadium are also present, as well as scenes of the empty venue, which were useful for providing the classifier system some negative examples with high texture content.

---

[1] Function `adapthisteq.m` of the MATLAB 7

Unlike scenes framed by surveillance cameras in other environments, images taken in stadium environments have peculiarities that justify our choice of acquiring a new dataset instead of exploiting others already available, such as the one presented in [1]. Despite the large number of images that can be acquired in stadium environments, the framed scenes are highly repetitive. As a result, the number of different scene conditions is strongly reduced. This reduction is mainly due to the fact that security officers tend to leave cameras in the same position for extended periods of time and the fact that people infrequently move while intent on watching a game. Moreover, the public normally looks similar even when framed from different viewpoints. However, there are times when the natural light can shift dramatically during the course of recording, making the same scene appear very different.

Out of all the recordings, 901 frames were chosen to best represent all possible scenarios that were observed during the match (see Figure 1 and 2, for examples). The frames were then organized into 19 short subsequences. It should be noted that the sequences for training and testing the classifiers were revised in this paper with respect to what was done in [10]. In this work, special care was spent in assuring that the training and testing sets did not include sequences taken from the same camera with the same orientation (thus simulating a real application scenario). This choice lead to a harder test for the classifier generalization capabilities, and justifies the lower performance obtained by the system described here with respect to [10].
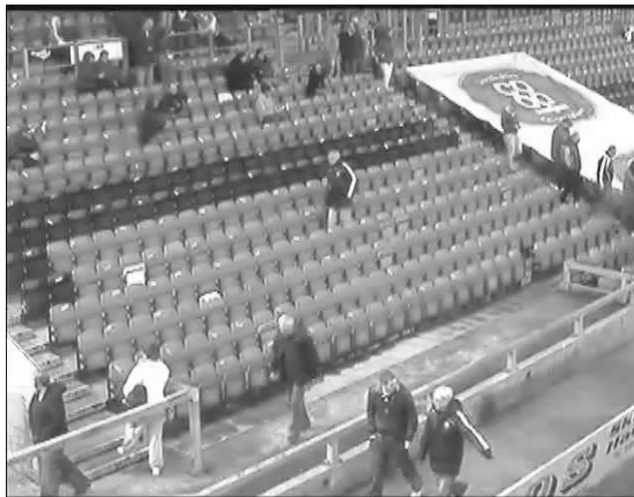
Figure 1. A typical image acquired inside a large venue.
The crowd is not the only framed entity providing high texture content.

Figure 2. Crowd can be observed from different scales in the same frame.
Other objects with strong texture content are also present in the image.

4.2 Experiments

The area under the Receiver Operating Characteristic curve (AUC) is used as the performance indicator. The area under the ROC is considered one of the most reliable performance indicators [25] as it is based on both sensitivity and specificity. The ROC curve is a plot of the sensitivity versus false positives (1 - specificity). The error area under the ROC curve (EUC) can be interpreted as the probability that the classifier will assign a lower score to a randomly chosen positive sample than to a randomly chosen negative sample.

As the testing protocol, we used the leave-one-out cross-validation method, where in each fold the frames of a given sequence are used as a testing set, while the other frames of the other eighteen sequences are used to build the training set.

Table 2 reports the results in the first experiment, where we compare the different pre-processing approaches (adaptive histogram equalization and the four color constancy approaches) using the most widely used descriptor for person identification, namely, the HOG descriptor. The label NO is the performance obtained when no preprocessing approach is applied.

Pre-Processing	4 regions	16 regions
NO	67.38	77.30
AH	**76.02**	**81.27**
GW	68.02	77.41
MR	68.13	77.15
SG	68.75	77.50
GE	76.24	77.94

Table 2. Accuracy obtained using different feature sets.

As can be seen in Table 2, it is clear that color constancy has little impact, while the application of adaptive histogram equalization (AH) improves performance.

Pre-Processing	4 regions	16 regions
HOG	76.0	81.3
HARA	60.4	82.5
LTP	82.4	93.0
LBP	75.1	91.9
SA	73.1	72.2
FUS_4	**83.2**	92.5
FUS_16	81.8	**93.2**
FUS	82.5	93.1

Table 3. Comparison among different approaches.

In table 3 we compare the descriptors (preprocessed by AH) described in section 2. We also report the following fusion approaches:

- *FUS_4* is the weighted fusion between HOG (weight 1) and LTP (weight 4); it obtains the best performance in the *4 regions* testing protocol;
- *FUS_16* is the weighted fusion between LBP (weight 1) and LTP (weight 3); it obtains the best performance in the *16 regions* testing protocol;

- *FUS* is the weighted fusion of HOG (weight 1), LBP (weight 2), and LTP (weight 6).

The following conclusions can be drawn from the results reported in Table 3:
- LTP outperforms the other approaches;
- LBP obtains performance similar to LTP in the *16 regions* set (outperforming the other tested descriptors), while in the *4 regions* set it obtains a performance similar to SA and HOG;
- The fusions are quite useful but perform differently than they do in other problem domains (e.g., image sub-cellular classification [3]); it does not enhance the performance of the best single descriptor.

In Figure 3 we report an example where only one subwindow (surrounded by a black frame) is misclassified by our proposed method. Notice that the misclassified example contains three persons, so it is quite similar to the class "*med and high crowd*" that is composed by the images containing four or more persons.

Figure 3. Example classified best by our system.

5. CONCLUSION

This paper focused on the study of texture descriptors for training an ensemble of machine learning algorithms for crowd image classification. The system proposed in this work is tested on a difficult dataset built using video sequences of real football matches at a local stadium arena. We performed several tests using sequences extracted from different cameras using two different testing protocols based on the original images, size 640×480, being divided into either four or sixteen regions. In the first protocol, the systems are trained and tested with the full image divided into four regions; in the second protocol the systems are trained and tested with the full image divided into sixteen regions.

Based on an analysis of prior research in other domains, we propose a method for automating crowd localization based on a set of SVMs trained using different descriptors. For combining the different descriptors, we train a SVM separately for each descriptor with the results combined using a weighted sum rule. It is interesting to note that the behavior of the each approach changes depending on the two different testing protocols.

In future work we plan on improving the performance of our system by evaluating other texture descriptors and different methods for combining ensemble evaluations. Moreover, since the images are acquired by cameras that are rarely moved, it may also be possible to develop an approach based

on background subtraction. Our idea is that the model for the background could be rebuilt after every camera motion.

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ON EFFECTIVE PEDAGOGICAL PRACTICE IN TEACHING COMPUTER PROGRAMMING TO CS/CIS MAJORS

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ABSTRACT

This paper argues a few pedagogical approaches to deliver an effective computer programming course to CS/CIS students, or students of other majors who are serious about computer programming. Some topics covered in this paper include programming aptitude, teaching objectives, and effective teaching approaches.

INTRODUCTION

"A variable in a programming language is . . . a memory location." Huh? At this precise moment students in an "Intro to Computer Programming" class may start knitting their eyebrows. If they're unable to straighten their brows after two or three additional lectures, they will likely not understand what a data type is or how a function is composed. They will surely perform poorly in the course, and possibly drop out. Similarly, some working, established developers/programmers cannot adequately define a variable, and they too are probably performing poorly, which may explain why reams of badly written code continue to clog up companies' systems and cause stomach upset among subsequent programmers tasked with cleaning up the mess.

Colleges have decreed Computer Programming to be a core fundamental course for all Computer Science (CS)/Computer Information Systems (CIS) majors. Therefore, a good programming foundation is not only essential for computer science students to earn their degree, but can potentially elevate the quality of software engineering in the industry as well.

Since 2010, the field of software engineering has enjoyed renewed popularity, bolstered by both high salaries and a plethora of available jobs [3]. As a result, Forbes magazine recently ranked Computer Science third among the 15 most potentially lucrative college majors [8].

Quick Facts: Software Developers	
2010 Median Pay	$90,530 per year; $43.52 per hour
Entry-Level Education	Bachelor's degree
Number of Jobs, 2010	913,100
Job Outlook, 2010-20	30% (Much faster than average)

TABLE 1. Quick Facts: Software Developers. Source: http://www.bls.gov.

The number of Computer Science bachelor's degree programs being offered at U.S. colleges and universities increased by 11 percent in 2010 over the previous year, according to the 2009-2010 Computer Research Association's Taulbee Survey [15]. Many institutions of higher learning saw a sizeable increase in enrollment among Computer Science and Computer Information Systems students over the ensuing years. Columbia University, for example, witnessed a 12-percent surge in Computer Science students in 2012 [2].

With more and more students potentially embarking on careers in computer programming, there is a clear and present need for high academic standards.

COMPUTER PROGRAMMING APTITUDE

Is learning to program "notoriously difficult" [4] or, given the proper teacher, environment, resources, and time, achievable by practically anyone?

Conventional wisdom holds that computer programming students naturally fall into one of two categories: those who find programming fairly easy to learn, and those who find it virtually incomprehensible. The dropout rate of students taking their first computer programming course is strikingly high – estimated by some [13] to be between 30 and 60 percent.

Although no nationwide statistical data is available to attest to this perceived trend, each college may observe the phenomenon to varying degrees. Data collected by the Department of Statistics and Computer Information Systems at Baruch College in New York City, from eight sessions of programming language courses (both introductory and advanced) over a five-semester period in 2011-2012, shows a mean dropout rate of 14.55 percent. The failure rate in the sample data was relatively insignificant, presumably because many students elected to circumvent "failure" by simply withdrawing; it should be noted, however, that a student's reason for withdrawing from a class may not necessarily be due to academic difficulties.

  CIS3100: Object-Oriented Programming I
  CIS4100: Object-Oriented Programming II

Semester	Course ID	Section ID	Enrolled	Withdrawals	Failures	Dropout rate (%)
Summer 2012	CIS3100	S3DA	25	0	0	0
Spring 2012	CIS4100	PMWA	32	11	2	34.38
Spring 2012	CIS3100	QMWA	33	8	0	24.24
Fall 2011	CIS4100	QTRA	19	3	1	15.79
Fall 2011	CIS3100	PTRA	34	6	0	17.65
Summer 2011	CIS3100	S5DA	17	1	0	5.88
Spring 2011	CIS4100	TR6A	19	1	0	5.26
Spring 2011	CIS3100	TR73A	34	1	1	2.94
Total			213	31	4	
Sample mean						**14.55**
Sample median						**10.84**

TABLE 2. Dropout rate of eight sessions of programming language courses in 2011-2012 at Baruch College, City University of New York (CUNY).
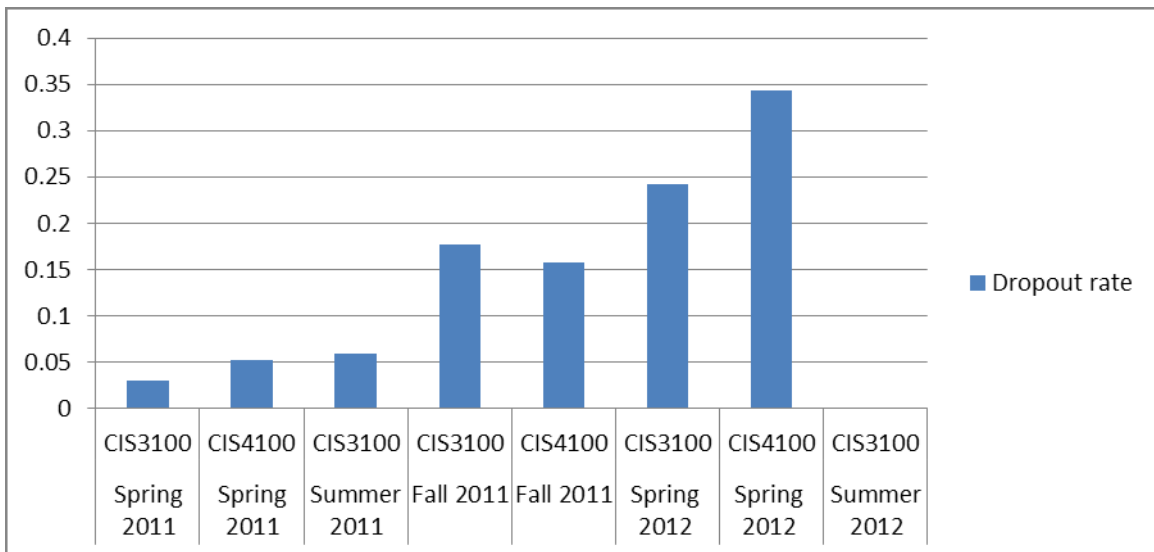
FIGURE 1. Dropout rate of eight sessions of programming language courses in 2011-2012 at Baruch College, CUNY.

From the above chart (FIGURE 1), we can see a noticeable increase in the dropout rate, except for Summer 2012, when the dropout rate was zero. If we take a closer look at the data as it pertains to both introductory computer programming courses and advanced computer programming courses, we can see a significantly higher dropout rate for advanced students - 21.43 percent, than that for programming novices which stood at a bit more than 11 percent. The observation seemingly contradicts the notion that beginning students are more apt to drop out.

Semester	Enrolled	Withdrawals	Dropout rate (%)
Summer 2012	25	0	0
Spring 2012	33	8	24.24
Fall 2011	34	6	17.65
Summer 2011	17	1	5.88
Spring 2011	34	1	2.94
Total	143	16	
Sample mean			**11.19**
Sample median			**5.88**

TABLE 3. Dropout rate of CIS 3100 courses in 2011-2012 at Baruch College, CUNY.

Semester	Enrolled	Withdrawals	Dropout rate (%)
Spring 2012	32	11	34.38
Fall 2011	19	3	15.79
Spring 2011	19	1	05.26
Total	70	15	
Sample mean			**21.43**
Sample median			**15.79**

TABLE 4. Dropout rate of CIS 4100 courses in 2011-2012 at Baruch College, CUNY.

Nevertheless, the above statistical data only reflects the dropout rate at one particular college during a specific time period; such a small sample size remains insignificant. However, assuming that the general dropout rate among computer programming students is higher than that of students in most other disciplines, how can this knowledge be utilized to achieve more effective teaching? Well, for starters, the idea that "with careful teaching, adequate motivation, and sufficient time, anybody can learn anything" [4], probably doesn't pertain to learning computer programming.

If programming requires some degree of aptitude on the part of the student, is there a way we can quantify a programming student's likely success? According to "Towards a Model of Student Success in Programming Courses," an academic paper by Amy B. Woszczynski, et al. (2005) [14], after nearly four decades of studying various predictability factors, "researchers and educators alike have failed to agree on exactly which variables actually predict student success." We can, however, be certain of one factor: critical thinking (as opposed to rote memorization) is, well, *critical* for any programmer. Computer programming is a process that, when done properly, utilizes a programmer's ability to think abstractly, creatively, and independently in order to solve

problems. These cognitive/behavioral qualities are essential for a novice programmer to be able to code beyond "Hello, World."

By acknowledging that some students are innately better suited to computer programming than others, we can more accurately gauge our teaching objectives and methodologies.

TEACHING OBJECTIVES

To facilitate learning for future software engineers

Since we know that programming is not for everyone, we shouldn't indulge in a "no child left behind" mentality. Instead, we should set the bar high, striving to provide the software engineers of tomorrow with a thorough understanding of computer programming language today. The learning assessment should give substantial weight to the importance of this objective, meaning the magnitude and multitude of the assessment should be clearly defined in order to meet the criteria of that of a qualified software engineer.

To gear lectures toward being concept-centric, not syntax-centric

When teaching programming languages to CS/CIS majors, the goal shouldn't be to create experts in any specific programming language, especially since we don't know which languages will be used by the students in their future endeavors. Rather, the ideal should be to form an overall programming foundation via a demonstrable language. All programming languages share common properties and underlying principles. Thus, we need not ruminate over which languages will be favored in the future; instead, we can educate students to quickly learn practically any programming language through laying a solid foundation for their general programming knowledge and skills. In other words, emphasis should be placed on getting students to fully grasp the concepts of programming, rather than the syntax, associated with a particular language. We want the students to understand why a program works, not just to get the result right. In his book *Thinking, Problem Solving, Cognition*, Richard E. Mayer shows that programmers who know *how* their programs work are inevitably more successful than those who do not [11].

EFFECTIVE TEACHING APPROACHES

In today's Information Age, a one-sided teaching method – whether it's weighed toward the instructor or the student – seems doomed to non-fluidity and ineffectiveness [10]. Ideally, there is only *active* teaching and *active* learning efficiently combined. Passive teaching or learning

simply doesn't make sense in terms of efficacy. In actuality, teaching and learning are forever intertwined – a single process, as seen from two different vantage points.

Heuristic instruction

Regardless of how much a student actively engages in his or her own learning process, the input and guidance of an experienced, knowledgeable teacher is essential for successful instruction to occur. Because programming is a conceptual, formulaic, and logical endeavor, it's crucial for instructors to have a crystal-clear understanding of their subject matter and to be able to simplify for students some fairly complicated ideas. Because programming is also a skill that requires practice and experience, a qualified instructor must be hands-on; i.e., able to code, read code, and debug code at his/her ease.

Programming is essentially about problem solving, so instructors should refrain from coddling students, which can stifle both creativity and independent thought. Students should be advised to maximize their time by trying to solve problems and absorb concepts on their own. To prod students into thinking on their feet, an instructor can follow up a discourse on, say, a new methodology by immediately asking students a series of pertinent questions. A brief question-and-answer session can achieve two goals: 1) It enables students to more thoroughly digest the information discussed; and 2) It allows the instructor to gauge whether students have misconstrued any concepts or are having difficulty applying them.

Different modes of learning

Learning by Doing

Coding is clearly not a "spectator sport" [1]. Students have no choice but to participate and practice in order to familiarize themselves with coding. "Learning by Doing," a term borrowed from economists, is a methodology by which programmers can hone their skills. By completing homework assignments and other projects, students can internalize programming concepts and explore new ways to solve problems.

Students are generally accustomed to a pattern of learning: listening to lectures, reading and memorizing facts, and finally taking exams. But this routine doesn't apply when it comes to learning programming. There is really not much that a programming student can memorize to ensure his or her success. Students have no choice but to "get their hands dirty" with plenty of practice. Only through rigorous, hands-on practice can students truly understand what is taught in class – and gain keener insights. Also, practice invariably leads to more practice, as the motivated student seeks to get better and better at programming.

Learning by Teaching

A methodology by which the student becomes the teacher and delivers a lesson or part of a lesson to the class, "learning by teaching" is an effective way to reinforce a student's knowledge [7]. It not only necessitates that a student fully comprehends the topic being discussed, but will likely provide the student with more confidence and improved communication skills as well, through his/her own didactic approach. Teaching computer programming, mostly abstract concepts, is by no means an easy task. Therefore, the method is conducive to effective learning especially for top students. Students who were able to deliver the teaching sessions successfully – namely, those who were able to explain the concepts using graphs, if applicable, and sample code, and were able to answer other students' questions fluently and correctly – proved adept at incorporating newly learned concepts into their programming practice.

Student lecturers should be selected on a voluntary basis only, as it could prove counterproductive if the instructor forces certain students to give lectures. The instructor may also consider offering incentives to student lecturers. The student who does the teaching, of course, is certainly not the only beneficiary of the "learning by teaching" method. Other students may find the approach a refreshing way to learn and thereby become more interested and engaged in such lectures.

But what if a student is unable to understand and/or deliver the material effectively? First, the method should only be employed midway through the semester, at the earliest, so that students have sufficient prior knowledge of the course material. Second, the instructor should have a relatively good estimate of the student's level in the course. If necessary, the instructor can provide direction and assistance to the student in preparing a lecture. Third, if, in the end, the student is unable to deliver a proper lecture, the instructor may need to revisit the topic – both with the lecturer and the other students.

In Baruch College's Fall 2010 CIS4100 course, one student taught a session on Linked List and another student taught a session on Queue. Both of these students were able to aptly explain the material, illustrate what they were talking about, and address questions from their classmates. In their final projects, the two students skillfully used the corresponding data structure, Linked List or Queue, to enhance their programming professionalism and sophistication.

Students are primarily freethinking and creative, so they tend to give lectures that are more fun in nature than pedagogical. For example, a student in Baruch's Fall 2012 CIS3100 session gave a lecture on C-String in C++ in which she made a vivid presentation on the whiteboard that captivated the class.
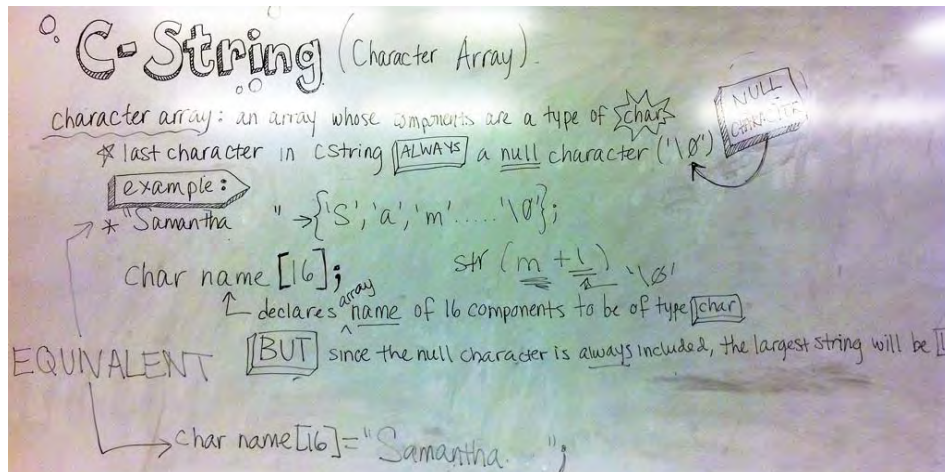
FIGURE 2. Part of the whiteboard writings of a student who gave a lecture on C-String.

Independent Learning

Computer programming, for the most part, is a solitary journey. In the workaday world, a programmer must single-handedly produce code; team efforts occur only when there is code integration to perform. Thus, independent thinking and learning skills are vital for a student to do well in computer programming courses. In fact, self-teaching/learning should be listed among programming courses' learning objectives.

However, students should be encouraged to study in groups, on the basis of equal participation and contribution, since working collaboratively may help novice programmers feel more comfortable and supported in learning and practicing programming. In addition, the instructor should encourage students to raise and answer questions in class to promote independent and critical thinking.

Avoiding "expert blind spots"/reflexive teaching

A phenomenon known as the "expert blind spot" is an exceedingly common occurrence among instructors who have been teaching the same course for many years. When introducing a new concept to students, these veteran instructors may inadvertently apply prior knowledge – which they possess, but the students do not. This potential pitfall is magnified in computer science education because concepts in programming are sometimes linked sequentially. Without previously learned concepts in place, it will be difficult, if not impossible, for students to grasp lessons.

How can we recognize and overcome expert blind spots when teaching programming courses? We may adopt the following three strategies:

1. Prepare well-thought-out course materials and presentations.

2. Monitor and improve teaching methodologies and materials continually and adaptively.

3. Encourage students to speak up by being open and non-intimidating. (This point is important because if there's not free and open communication between the instructor and the students, the instructor may never know what is actually going on with his/her students, their progress in the course, or if they've adequately absorbed the knowledge.)

Bottom-up/progressive teaching

The inverted-curriculum approach [12] enables students new to programming to create some remarkable programs – through the use of built-in libraries and pre-defined functions – almost immediately. The method is a top-down approach meant to provide students with an overall picture that can be studied in detail later. It may, however, give students the mistaken impression that they're great programmers, or that programming is a breeze, and thereby curtail students' desire to exercise due intelligence. This method may be more suitable for students who want to know a bit about programming but who will not be pursuing a programming career. For CS/CIS majors, the progressive approach may help them create a more solid programming foundation.

Considering learning programming as building a house, you begin with one brick, say programming *tokens*, then add another, say *functions*, and so on. Therefore, a "bottom-up" approach may be more natural for teaching programming. We start slowly, spend as much time as necessary to ensure that students understand the most fundamental concepts, then move up to the next level. The progress can be sped up in conjunction with students' comfort levels.

CONCLUSION

Through examining a few aspects of teaching programming courses to CS/CIS majors, we may conclude that although programming is not for everyone, it should be taught rigorously nonetheless. The focus should not be on decreasing the dropout rate – especially since we don't really know what drives it. Rather, we should focus on understanding the nature of programming education and improving pedagogical quality as much as possible.

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ITM – The Development of a New Major

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ABSTRACT

Technology development and a persistently competitive business environment have challenged education programs to produce graduates with the skills required for successful participation in the Information Technology (IT) field. Research reveals movement in industry's requirements for both technology skills and soft skills. Faced with a shifting target, IT educators in higher education institutions need to respond with a curriculum that prepares students with the necessary knowledge, skills, and abilities for a career in this field. This paper is the first in a series of papers describing events that led to the development of a new major: Information and Technology Management (ITM).

Business and Technology Education, Curriculum Design, Curriculum Development, Information Technology Management, IS/IT Major

INTRODUCTION

This is the first in a series of papers describing the research, thinking, and events that led to the development of a new major in Information and Technology Management (ITM) in the College of Business at Bloomsburg University of Pennsylvania in 2007.

Bloomsburg University of Pennsylvania

Bloomsburg University is one of the 14 universities within the Pennsylvania State System of Higher Education (PASSHE). It comprises four colleges: Business, Education, Liberal Arts, and Science and Technology (generally abbreviated as COB, COE, COLA, and COST, respectively). In 2007, the COB offered three related majors, Business Information Systems (BIS), Computer Information Systems (CIS), and Management Information Systems (MIS). The former was housed in the Business Education and Business Information Systems Department; the latter two were housed in the Computer Information Systems Department.

As might be surmised, the similarity of the names caused students a lot of difficulty in distinguishing the majors. Parents and faculty were also confused. In fact, there were definite distinctions to be made, but they were hard to articulate to people unfamiliar with the field of information systems. BIS had evolved over a couple of decades or more, originating from the Business Education major and starting as Office Automation, then Office Information Systems, and becoming Business Information Systems around 2005. The name changes were accompanied by gradual shifts in the focus of the major. CIS was created as a major back in the

1960s, jointly by the Mathematics department and faculty within the business school; it eventually was fully housed within business. MIS had grown out of the CIS program, and had been in and out of moratorium due to poor enrollment; in 2007 it was out of moratorium, but struggling.

Information and Technology Management

The ITM concept grew out of the move of a faculty member from the CIS department to the BE&BIS department in 2007. That faculty member brought a desire to update and refocus the BIS curriculum, which at the time was perceived widely as a kind of "CIS without the programming". This faculty member suggested taking advice from the BIS Advisory Board, from IS curriculum and industry research, and other faculty to create a program that is essentially a management program, as an HR or Supply Chain program might be a management program, and focus on the Management of Information and Technology. Several names were suggested, but always the word "Management" was considered an essential element in the name, not only because that was the focus, but because it was felt that students would better understand the program's purpose with that word in the name, and also because it would help to differentiate the new program name from CIS and MIS. Eventually, the name Information and Technology Management was adopted.

A recent review of the literature on curriculum, program names, and industry developments, presented below, reinforces the type of research and thinking that went into developing the new program.

IT CURRICULUM

Technology development and a persistently competitive business environment have challenged education programs to produce graduates with the skills required for successful participation in the Information Systems (IS) field [9] [13] [17] [31] [33]. The appropriate task for IS educators is to design a curriculum that prepares students with the necessary background, skills, and abilities required to become effective actors within the IS field [10]] [17] [33]. Once developed, curriculums must evolve with the rapid changes in the IS field [9] [15] [17] [22] [31] [33].

Model curriculums have value because they provide a basis for an educational institution to design its individual program [26]. The development of a model curriculum dates back to 1972 with the publication of the Association for Computer Machinery (ACM) Graduate and Undergraduate Programs in IS Curriculum. Revised versions of this curriculum were published in 1983 and 1990 with the cooperation with the Institute for Electrical and Electronics Engineers (IEEE). In 1981, the Data Processing Management Association (DPMA) published their first model curriculum with updated versions released in 1985, 1991, and 1994. These separate efforts culminated in a joint partnership between ACM, DPMA, and the Association for Information Systems (AIS) and the creation of the IS 1997 Model Curriculum and Guidelines for Programs of Information Systems. Minor updates of the IS 1997 occurred in 2002.

Examination of curriculums of the 1970s reveals a prominent focus on mastering specific programming languages, number-crunching activities, mechanization solutions, and the system development life cycle. Curriculums were enhanced in the 1980s to include database management techniques and decision support systems in order to analyze the increasing amount of organizational data. During the 1980s the focus was expanded beyond mechanization of operations to data analysis activities that support the management of an organization. Technological developments in data storage, processing speed, and network capabilities in the 1990s once again changed the focus of the activities and the scope of the data analysis. The 1990s curriculums incorporated courses that dealt with accumulating and analyzing large repositories of transaction data and transferring data across organizations. A sample of 108 AACSB-accredited colleges and universities in CIS/MIS to identify the most common courses was collected in 1996 [20]. They report that most curriculums included COBOL I and II, database management systems, data communications, data/file structure, decision support systems, management of IS resources, micro-applications, and systems analysis and design.

During the 1990s, research reports that IS programs with emphasis on technology may produce graduates that lack some of the other business, communication, and interpersonal skills that are so vital to IS practitioners [32]. Graduates with a more holistic view of integrating technologies, applications, data, and business functions were in demand by industry. Many researchers explain that industry desire graduates who combined technical capabilities with business operations skills, interpersonal skills, and the ability to manage and lead organizations as they integrate and reengineer their processes [18].

Gaps between academics perspective and practitioners' perspective in valuable IS skills and abilities were reported in research; in particular: interpersonal skills, critical and creative thinking skills, and IS technology skills [9]. Knowledge of IS technology was valued more by academics than practitioners while interpersonal skills and business knowledge was more highly valued by practitioners. IS programs should include less programming and system development skills and more business thinking, communication, project management, and system security management [2] [14] [27].

With technology evolving at a rapid pace and in the midst of reports that IS curriculum was not synchronized with industry requirements, a need for another review of IS model curriculum was recognized. A task force from the Association of Computing Machinery (ACM) and the Association of Information Systems (AIS) was formed in 2009 to recommend the structure of the IS curriculum [4]. This recent version was produced by ACM and AIS in 2009 with the final version being renamed to IS 2010 after a Wiki campaign eliciting academic review.

The IS 2010 curriculum identifies the guiding principles of the IS profession which include the development of interpersonal skills, critical and creative thinking, and IT technology skills that focus on the implementation (not development) of applications and hardware. In addition, curriculums should include security management, database management, and network architecture [34]. IS 2010 also recognizes that IS is expanding into a broader domain that includes other fields such as health care and government. This blurring of disciplines may facilitate the need to encourage more students to minor in IS, the creation of joint programs, and the closer alignment of curriculum with local industry [4] [32]. In general, IS academics agree

that the field is concerned with information and organizations, and for all practical purposes includes computers [32].

Program Names

Research of colleges and universities that provide a four year undergraduate degree in the study of information systems/information technology within a business school reveal a wide variety of program names with approximately 24 different names identified between 1985 and 2007 [1]. Different program labels reflect the historical development of the field in determining curriculum characterization and emphasis [31]. This definitional issue has been subject to investigation and debate since the establishment of the field in the 1960s. The most common collegiate program names identified are Management Information Systems and Information Systems with other common names including: Information Technology, Computer Information Systems, Business Information Systems and Business Information Technology. The term *Information Systems* (IS) has become the most commonly accepted, generic term to describe the discipline [31]. Studies reveal differences in curriculum but show no significance in the content of IS/IT programs based on program name [25] [31].

The lack of standardization in names remains an issue of concern because of the confusion it maycause for stakeholders in information systems/information technology programs [1] [31] [33]. Yet, there does not seem to be a drive towards standardization of the name. Typically, the definition of any academic field is very important to stakeholders. For internal stakeholders if helps focus the research and curriculum development. Externally, it has some impact on students' decisions to choose a major. Interesting to note, studies did not correlate employers' hiring decisions with program names. Given the breadth of the field and diversity of interests, it may not be possible to achieve a definition of this field that would be accepted as the dominant perspective. This suggests that having more than one definition, with each focused on different purposes, may be at least a useful complement to a "one size fits all" approach [1] [31]. Many argue for the need for more than a single, unitary definition that demonstrates an employment-oriented approach [33].

INDUSTRY

The U.S. Bureau of Labor Statistics has consistently listed IS jobs among those likely to increase in the next decade and a continued effort by domestic business to seek competent hires [16]. Many scholars believe that IT personnel are one of an organization's most important resources, and that managing, retaining, recruiting, and replacing such workers are critical challenges for success [3] [11]. Industry leaders express concern that US and European companies have the potential to lose their competitive edge as more graduate from institutions in developing countries and being working for competitors abroad [3] [16]. Required job skills have been driven by sweeping changes in new technologies as well as competition among companies motivated to differentiate their products and services. This trend explains why many organizations seek well-trained IS graduates regardless of any downward trend in the economy or offshore outsourcing [17].

Several empirical studies support the idea that the role of programmers has changed. A historical review of the skills required for programmers between 1970 and 1990 reveals that the importance of behavioral skills has increased over requirements of technical skills [7] [30]. It was observed that programmers cannot complete their task without communicating with clients to understand their business requirements [7]. Organizations required their IT staff to become more business-partner oriented rather than to remain mere technicians. Multiple studies confirmed earlier findings which report that managers value people skills as much as, or more than, technical skills [19] [28]. More recent studies have shown that it is also important for IS employees to possess behavioral skills such as communication [6] critical thinking [8] and business knowledge [24].

Through the analysis of job advertisements for 1988, 1996, and 2001, research reports that the systems analyst was the most frequently occurring position in terms of total number of ads in the IS job market [12]. This popularity may be attributed to the changing environment of the IS field. Since IS professionals are required to understand business processes and integrate them into technology-based solutions, the role of IS professionals has gradually changed from that of a program code writer to that of a business partner [12] [21] [23] [8].

Recent research reports that employers seek job candidates who possess a strong systems orientation and who understand the concept of a business value chain [5] [29]. The ability to integrate skills and see the big picture from a business perspective is highly valued. Critical skills for IS field include soft skills and a fundamental understanding of database, web knowledge, and operating systems. Technical skills in specific enterprise resource planning systems, artificial intelligence, statistics software, CASE tools, and Geographic Information Systems are not valued [5] [29].

Today's professional environment needs technical versatility and expertise in multiple domains within an organization. The greatest value that IS graduates add to an organization is their ability to assess business requirements and opportunities in ambiguous organizational situation and design solutions using heuristics, improvisation, and opportunistic combinations rather than prescribed systems development methodologies like the system development life cycle [29] [33]. More than knowledge of any particular systems design and development methodology, IS graduates should be able to analyze requirements and develop solutions for less structured, complex problems [29] [33]. Breadth of knowledge across several IS technical and conceptual areas (programming, networking, database design, systems analysis) is more important than depth of knowledge in one particular IS technology or conceptual area, especially for an entry level IS position [29] [33].

IS professional must have good analytical and critical thinking skills to become problem solvers. Many CIOs claim that graduates lack the business thinking and communication skills that are now required for corporate IS jobs. This deficiency continues to be an issue and is critical to the success of the IT industry especially since the vast majority of the II workforce initially receive their training from academia [4]. IS professional must have good interpersonal communication and team skills in order to understand system requirements and have the ability to collaborate with other business professionals. Employers still desire technical skills, (programming, systems testing, desktop support, database design and management, and data communications, but they

also emphasize soft skills that include problem/opportunity solving skills, relationship/conflict resolution skills, as well as project management skills [4].

IS professional must be able to design and implement solutions to improve the organization's performance and not just to adhere to specified rules without consideration of business processes. This shift in the IT mission from delivering technology based solutions to managing the process of delivering business solutions leads academics to shift their focus from a technology based curriculum to a business intergraded approach. IS graduates are expecting to move into jobs that require managerial skills but the inadequate coverage of areas such as security and project management and too much emphasis on traditional systems development has led some to believe that there is not sufficient emphasis in curriculum on integrating technology, application, and business functions [4] [10] [29].

DEVELOPMENT OF ITM AS A SEPARATE MAJOR

The ITM major was created by creating several courses specifically for the new program along with including courses existing in the BIS major and reworking them to fit the management focus of the new program. New courses in the curriculum include: Information and Technology Applications, Data-Driven Web Development, Systems Security, Management, and Cases in ITM. Other existing courses, for example Human Factors in Information Systems, were reworked and renamed to emphasize the management aspects of the topic.

It was also desired to incorporate the Information and Technology Management Applications course into the General Education program as a quantitative course, which was accomplished.

The new program, new courses, and course changes were all brought through the Bloomsburg University curriculum process as a bundle in late 2007, and were all approved, such that the new program took effect in Fall 2008. The general education course component was added a bit later, and several of the courses have recently been approved for online offerings, and have been offered online several times.

CONCLUSION

The new program has reinvigorated the information and technology field at Bloomsburg University. The number of majors has nearly tripled since the program change was made; now being roughly 100 students. The CIS program used to be the leading program of the three, but enrollments in it and MIS have declined so precipitously that both CISD and MIS have been put into moratorium and are essentially closed for further business at the time of this writing. The ITM faculty has made continuing efforts to improve the curriculum, and will soon be going through a major review, which likely will result in further changes. Future reports will describe curriculum and assessment development and recruitment of faculty and students.

The ITM web page may be found here:

http://www.bloomu.edu/itm

The list of ITM courses, with their descriptions, may be found here:

https://siscs.bloomu.edu/psp/csprod/EMPLOYEE/HRMS/c/COMMUNITY_ACCESS.SSS_BR OWSE_CATLG.GBL

(Please look under the letter I for ITM.)

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WILLINGNESS TO STUDY ABROAD: AN EXAMINATION OF KUWAITI STUDENTS

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ABSTRACT

International education is an increasingly important part of business programs throughout the world. This paper investigates the willingness of Kuwaiti business students to study abroad. It tests the hypotheses that student willingness to study abroad is related to a number of variables, including self-efficacy, perceived benefit of study abroad, language ability, previous international experience and having friends and family with international experience. Implications for designing and marketing business study abroad programs are addressed.

INTRODUCTION

International education has become a big business for the United States. Many U.S. colleges and universities are dependent upon international students for a large portion of their tuition revenue and enrollment determined budget and this dependence will likely increase (Agarwal & Winkler, 1985). Additionally, international students studying in the U.S. contribute more than 12 billion dollars annually to the U.S. economy (Altbach, 2004). Approximately two million students currently study outside of their home country. This number is expected to increase to about eight million by 2025 (Altbach, 2004). Of these two million students, 723,277 are international students choosing to study in the U.S. This is a thirty-two percent increase since the 2000-2001 academic year (Institute of International Education, 2011). As this dependence upon international students increases, it becomes necessary for U.S. colleges and universities to understand why these students choose to study abroad and what factors can lead them to choose the U.S. over other locations.

For these international students in the U.S., business management is the top field of study with 21.5 percent choosing this as their major (Institute of International Education, 2011). The number of Middle Eastern students studying in the U.S. has increased by sixteen percent from the 2009/10 academic year. There has been a particularly strong increase in students from Qatar, UAE, Iran, Saudi Arabia, and Kuwait (Institute of International Education, 2010). This paper focuses on Kuwaiti business students and their willingness to study abroad.

BACKGROUND AND LITERATURE REVIEW

Background

In recent years, Kuwait has been taking significant steps toward investing in education. Private higher education was banned in Kuwait for more than three decades. Kuwait University, a state owned university, was the only option for students who wanted to earn a college degree in Kuwait. However, as the number of Kuwaiti students demanding a college education grew to approximately 1 million in the 1990s, Kuwait University could not keep up (Mills, 2009).

About a decade ago, Kuwait lifted their ban on private higher education but not without several requirements for the private investors wishing to develop their own universities. One requirement is that all new private universities must have a foreign partner university. Since this policy has been put into place, there have been eight new universities and nine more have been authorized to open in the next few years (Mills, 2009). Several recognizable U.S. universities are paired with the private Kuwaiti institutions. For example the University of Missouri at St. Louis is paired with the Gulf University for Science and Technology and Dartmouth is paired with the American University of Kuwait. This pairing could be helping Kuwaiti students gain a recognition and connection to American universities making international study in the U.S. more comfortable and enticing.

The number of Kuwaiti students leaving the country in order to continue their education continues to increase (Oxford Business Group, 2011). More than two thousand Kuwaiti students

are studying in the U.K. and this number has been steadily increasing since 2004. Additionally, the number of Kuwaiti students studying in the U.S. has increase by 22.8 percent between the 2009/10 school year and the 2010/11 school year (Institute of International Education, 2011). This growth is unlikely to slow. More than three thousand students attended the annual Kuwait Study Abroad Fair in February of 2011 and more than 3800 applications were received for 1800 study abroad positions (Oxford Business Group, 2011). This growth could be driven by the November 2010 government policy change. Moudi Al Humoud, then minister of education, announced that salaries for study abroad students would be increased by 20%. Moudi Al Humoud announced at the 27th annual conference of the American Branch of NUKS that "We look at any increase as an investment in the human factor and our students deserve more."

Literature Review

As study abroad has continued to increase in popularity, there has been an increase in the literature seeking to explain it. Hackney, Boggs, and Borozan (2012) conducted a study on the willingness of American business students to study abroad. Based on a survey of over 300 students from a Midwestern university, they concluded that students are more willing to study abroad short-term than they are long-term. They also found that personal, situational, and location variables influence students' willingness to study abroad. Surprisingly, results showed no relationship between having taken an international business course and willingness to study abroad. This paper is meant extend Hackney et al.'s (2012) research by examining Kuwaiti business students' willingness to study abroad.

Salisbury, Umbach, Paulsen and Pascarella (2009) focused on students' choice process of the intent to study abroad. By applying the student choice theory (Paulsen & St. John, 2002; St. John & Asker, 2001) and Laura Perna's (2006) integrated model used by her to predict college choice, they found that socioeconomic status, social capital, and cultural capital influence students' intent to study abroad. They also concluded that females were more likely to study abroad than males.

Kim and Goldstein (2005) examined the characteristics of students who intended to study abroad relative to those who did not. They observed factors related to intercultural attitudes such as ethnocentrism, apprehension of intercultural communication, interest and competence in languages, prejudice, ambiguity tolerance, and expectations about study-abroad programs. They found that students who had favorable expectations of study abroad differed from their counterparts in that they had lower levels of ethnocentrism and intercultural communication apprehension and a greater interest in foreign languages. The authors suggested that in order to increase student interest in study abroad, universities should seek to reduce ethnocentrism and apprehension about communicating with culturally different individuals. They also suggested that universities could create programs that assist students in understanding the value of foreign language study.

Presley, Damron-Martinez, & Zhang (2010) applied Ajzen's theory of planned behavior to study business students' intention to study abroad. The theory of planned behavior is a social psychology model that examines the connection between an individual's attitudes and behavior. According to this theory, the likelihood that an individual will execute a specified behavior

depends on their behavioral intention to execute that behavior. There are three predictors of behavioral intention (1) attitude toward the behavior, (2) subjective norm, and (3) perceived behavioral control. An individual's attitude toward the behavior is the degree to which they positively or negatively evaluate the behavior in question. The subjective norm is social factor concerning the perceived peer pressure affecting whether or not the individual will perform the behavior. Perceived behavioral control is the ease or difficulty with which an individual can complete the behavior. This takes into account both past experiences and foreseen obstacles. If these three factors are strong, the individual is predicted to have a greater intention to perform that behavior. Their results showed that students' intention to study abroad was influenced by all three factors.

Extending the theory of planned behavior, Goel, de Jong, and Schnusenberg (2010) incorporated personality traits such as conscientiousness, openness to experience, and extraversion. The authors argued that personality plays a role in students' beliefs related to studying abroad. They hypothesized that behavioral beliefs, subjective beliefs, and control beliefs are positively associated with the intention to study abroad and that all three personality traits are positively related to behavioral beliefs, while conscientiousness is positively related to subjective beliefs, and both conscientiousness and extraversion are positively related to control beliefs. Results showed that extraversion was positively related to behavioral beliefs, and both conscientiousness and extraversion were positively related to control beliefs. The authors concluded that personality does indeed play a role in students' beliefs relating to study abroad and different personality traits influence different beliefs to differing extents.

Relyea, Cocchiara, and Studdard (2008) examined students' motivations to study abroad in regard to risk propensity and perceived value. They did this by applying the expectancy theory. They found that risk propensity has a direct relationship with the likelihood to engage in an international experience and that the perceived career value moderates this relationship. This suggests that motivating students can be very complex and challenging. The authors imply that it is the responsibility of the university to provide its students with a global education and to teach them the value provided by an international experience, and university administrators need to attempt to mitigate risk and demonstrate to their students that it is manageable.

Toncar, Reid, & Anderson (2005), examined the difference between business students' and non-business students' motivations to study abroad. The found that business students were more pragmatic, more concerned about financial costs, and more concerned about the effects participation would have on graduation and future career opportunities. However, they found that program preferences for each group of students were relatively equivalent. The authors concluded that while the students' motivations may differ, universities could develop programs to satisfy both groups simultaneously.

Using expectancy theory, Sánchez, Fornerino, and Zhang (2006), analyzed the relationship between student motivations and intentions to study abroad. Their study focused on U.S., Chinese, and French business students studying in their home country. Results showed that the same four barriers existed for each nationality; familial, financial, psychological, and social. There were also similarities in motivations, however the authors suggested that while the

students were encouraged and discouraged to study abroad by similar stimuli, the specific composition of these stimuli differed in different countries.

Koirala-Azad and Blundell (2011), focusing on Nepali high school and university students, examined the motivations and feelings of both the students who choose to leave the country for higher education and those who choose to stay. They found that the decision process to stay or to go is filled with complicated choices and many influences. By conducting interviews, they concluded that cost is one of the main barriers for students choosing to study abroad. They also found that women faced additional barriers such as extremely protective parents and the fact that upon completion of a bachelor's degree, a Nepali woman in her early to mid twenties is considered too old for marriage. Culture also played a huge role. Not only did most students feel an intense nationalism, consistent with Nepali culture, they put their families first which often created another barrier to study abroad. The authors claimed that overall, the students interviewed seemed to want to study abroad regardless of whether or not it was an option.

THEORY DEVELOPMENT AND DISCUSSION

Study abroad gives students the opportunity to learn and grow as an individual. Research has identified several benefits, both personal and professional, that result from participating in a study abroad program.

Participation in study abroad programs has been shown to increase students' concern for international politics, cross-cultural interest and broaden their worldview (Carlson & Widaman, 1988). Consistent with Salisbury et al. (2009), Dwyer and Peters (2004) found that study abroad resulted in benefits such as increased maturity, self confidence, tolerance of ambiguity, and language competency. Students can also develop emotional resilience, flexibility, and greater independence while studying abroad (Kitsantas, 2004). By studying abroad, students get the opportunity to enhance their understanding of different cultures, races, customs, and business practices, which increases tolerance, respect and open mindedness (Praetzel, Curcio, & Dilorenzo, 1996). After completing a study abroad program, students are more able to think of national groups in terms of individual characteristics instead of solely in terms of non-personal attributes such as cultural traditions, food, and famous people from that country.

Not only do these benefits help the student grow as a person, they can also help the student be more marketable to future employers. Students who spend time abroad develop "a deeper understanding and respect for global issues, more favorable attitudes toward other cultures, stronger intercultural communication skills, improved personal and professional self image, and better foreign language skills" (Salisbury et al., 2009). The 2003 Rand Corporation Study "What makes a Successful Career Professional in an International Organization" managers identified the most desirable qualifications of new hires. Many of these are skills that can result from participating in a study abroad program such as cross-cultural competence, or the ability to work well in different cultures and with people of different origins, interpersonal and relationship skills, ambiguity tolerance and adaptability (Matherly, 2005). Loh, Steagall, Gallo, and Michelman (2011) found that student perceptions that study abroad will enhance their job market prospects is associated with the amount they are willing to pay for the study abroad experience.

Expectancy theory states that individuals will be motivated to exert effort if they believe that doing so has valence or will result in a reward (Greenberg, 2010). Based on the numerous benefits research has identified result from studying abroad, we predict that the more students perceive the personal and/or professional benefits of study abroad, the more willing they will be to participate in a study-abroad program.

- H1: *Willingness to study abroad is positively associated with perceived personal benefit.*

- H2: *Willingness to study abroad is positively associated with perceived professional benefit.*

Self-efficacy can be defined as an individual's belief about his or her ability to successfully perform specific tasks (Greenberg, 2010). An individual with a high self-efficacy has a high level of confidence that they have the knowledge and skills necessary to execute a project, plan, or idea. We predict that self-efficacy, defined as student confidence in their knowledge, skills, and abilities to study abroad successfully, is associated positively with willingness to study abroad. Our hypothesis follows.

- H3: *Willingness to study abroad is positively associated with self-efficacy (belief that one possesses the knowledge, skills, and ability to succeed).*

Oftentimes, student behaviors are greatly influenced both positively and negatively by their family and/or friends. The individuals that one interacts with daily, communicates with and shares common interests with can have an impact on one's decisions. Research has shown that students especially value their parents opinions (Presley et al., 2010). Accordingly, we predict that students' willingness to study abroad will be positively related to the extent to which their family members have had international experiences. Furthermore, we predict that having close friends with international experience will increase willingness to study abroad.

- H4: *Willingness to study abroad is positively associated with having family and/or friends with international experience.*

Fear of the unknown may be motivation enough to cause students to avoid studying abroad in a foreign country. However, having previous experience traveling abroad either for vacation or study could wet a student's appetite for more. A previous international experience would likely boost a student's confidence that they can go abroad and be successful and alleviate some of the fear of the process. One of the most popular ways for students to gain this previous international experience is a short-term study abroad trip. For example, Lewis and Niesenbaum (2005), surveyed students who participated in a two-week summer study abroad trip to Costa Rica and found that upon returning to the U.S., half of them planned to study abroad again. Many of these students drew a clear connection from their desire to study abroad again to their experience in Costa Rica. While the level of student willingness to study abroad could depend on whether their original trip was positive or negative, it is the authors' contention that positive international travel experiences are far more common that negative ones. We hypothesize that student willingness to study abroad will be positively associated with having previous international experience.

- H5: *Willingness to study abroad is positively associated with having previous international experience.*

- H6: *Willingness to study abroad is negatively associated with having committed personal relationships locally/domestically.*

For many years, one of the main motivations behind study abroad was the opportunity to study or to practice a foreign language (Holland & Kedia, 2003; Dwyer & Peters, 2004; Presley et al., 2010. Research has shown that increased language proficiency is one of the many benefits of study abroad (Kim & Goldstein, 2005; Salisbury et al., 2009). Additionally, if a student has studied a foreign language they will feel more at ease in a foreign country that speaks that language than if they had no ability in that language whatsoever. The ability to communicate in a foreign country can make the experience much more positive. Accordingly, we predict that foreign language competence is positively associated with willingness to study abroad.

- H7: *Foreign language ability is positively associated with willingness to study abroad.*

Research has shown that there is a gender gap in study abroad participants and that females are more likely to study abroad than males (Thomas & McMahon, 1998; Kim & Goldstein, 2005; Salisbury et al., 2009). Kim and Goldstein (2005) found that levels of language interest, low ethnocentrism, and low intercultural communication apprehension were significant when trying to predict interest in study abroad. Their results indicated that females not only had higher levels of language interest than males but also had significantly lower levels of ethnocentrism and intercultural communication apprehension. We predict that consistent with previous research, females will be more willing to study abroad than males.

- H8: *Females are more willing to study abroad than males.*

Program length is often an important factor when deciding whether or not to study abroad. Longer programs often cost more and require students to give up or leave their life behind for an extended period of time. Recently, short-term study abroad programs, which we define as lasting less than a semester, have become more popular, especially among business students (Holland & Kedia, 2003). Research has identified several barriers students face when considering whether or not to study abroad such as the fear of leaving the United States, financial constraints, and perceived or real lack of flexibility within their academic program (Lincoln Commission Report, 2005; Holland & Kedia, 2003; Albers-Miller et al., 1999; Salisbury et al., 2009). Participating in a short-term study-abroad program may allow students to mitigate some of these barriers. For this reason, we predict that students will be more willing to study abroad short-term than long-term.

- H9: *Students are more willing to study abroad on short-term programs than on long-term programs.*

As mentioned before, studying abroad can be an intimidating experience. Students have to adapt to new places, cultures, and people all at once. Doing this in an area that speaks the same

language might alleviate some of the fear. Accordingly, we hypothesize that students will be more willing to study abroad in Arabic-speaking locations than non-Arabic-speaking locations.

- H10: *Students are more willing to study abroad in Arabic-speaking locations than non-Arabic-speaking locations.*

For many students, participating in a study abroad program means leaving their home country for the very first time. This is not only uncomfortable, but can also be viewed as threatening (Lewis & Niesenbaum, 2005). Many Arab parents think the U.S. is too far to send their children. Additionally, many Arab parents are reluctant to have their children, especially their daughters, exposed to American culture and society (Rugh, 2002). For these reasons, we predict that students will be more willing to study abroad in geographically close countries than geographically far countries.

- H11: *Students are more willing to study abroad in geographically close countries.*

Students often study abroad with the hopes of visiting cities or attractions of which they have only seen pictures. Usually, these are located in larger cities. Larger cities offer advantages to study abroad students that rural locations cannot such as more extensive technology, communications, and transportation infrastructure. Business students, in particular, may be attracted by the important centers of global commerce. Due to this, we predict that students will be more willing to study abroad in urban locations than rural locations.

- H12: *Students are more willing to study abroad in urban locations than rural locations.*

Traveling across the globe can be a very intimidating experience for students. Universities often provide the opportunity to study abroad with faculty or other students of the home university. This may help alleviate the fear of traveling to a foreign country. Study abroad professionals agree that students are more likely to participate if a business faculty member from their home university taught the courses while abroad (Holland & Kedia, 2003). Due to this, we predict that students will be more willing to study abroad with others than alone.

- H13: *Students are more willing to study abroad with others than alone.*

METHODOLOGY

Sample

A survey instrument (see Appendix 1 for sample questions) was distributed to business students at a private Kuwaiti university in 2011. The university has approximately 3,600 students. 135 usable survey responses were received from students including responses from freshman-, sophomore-, junior-, senior-, and graduate-level students. 80 percent of respondents were business majors, 19 percent were various other majors, and less than 1 percent was unknown. Respondents' majors can be broken down into 51 percent Marketing, 10 percent Accounting, 8 percent Management, 5 percent MIS, 1 percent Finance, 22 percent Other and less than 1 percent was unknown. 28 percent of respondents were males, 71 percent were females, and less than 1

percent was unknown. Only the responses of Kuwaiti citizens were examined for this research, though surveys were collected from 20 non-Kuwaiti citizens as well. The average age of respondents was 21.9 years and the range was from 17 to 29 years old.

Survey Instrument

The survey instrument used was composed of four sections. The first section addressed socio-biographical factors and demographics such as age, gender, personal relationships, major of study, and highest degree obtained. The second section asked respondents to rate their proficiency in foreign languages on a scale of zero to five; zero representing no ability and five representing a fluent and native speaker. Additionally, the second section included questions of quantity such as "How many foreign countries have you visited?" or "How many of your close friends have lived, studied, or worked abroad?" The third section questioned agreement with items related to willingness such as "I am willing to study abroad short-term (less than a semester program)." Respondents were asked to rate the extent to which they agreed or disagreed with a specific statement using a six-point Likert scale as following: 1= strongly disagree, 2=disagree, 3=somewhat disagree, 4=somewhat agree, 5=agree, and 6= strongly agree. A six-point scale was used, which prevented neutral responses. The questions were clear and unambiguous, and therefore suitably measured with single-item measures (Wanous, Reichers & Hudy, 1997). The fourth section of the survey instrument included four open-ended questions asking students to list countries in which they had previously lived, worked, studied, or visited. Before being administered to the Kuwaiti students, the survey was administered to American and International MBA students at an American university, who were graduate assistants to test its reliability and validity. Questions were deemed easy to understand and straightforward. Sample questions are shown in Appendix 1.

EMPIRICAL ANALYSIS AND FINDINGS

Empirical analysis is ongoing but initial findings are interesting and revealing. As shown in Figure 1, Kuwaiti students show a slight preference for long-term study abroad programs rather than short term programs. This contrasts with findings by Hackney et al. (2012), who found that American students exhibited a statistically significant preference for short-term programs. Figure 2 shows that Kuwaiti students prefer to study in Europe, Australia, and North America more than Asia, Latin America, and Africa. Figure 3 shows a preference to live in countries where Arabic is not the dominant language. Figures 4 and 5 shown language proficiencies of the Kuwaiti students. Most respondents are fluent in more than one language, with European languages being the most common second languages spoken by respondents. Figure 6 shows that respondents are equally open to living in geographic locations that are close or distant. Figure 7 shows a strong preference for urban, as opposed to rural, locations, and Figure 8 shows a strong preference for living or studying abroad with others as opposed to going alone. Responses described in Figures 7 and 8 are consistent with Hackney et al. (2012) but responses described in Figures 3, 4, 5, and 6 are in contrast to findings for American students (Hackney et al., 2012). These findings are interesting, and ongoing statistical analysis is being conducted to determine the degree of support or lack of support that is provided for all of the hypotheses presented in the theory section of this paper.

Figure 1: Kuwaiti Student Willingness to Study Abroad

Willingness to Study Abroad

Short-Term: 4.16
Long-Term: 4.38

Y-axis: Strongly Disagree - Strongly Agree (1.00 – 6.00)
X-axis: Duration of Trip
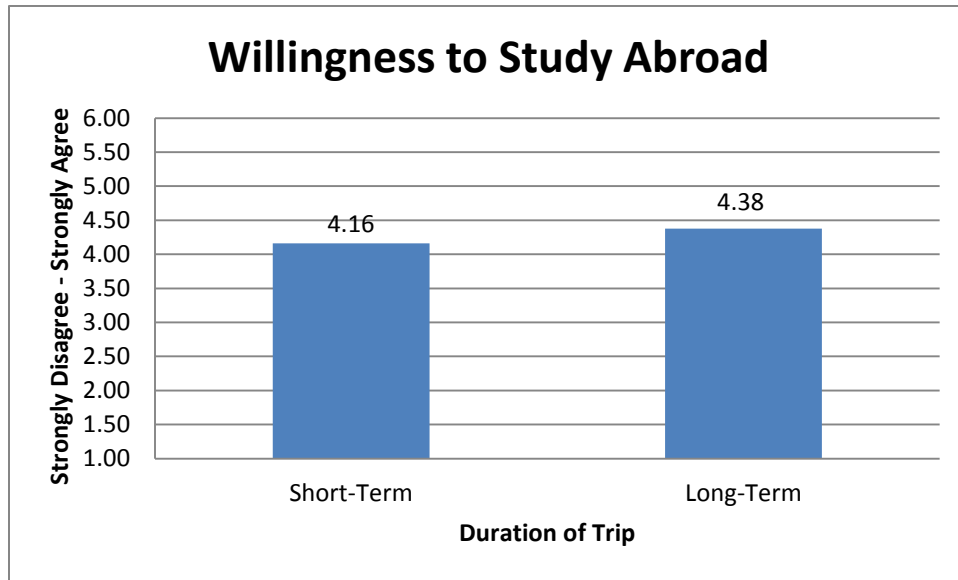
Figure 2: Kuwaiti Student Willingness to Live in Different Locations

Willingness to Live in Different Regions

Europe: 3.62
3.42
North America: 3.19
2.89
Latin America: 2.60
2.35

Y-axis: Strongly Disagree - Strongly Agree (1.00 – 6.00)
X-axis: Region
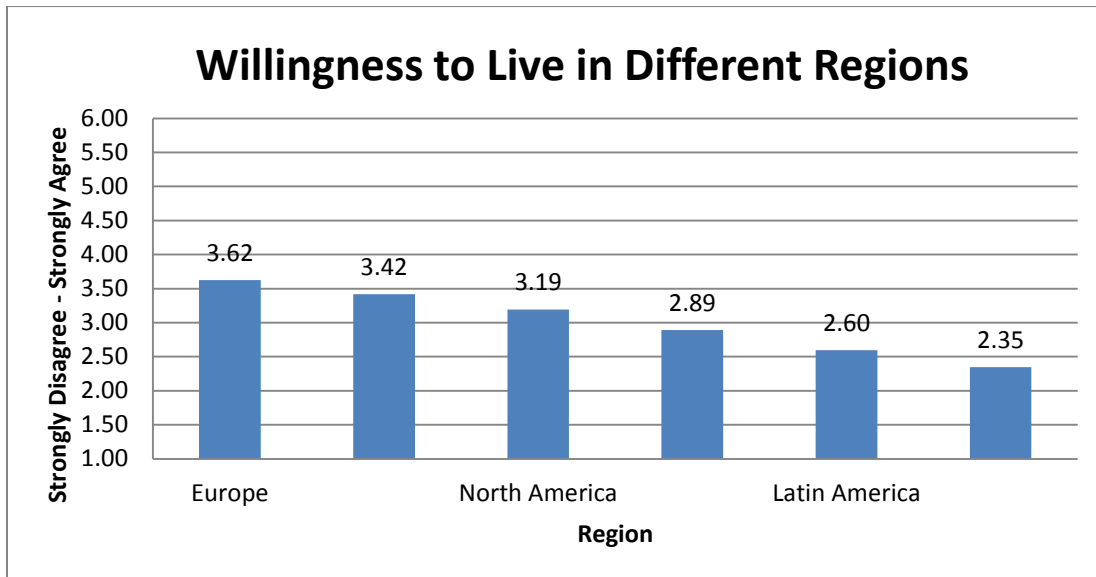
Figure 3: Willingness to Live Where Arabic is Spoken

Willingness to Live where Arabic is Spoken
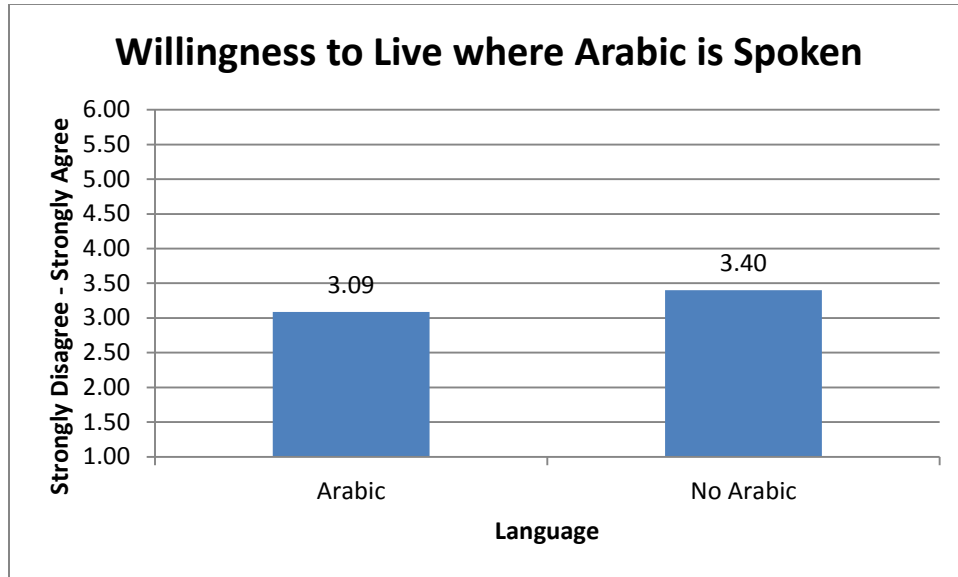
Figure 4: Rate of Language Proficiency by Respondents

Rate of Language Proficiency by Respondents
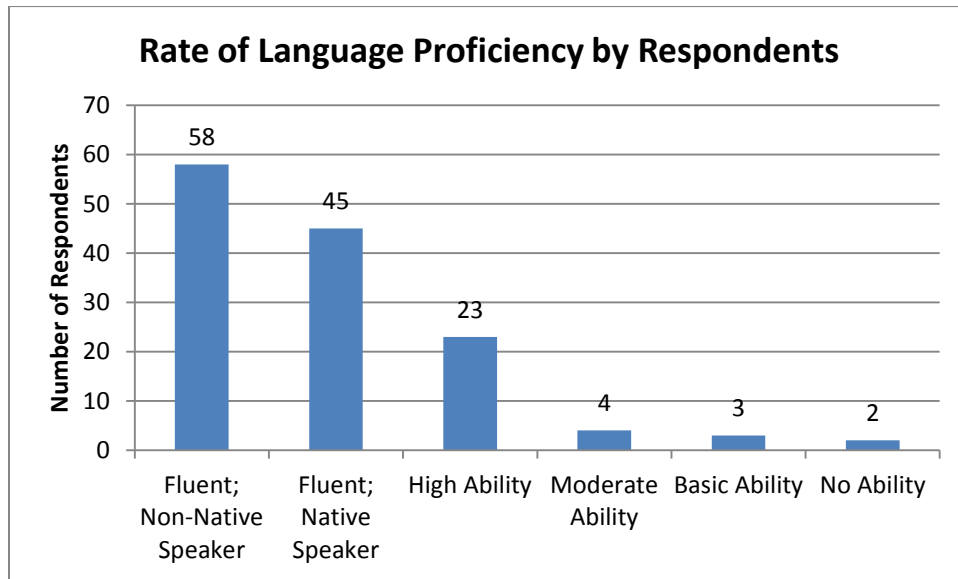
Figure 5: Languages Rated Most Frequently

Languages Rated Most Frequently

Language	Number of Respondents
English	124
French	96
Spanish	54
German	21
Chinese	19
Other 1	8
Other 2	2
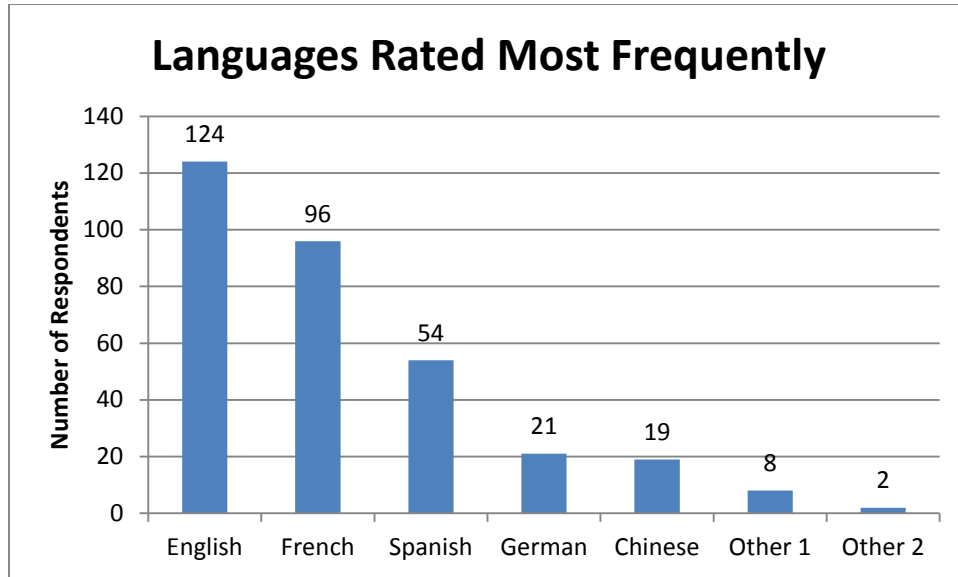
Figure 6: Willingness to Live in a Geographically Close or Far Location

Willingness to Live in a Close or Far Location

Strongly Disagree - Strongly Agree

Distance from Kuwait	Value
Far	3.06
Close	3.04
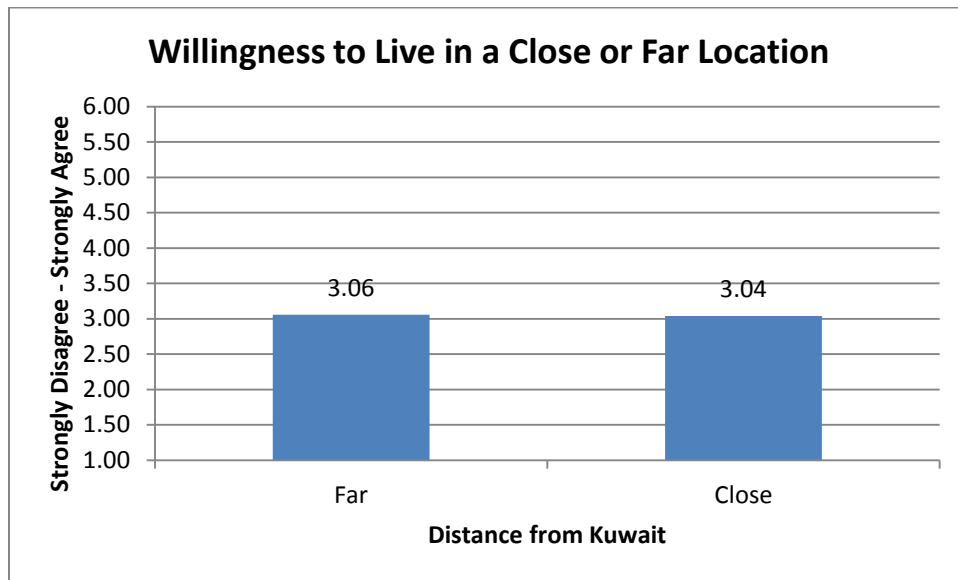
Figure 7: Willingness to live in Urban Versus Rural Locations

Willingness to Live in Urban or Rural Locations

Rural: 2.37
Urban: 3.44

(Y-axis: Strongly Disagree - Strongly Agree, 1.00 to 6.00)
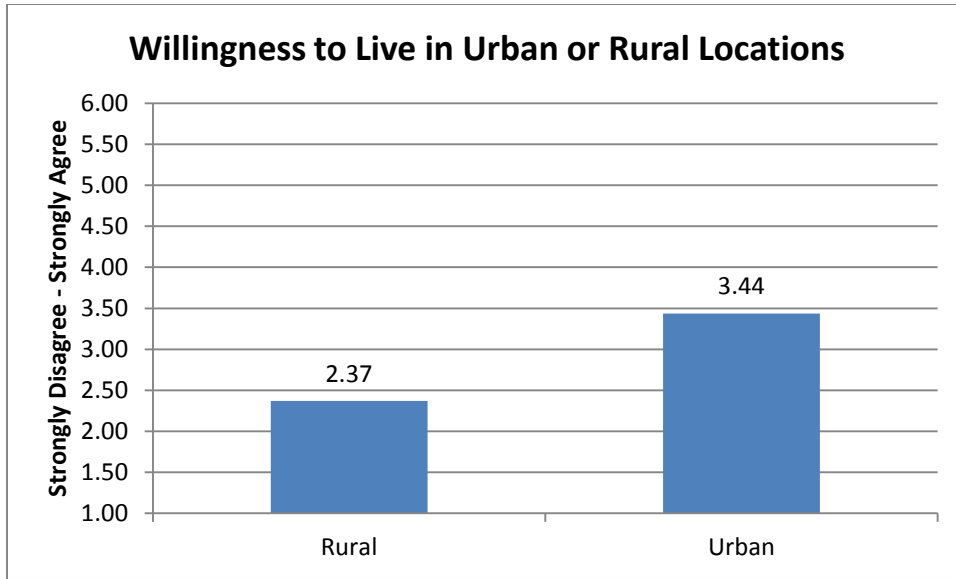
Figure 8: Willingness to Travel with Others Versus Travel Alone

Willingness to Travel with Others or Alone

With Others: 3.64
Alone: 2.74

(Y-axis: Strongly Disagree - Strongly Agree, 1.00 to 6.00)
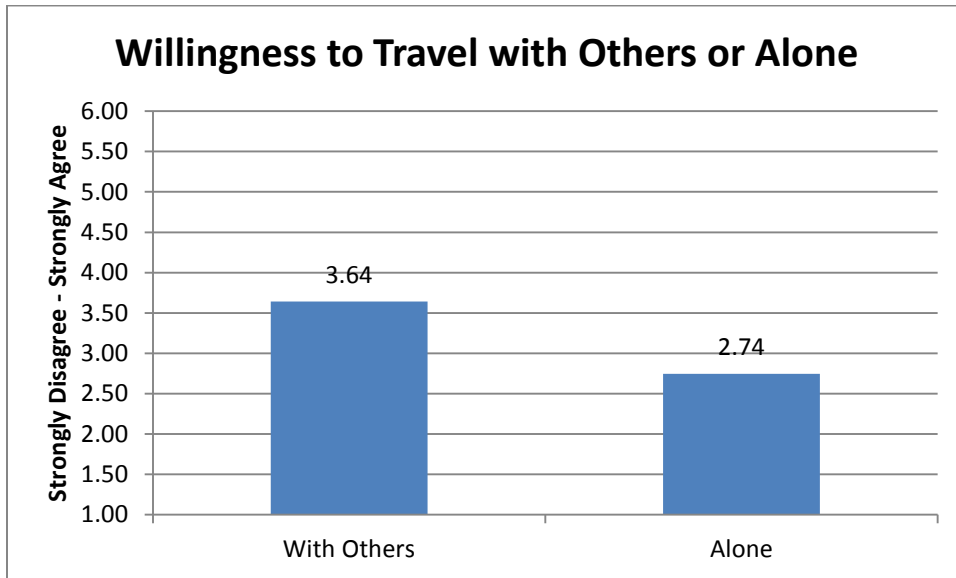
DISCUSSION, LIMITATIONS AND CONCLUSION

The choice to study abroad is influenced by a multitude of situational and personal factors. Study-abroad participation is of high interest to U.S. and foreign institutions in light of the growth of higher education in developing nations and the slight decline in some developed markets due to population and technological shifts. Our preliminary findings indicate that Kuwaiti students prefer to study in Europe and locations with an Anglo-European heritage. Additionally, Kuwaiti students prefer urban locations and prefer to study abroad with others who are familiar or close to them. These findings are interesting, and in line with findings for American students. Other findings are quite different from previous studies' findings about American students. In particular, Kuwaiti's do not seem to be bothered by geographic distance as Americans are, they indicate a clear willingness to study abroad long-term, and Kuwaiti students have more developed abilities in second languages.

Since there is disagreement among scholars as to the appropriate or best length of time to study abroad in order to realize benefits, and since Kuwaiti students seem more willing to study abroad long-term than American students, it would be interesting to study in greater detail the impacts of long- versus short-term study abroad programs for business students from different countries. Short-term programs are very popular in the U.S. but Kuwaiti's indicate a preference for long-term programs. Other interesting areas for continued investigation are the differences for men versus women in the Middle East versus the West. American women are more willing and likely to study abroad than American men. This study is still investigating differences between Kuwaiti men and women.

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APPENDIX
Sample survey questions

Section 1

Which best describes where you were mostly raised?	Rural / Small town / Medium town / Large city

Your current class standing: Freshman / Sophomore / Junior / Senior / Graduate / Post-Graduate

Highest degree you have already completed:
None / High School / Associate / Bachelors / Masters / Doctorate

Undergraduate major: Accounting / Finance / Management / Marketing / MIS / Other

If you circled Other, please indicate major: _____

Section 2

Please circle appropriate numbers below to indicate your proficiency in these languages
(0=No ability at all, 1=basic ability, 2=moderate ability, 3=high ability, 4=fluent non-native speaker, 5=fluent native speaker)

Spanish	0	1	2	3	4	5
French	0	1	2	3	4	5
German	0	1	2	3	4	5
Chinese	0	1	2	3	4	5
English	0	1	2	3	4	5
Other (1) _____	0	1	2	3	4	5
Other (2) _____	0	1	2	3	4	5

Please circle the number on the right that best answers the following questions

How many of your close family members have lived, studied or worked abroad?	0	1	2	3	4	5+
How many of your close friends have lived, studied or worked abroad?	0	1	2	3	4	5+
How many times have you studied abroad short-term (less than a semester)?	0	1	2	3	4	5+
How many times have you studied abroad long-term (a semester or more)?	0	1	2	3	4	5+

Section 3

Please indicate how much you disagree or agree with the following statements.	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
International experience is beneficial for professional and career development	1	2	3	4	5	6
International experience is beneficial for personal development	1	2	3	4	5	6
I am willing to study abroad short-term (less than a semester program)	1	2	3	4	5	6
I am willing to study abroad long-term (semester or longer)	1	2	3	4	5	6

AN INFORMATION SYSTEMS DESIGN THEORY FOR STRATEGIC DECISION SYSTEMS: THE CASE OF A CANDY MANUFACTURER

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ABSTRACT

Organizations face strategic decisions that can be unstructured, complex, unique, and hinge on factors both unknown and unknowable. Even the nature of strategic decisions organization face can develop unpredictably over time as the outcomes of preceding decisions emerge. Our research considers the case of a confectionary products manufacturer determined to increase their presence in the United States by aggressively growing a chain of retail stores as a new channel of distribution. Their goal was to transform a few disparate manufacturing outlets into a nationwide chain of over 300 full-line retail stores. The company perceived the window of opportunity to be closing rapidly and therefore was determined to roll out those stores in very short order.

To achieve this goal, management relied on several strategic decision systems as support. Although they proved instrumental to the company, the requirements, development, implementation, and use of these systems reflected the unstructured processes, unpredictability, and rapid changes of the strategic decisions they supported. Best practices such as incremental and iterative system development methodologies such as agile methodologies were not entirely suitable under the very high levels of unpredictability inherent to the type of strategic decisions we are researching, nor do existing information systems design theories completely address the issues this company faced. Motivated by these challenges, our case study derives a cohesive information systems design theory for systems to support highly unstructured strategic decisions. This theory is a contribution of interest to those researching information systems design theories, and to practitioners seeking to build similar systems.

INTRODUCTION

Mintzberg and others have defined strategic decisions in relation to their importance for an organization, and characterized strategic decision-making as an unstructured process having "novelty, complexity, and open-endedness" (Mintzberg, 1978; Mintzberg, Raisinghani, & Theoret, 1976). According to Mintzberg et al.(1976), organizations are often only vaguely aware of a strategic decision's starting and ending points and the decision process proceeds iteratively, alongside the continuous possibility of discontinuities. Mintzberg and others have also classified strategic decisions on a continuum ranging from voluntary strategic decisions such as those made to pursue new opportunities, to involuntary strategic decisions such as those necessitated by crises. Here we focus on the former: strategic decisions stimulated by opportunities.

This class of strategic decisions is characterized by decisions with no precedents, that are ill-structured, and that are not readily modeled or analyzed. They are complex, nonlinear, and fragmented; thus not well suited for decision support models(Bennett, 1998). As with the company we analyze in this paper, their strategic decisions were highly unstructured, complex, with no best set of steps known, or even knowable, *a priori*.

This research presents a case study of a company endeavoring to create information systems to support strategic decisions and, from case-based evidence, extracts a design theory for developing of strategy-aiding information systems. The company is a large European manufacturer of confectionary products who was attempting an aggressive expansion of its presence in the United States. As the company prefers not to be identified, it is referred to as Venus Chocolates in this paper. Their strategic decisions were focused on transforming a group of six retail stores that had been opened as factory outlets entirely secondarily to their main channel of wholesale distribution. The strategic plan they fixed on was to introduce a nationwide chain of 300 or more full-line retail stores in the U.S. within three years. The company committed to such a very rapid expansion despite the potential risks because of their financial situation, their presence in other countries, and anticipated responses on the part of their competitors if they did not move quickly.

Based on the evidence accumulated from the case study outlined we extract, evaluate, and propose a new design theory for systems supporting this class of strategic decisions. Analysis of the evidence shows that existing system development methodologies are not entirely applicable, and comparisons show that principles of existing design theories are not entirely adequate. Our research proposes a new design theory in an area where developing design theories has been challenging, and one that can be of benefit to practitioners. It has the potential to spur the application of information systems for business intelligence and predictive analytics to be more effectively applied in new and higher levels of business planning and decision-making.

The remainder of this paper is organized as follows. First, existing research of design theory is reviewed. After the case itself is presented, the methodology and the data available to the researchers for the case study are described. The design theory derived from this case is presented, followed by a discussion of the comparison to existing design theories and lastly, conclusions.

THEORETICAL BACKGROUND

IS design theories are not new, being well-established for many classes of information systems. Design theories are distinct from other IS theories because they are prescriptive rather than descriptive or predictive(Walls, Widmeyer, & El Sawy, 1992), focusing on how problems can be solved to achieve goals. Developing IS design theories starts with a set of goals for which one or more processes are prescribed. Processes are intended to produce the artifacts and outcomes best able to meet the specified goals. Building and evaluating IS artifacts are the core phases of IS

design science research (March & Smith, 1995) and while these phases have been viewed in design science research phases to be followed by phases for theorizing and justifying, studies of information systems (IS) design theory focus on the first two phases of building and evaluation (Aier & Fischer, 2011) as we have.

IS design theories are at the core of the discipline (Weber, 2003). Relational database theory is one example of an IS design theory(Walls, et al., 1992), as is the System Development Life Cycle (SDLC). Each prescribes processes to achieve a desired result (for example, normalization to produce a consistent database and the waterfall method to develop a system), and each prescribes instantiations as the artifacts for the same purpose (for example, a database with assured data integrity or a completed system that meets requirements).

IS design theory provides guidelines for system developers, and as a result has sometimes been incorporated in best practices. A best practice used by developers can include all the elements of design theory. For example, best practice recommendations for creating object-oriented software include processes that are prescribed by the Rational Unified Process (IBM, 2011)in order to produce artifacts such as UML class, sequence, and collaboration diagrams. As does design theory, best practices prescribe both processes and artifacts, but can come from a design theory proposed by researchers and after successful empirical testing becoming established in the field.

Best practices by themselves do not constitute elements of an IS design theory because they are established and routine, (Hevner, March, Park, & Ram, 2004). Hevner et al. argue that to be relevant, IS design theory research needs to address either new, unsolved problems, or to solve problems in innovative, more efficient ways. For example, the research by Markus, Majchrzak and Gasser (2002)was sparked when existing design theory was found lacking for a modeling application they were developing to support organizational design.

Three essential components for an IS design theory area set of requirements, design principles that can be applied and tested, and an evaluation of that theory (Gregor, 2006; Marx, Mayer, & Winter, 2011; Walls, et al., 1992). Just as design can be for either function or form, an IS design can be for either processes or instantiations. Artifacts of an IS design theory include constructs, models, methods, and instantiations (Hevner, et al., 2004). Constructs are terms and vocabulary, which help define problems and solutions; constructs are described in the case study presented in this paper.

Models are abstractions and representations of context, and are used to determine the objectives for the solution and the capabilities the system needs to provide – the requirements component of a design theory. Design principles are the components of a design theory that explain and prescribe methods to improve the effectiveness of an information system, which is the primary goal of an IS design theory. Our analysis of case evidence develops a set of 11 design principles grouped into three overarching meta-system requirements. Instantiations also define the scope of

an IS design theory and are used to ascertain its validity; we follow prior research and evaluate our design theory by demonstrating that it is based on a successful instantiation.

Fully developing IS design theories is an iterative process and accomplished with conducting steps "design" and "build" (March & Smith, 1995). After theories and associated measurable hypotheses are first advanced, systems should be built using those theories as guidelines. If the results are successful, the theory can be empirically validated. If not, the cycle is repeated.

When Walls, Widmeyer and El Sawy (1992) developed an IS design theory for executive information systems they noted that commercial software vendors at that time were responding to market needs, rather than proceeding from specific design theory. They argued that design methods based on well-founded IS design theory will lead to better software. We believe this is just as true todayfor business intelligence and predictive analytics software, and particularly so for software to support highly unstructured processes such as exemplified by the strategic decisions described in this case.

The most relevant IS design theories address "wicked" problems(Rittel & Webber, 1984). Hevner, March and Park (2004)typify these problems as having 1) Unstable requirements, 2) Ill-defined environmental contexts, 3) Complex interactions among subcomponents of the problem and solution, 4) Inherent need for flexibility in design process and artifacts, 5) Dependence on human cognitive abilities (creativity) for success, and 6) Dependence on social abilities (teamwork) for success. The strategic decisions made by Venus Chocolate's management team had each of these characteristics and qualify as wicked problems.

The goal of our research is to derive and propose a design theory which includes design principles based on archival evidence from Venus Chocolates. These are the first steps; in order to move forward with evaluation and confirmation of that design theory through testing subsequent instantiations in future research. The case study that is the subject of this research and source of our design theory is described next.

CASE STUDY

Venus Chocolates had distributed its line of premium confectionary products in the United States solely through a wholesale channel. To support this channel they developed some manufacturing capacity within the US, but relied on imports from Europe for the majority of their products. Venus Chocolates was aware that per capita consumption of their product category was far lower in the US than in Europe and became convinced this presented an opportunity. Management also noted the success of a highly profitable small group of retail stores Venus Chocolate had opened primarily as outlet stores. However, management also believed the window of opportunity to establish a chain was closing quickly. Guided solely by this vision, and confident that great

potential for a retail chain must exist, the decision was made to pursue an aggressive introduction and expansion of a retail chain.

Management was apprehensive of the impact the rollout of retail stores would have on existing operations and organization. Could the company meet the manufacturing, distribution, and infrastructure requirements of a rapid, large-scale retail network rollout and new channel of distribution? More importantly, with so little retail experience could the strategic decisions the company faced even be articulated? A lament voiced by a senior manager was that "We don't even know what we don't know." The set of strategic decisions necessary to fulfill this vision were not only vaguely defined but also complex and intertwined.

However, the management team knew their strategic decisions would be interrelated and intertwined, and they also realized that defining and drawing boundaries is one indicator of success for companies in dynamic, high-velocity markets(Eisenhardt & Martin, 2000).

Management was aware that many of their decisions hinged on factors such as the size of the potential retail market as well as the product mix, marketing strategy, and the numbers, profiles, locations, and rollout timing for new stores. Some of the interrelated decisions for the existing operations included determining the capacities and schedules for manufacturing, storage, and distribution. For example, if domestically made products (as opposed to European made and imported) were to be a major element in the highly seasonal retail product mix, how much more manufacturing capacity would be needed and when? How much additional storage space for raw materials and finished goods would be required? If some capacities were to be exceeded prior to the introduction of additional capacity, could outside facilities be leased, or would European capacity be available? If so, what would be the additional timing, transportation, and storage requirements for these imports?

Figure 1 summarizes the nature of these decisions in an ad-hoc diagram created during an informal meeting shortly after the decision was made to introduce retail stores and one of the authors of this paper began his relationship with the company.
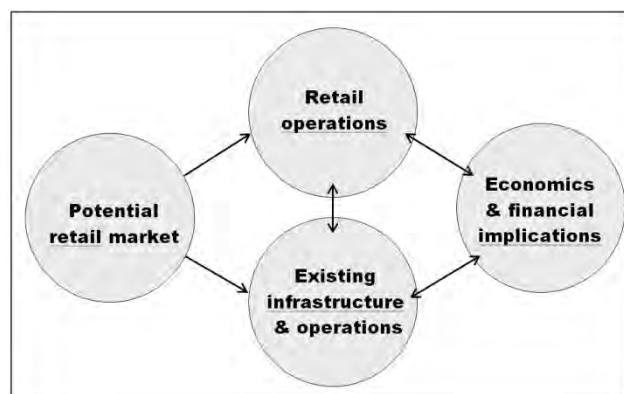
Figure 1: Areas of interrelated and intertwined strategic decisions

This figure shows management's conception that the product mix planned for the retail stores relied on manufacturing and distribution capacities, but planning for capacity required assumptions about the specific product mix. Both depended on the size of the potential retail market, how fast the chain could be expanded, and the degree of interaction – positive and negative – between the retail and wholesale channels. And, all of this is without considering influences affecting all three factors, which included the ability to make organizational changes, financial constraints, and potential responses from competitors.

The implications were that eliciting requirements for systems to support Venus Chocolate's strategic decisions might be complex, but some of the system requirements were simply unknowable. Although some elements from existing methodologies and design theories were applied, others were not, and this paper is an investigation of a case from which new design principles was developed and evaluated.

Throughout the expansion, Venus Chocolates held formal meetings at least every quarter for review progress and formulating new strategic decisions. One consequence of meeting frequently was that the strategic direction for the retail stores rollout and infrastructure could, and did, change dramatically in a short time as more experience with retail stores was accumulated. Another was that any strategic decision system under development had the potential to be scrapped or significantly revised.

Kiosks, for example, were completely outside the scope of management's thinking at any time during the first year of expansion yet considered as an option after some experience with the chain. These were not simply a new form of store, but a new type of outlet attached to individual stores having significant implications for the design of the strategic decision systems regarding forecasting, inventory, merchandising, and the supply chain. Yet as with the retail stores, management did not possess the experience to express any system requirements related to kiosks; this is but one of many such contingencies that needed to be incorporated into the systems on an ongoing basis.

As Venus Chocolates continued using these strategic decision systems to further expansion until the chain reached 80 stores in clusters on the East Coast stretching from Maine to Florida, the systems became a relatively stable set of tools, with major revisions and the need for entirely new systems dwindling. At that point, the author who had been a contract employee started to pursue other projects and lost daily contact. Ultimately, as more stores were opened, management concluded that the fastest way to expand, especially on the West Coast, was through acquisition. A significant competitor was acquired by Venus Chocolates, and shortly afterwards the systems were abandoned.

RESEARCH METHODOLOGY

Case Study Research

Case studies have long been an accepted methodology for IS research (Orlikowski & Baroudi, 1991),and case studies are in particular an appropriate methodology for studying IS design theories(Hevner, et al., 2004). Case study research is most appropriate when a phenomenon cannot be studied outside its natural setting, when no control or manipulation is necessary (or feasible), and there is not an established theoretical base (Benbasat, Goldstein, & Mead, 1987). It also produces results that can be relevant and meaningful to practitioners (Gordon, 2008).

Grounded methodologies to develop design theories can be divided into three classes: empirical, theoretical, and internal (Goldkuhl, 2004). Our research uses a grounded empirical methodology to analyze historical data from a past instantiation, somewhat distinct from related empirical grounded methodologies such as used for action research. Although analyzing historical data from the past eliminates the possibility of co-creating a design theory while designing and deploying a system such as Markus, Majchrzak and Gasser (2002)were able to do, historical case studies do provide great scope for reflection and are useful as a method for extracting knowledge from events that have already occurred (O'Brien, Remenyi, & Keaney, 2004).

Mode of analysis

One of the authors of this paper was involved as a contract employee for Venus Chocolates during the years in which they were embarking upon this effort. This contract was for a sequence of projects, undefined at the outset, each of which was to develop systems and solutions for strategic decisions. This author had no research agenda during this contract, and had no affiliation with the company afterwards.

However, for deriving a design theory the evidence available from this case was emphasized in favor over the direct observations that were available. Virtually all memos, personal note journals, documents, and software had been retained and were in the body of evidence for this case study. These included more than 1,000 individual pages of individual documents; among these were some 100 formal memos and 25 PowerPoint presentations shown at various company meetings. Many of these had been part of presentations and used by senior management to evaluate proposed options for strategic directions; others were financial statements and project reports. The evidence also included roughly 50 informal documents from sources such meeting minutes, handwritten notes taken during meetings and discussions, and journal notes.

Importantly for IS design theory development, the archives also included IS artifacts from the systems developed and used by Venus Chocolates in the form of design documents, system documentation, outputs, and the actual software. Thus, aside from interviews, four of the five sources of evidence most suitable for case studies were available– direct observation,

documentation, archival records, and physical artifacts (Yin & Yin, 2003) –and paved the way for historical analysis.

Different levels of structure and formalism can be used to analyze case evidence; Robson (2002) categorized these into the four basic approaches with increasing levels of formalism from Immersion, Editing, Template, and Quasi-Statistical. Immersion approaches are the least structured, and place reliance on interpretations made by the research. Quasi-statistical approaches are the most formal, and typically incorporate some form of quantitative analysis. The most suitable approaches for case studies in software engineering are the Editing and Template approaches (Runeson & Höst, 2009). The difference is in the extent the researcher's goal is to test hypotheses and has a priori research questions; using the former approach the researcher develops findings purely based on what emerges from analyzing case evidence. Here we are developing theory, and the Editing approach fits with our methodology.

To analyze the case evidence and evaluate whether or not a new design theory was warranted based on that evidence we followed a careful process with three major stages conducted iteratively: artifact identification, initial design theory development, and revisions from peer review.

Identifying IS artifacts is key to developing an IS design theory (Hevner, et al., 2004) and the first stage of our methodology involved identifying artifacts from the body of evidence. IS artifacts were conceptualized by March and Smith (1995) as constructs, models, methods, and instantiations. As defined by March and Smith constructs are the terms and language by which concepts are communicated. Models provide representations of reality and define solution spaces. Methods are documented processes, and instantiations are the implementations of information systems.

To identify the artifacts within the large body of evidence spanning different topics we first sorted the archive chronologically. The researcher then reviewed each element in the archive independently, highlighting any IS artifacts they could identify, and for printed documents attached an explanation using sticky notes. The researchers took care to identify artifacts potentially relating to existing IS design theories, especially those that related to strategy and knowledge processes that are emergent, such as Markus et al.'s (2002) design theory.

Each researcher next reviewed and assessed the artifacts that had been identified by the other separately. Finally, over several meetings the researchers conducted a review and discussion regarding each artifact that had been identified from the evidence, determining whether each artifact was a valid IS artifact that was more than a best practice and relevant to IS design theory. If both researchers agreed that it was, the artifact was recorded and any related document pages photocopied for use in the next stage. If both researchers agreed that the artifact was not relevant,

it was dropped from further consideration. If the researchers disagreed then a discussion was continued until both had agreed and the artifact would be either recorded or dropped. At the end of this first stage, over 200 individual artifacts relevant to IS design theory had been identified.

The second stage was to use those artifacts to develop a tentative design theory. This involved three steps. In the first, the researchers separately grouped the artifacts based solely on their common content. In the second, the artifacts and their groupings were reviewed by both researchers together but with a more in-depth process than for the first stage. An author who was not involved with the Venus Chocolates project analyzed the data and evidence from a detached standpoint. This author played the role of 'devil's advocate', focusing on offering alternative explanations for phenomena found in the data. Justifications for the grouping for each artifact, as well as the groupings themselves, continued until eventual convergence of the detached and the immersed perspective of the second researcher. Continuing until convergence gave us confidence in the confirmability of the findings; confirmability refers to the degree to which the results could be objectively confirmed or corroborated by others (Myers, 1999).

The commonalities within the agreed-upon groups of artifacts were worded as design principles, each supported by the set artifacts identified from the case evidence. Finally, the last step of this stage involved repeating the same process used to develop design principles from commonalities in groups of artifacts, but this time to categorize the design principles by their commonalities with respect to general (or meta) system requirements for the strategic decision systems.The result was to arrive at a tentative design theory with design principles aggregated into meta system requirements.

For the third and final stage, the tentative design theory was presented informally to colleagues and formally presented at conferences. The feedback indicated that there were too many design principles, and based on this feedback we repeated the review and discussion process used in the second stage and determined whether there were artifacts that could have supported more than one design principle. We found several that could be justified, enabling us to consolidate several design principles. After consolidating principles, one of the meta- system requirements was left with only a single principle and so merged with the most related category of requirements.

The revised design theory was again presented to colleagues and peers informally and formally. This time the feedback we received was that certain design principles needed more clarification and for some there were questions regarding the degree to which the wording reflected the context of the underlying artifacts. We repeated the process from the second stage and re-examining the artifacts supporting those design principles we re-worded several principles to produce the finalized IS design theory presented next.

DESIGN THEORY DERIVED FROM CASE EVIDENCE

Table 1 shows the IS design theory for systems built to support strategic decisions. It is the result of identifying relevant IS artifacts from the evidence of the Venus Chocolates case and rigorously examining them for validity and alternative explanations for supporting these design principles and categories of system requirements.

MetaSystem Requirements	Discovered Design Principles
1. Systems must meet needs arising from strategic decisions that are emergent	1.1 Systems will need significant revisions at unpredictable points 1.2 Systems must accommodate extremely tight or even unrealistic deadlines to deliver results 1.3 Systems must accommodate functional areas and/or areas of expertise that do not yet exist and whose existence is not yet anticipated. 1.4 Rapidly changing system requirements and disruptive new requirements will limit the effectiveness of incremental software development methodologies
2. Systems must incorporate the unstructured nature of strategic decisions	2.1 Only general and incomplete system requirements can be specified 2.2 Correctness of outputs for many systems cannot be determined 2.3 Systems are expected to be abandoned upon realization of the strategic goal
3. Syst em users will be members of top management	3.1 Expect that user training will be limited or non-existent 3.2 Anticipate few opportunities for user acceptance testing 3.3 Plan for limited opportunities to use prototyping 3.4 Develop document and presentation compatible outputs fromsystems

Table 1: System requirements and design principles discovered from case evidence

An enumeration of the IS artifacts supporting each design principle would be lengthy, and therefore each design principle is summarized as follows.

Design Principle 1.1: Systems will need significant revisions at unpredictable points. The case study describes Venus Chocolates' strategy and how in order to fulfill that strategy committed the company to make strategic decisions concerning functional areas the company had no familiarity with. These were decisions based on factors and outcomes that were largely unknown or unknowable, and necessitated those decisions to be made rapidly. The case study also describes how new and unforeseen strategic decisions continued to face management during the expansion as the company gained more experience with a retail channel of distribution and

was able to assess outcomes. Artifacts from project plans, memos, and system requirements, as well as from the software itself, all reflect discontinuities from accommodating this stream of rapidly changing emergent strategic decisions.

Design Principle 1.2: Systems must accommodate extremely tight or even unrealistic deadlines to deliver results. A quote from an internal memo underscores management's urgency to move forward quickly in virtually every functional area:

> "The task of building a retail infrastructure spans information systems, hardware, software, organization, materials handling equipment, transportation, warehousing, policies, and procedures. Determining the obstacles and critical success factors necessary to support this venture will be vital to the growth of the retail channel. This needs to be tackled immediately."

This sense of urgency and need for quickly completed systems did not diminish throughout the introduction and expansion of the retail chain.

Design Principle 1.3: Systems must accommodate functional areas and/or areas of expertise that do not yet exist and whose existence is not yet anticipated. The strategy Venus Chocolates chose called for capabilities in functional areas entirely new to the company. Venus Chocolates realized they needed to acquire capabilities in real estate, construction, and design; all core competencies for a retail company but all areas in which Venus Chocolates lacked experience. While the company did have experience with wholesale distribution, the company's infrastructure was wholly unprepared to engage in a retail channel of distribution. As the expansion unfolded Venus Chocolates continued to require new and unanticipated capabilities to build their infrastructure, again needing to acquire new and unanticipated capabilities. In building these capabilities, the organizational structure changed radically and job roles became extremely fluid, consequently affecting the direction and implementation of strategic decision systems.

Design Principle 1.4: Rapidly changing system requirements and disruptive new requirements will limit the effectiveness of incremental software development methodologies. Incremental methodologies develop software using iterations in which a portion of functionality is completed with software that has been tested and approved. Schach (2008) and others such as Pleeger & Atlee (2006) and Sommerville (2007) point out that both incremental and purely iterative methodologies (e.g. based on the waterfall life-cycle model) proceed in steps from requirements specification through design, implementation, and testing, but in purely iterative methodologies these steps are phases which are completed to the extent possible before proceeding to the next phase. Purely iterative methodologies iterate by looping back to an earlier phase if necessary, such as tore-enter the requirements phase in response to changing requirements. While these methodologies do have the advantage of an inherently forced

discipline, incremental methodologies are more responsive to changing requirements because the iterations explicitly evaluate requirements throughout the system development process.

Agile methodologies are incremental methodologies particularly well-suited to handle changing requirements because functionality is developed in short, defined iterations. Agile methodologies emphasize implementing smaller pieces of working software early over systems analysis and requirements gathering, and focus on complete software delivered in short cycles than on potential modifications and maintenance that might occur after a system is completed and deployed.

Incremental methodologies proceed with iterations that have a defined set of requirements up front needed to design, build, and implement the increments of functionality that are prioritized highest. Agile methodologies are often test-driven and define requirements for iterations by creating a set of unit tests that, if passed, demonstrate that the functionality and requirements for an increment have been achieved.

There are many variations of agile methodologies, including Extreme Programming (XP), Crystal, and Scrum. All have advocates and all have been used successfully. Each has a set of varying best practices. For example, in Extreme Programming programmers work in pairs with no overtime allowed, and there is no specialization but rather collective ownership within project teams. Development cycles are approximately 2 or 3 weeks in duration (Beck et al., 2001). Scrum uses autonomous self-organizing teams that work in parallel and have daily meetings to plan for the next day during "sprints" of development lasting approximately 30 days.

However, all of these methodologies also revolve around very similar core principles, several of which limited their applicability for developing Venus Chocolate's strategic decision systems. These are beyond the difficulty in developing specifications and testing for increments from very vague requirements; also for Venus Chocolates the requirements were sometimes simply unknowable as is described for design principle 2.1.

Incremental and agile methodologies are predicated on having a high degree of involvement and availability on the part of the customer; for example, a tenet of Extreme Programming is that customers are integrated with development teams. Although the top management team was both the primary stakeholders, and the users, of the systems, design principles 3.1 and 3.2 are derived from artifacts found in the case evidence indicating that this was not realistic or even feasible for Venus Chocolates.

But a more important factor that limited the potential effectiveness of incremental development was the pace and nature of strategic decisions. Incremental methodologies are based on the premise that a complete increment delivers a piece of functional software. Incremental

methodologies emphasize the use of design patterns and proper techniques such as code refactoring on the basis that the increments of software will not need to be revisited except for minor modifications, if all. Examples of this for Extreme Programming are the practices of constantly refactoring code, continuous integration of software produced incrementally, and creating "simple designs that do not anticipate future changes to the system"(Beck, et al., 2001).

Strategic decisions, especially those for the company in our case, are often made without considering the impact on systems needed for current or for subsequent strategic decisions. Venus Chocolates' strategy necessitated a steady stream of frequently occurring decisions exactly in this mode. These decisions can be at any point during an increment. More than changing the direction of future increments, these strategic decisions could (and did) necessitate discarding the work in progress during the course of an increment. These decisions could (and did) not only obviate software completed in prior increments, but impact existing systems already in place. Camillus (2008) describes strategies in which "every response to a wicked issue will alter the problem the company faces and necessitate another change in strategy"; Venus Chocolates exemplified this but with very rapid cycles of changes.

The artifacts from the evidence related to decisions to introduce kiosks discussed in the case study is one example of a decision halting work in progress and leading to significant rework of previously deployed systems. Other equally disruptive strategic decisions included those to revise the format of the stores, reorganize the field management of the retail chain, and combine aspects of the wholesale and retail operations. Developers needed to understand the implications of those decisions on system requirements and then make modifications "after the fact."

Design Principle 2.1: **Systems must be built based on only highly general and incomplete requirements specifications.** In order to validate a system the system requirements need to be "correct, consistent, unambiguous, complete, relevant, testable, and traceable" (Pfleeger & Atlee, 2006). At Venus Chocolates, management expressed concerns, sometimes bordering on frustration, about the large number of unknowns the company was facing. An internal memo from the VP of Retail soon before the first wave of retail stores were to be opened reveals the depth of those concerns:

> "However, the infrastructure needed to support the retail stores is less clear…Also unclear are the steps the company needs to take to develop this infrastructure."

Consequently, the requirements for a system built to support decisions for this infrastructure were no less clear. More unknown and unforeseen needs continued to arise throughout the expansion of the retail chain, leading to no significant increase in the ability to elicit system requirements or in their clarity. Although top management was aware of this issue, they also viewed developing strategic decision systems as imperative. This design principle is consistent with Truex, Baskerville, & Klein's(1999)perspective that eliciting abstract system requirements

for emergent organizations is infeasible and that what would be produced would be little more than guesswork on the part of the users. Therefore they advocated that IS development in emergent organizations proceed with specifications that are "incomplete and usefully ambiguous."

Design Principle 2.2: The correctness of outputs for many systems cannot be determined. Knowing the criteria for system correctness is a key for system developers to test software and it is an integral of development methodologies. In the case of Venus Chocolates, many system outputs were in the form of projections or forecasts relating to the outcomes of specific decisions yet to be made. These systems cannot be validated at the time they are completed and their correctness only ascertained after future events. One example is from a system used to configure the retail distribution network with the costs of a configuration with three pool points, Elizabeth, Richmond, and Philadelphia, used in conjunction with store replenishment shipments from the company's distribution center presented in Table 8.

Location	Store freight	Primary freight	Handling	Inventory Carrying	Total Cost
Plant distribution ctr	$4,880,319	$0	$172,123	$3,611,436	$8,663,878
Elizabeth, NJ	$4,311,013	$196,741	$53,153	$0	$4,560,907
Richmond, VA	$2,691,840	$152,543	$37,435	$0	$2,881,818
Philadelphia, PA	$4,990,717	$331,479	$69,726	$0	$5,391,922
Total	**$16,873,889**	**$680,764**	**$332,437**	**$3,611,436**	**$21,498,526**

Table 8: Report with logistics costs of expansion network configuration

Measuring the correctness of this output and validating this system was infeasible for two reasons. The first is the unavailability of comparison data. For example, Inventory carrying cost is a key consideration in managing a supply chain. However, it is not a tangible cost and "Inventory carrying cost" does not appear on any P&L statement. Reconstructing this cost at some point in the future to ascertain the correctness of this system would be difficult at best, requiring retroactive calculations of inventories using the inventory policies for products held at each location, the marginal costs of each product, and the costs of capital, all data that in many cases is not available even after the fact.

A second reason correctness cannot be assessed is that each cost above is based on a specific projection of the size of the retail chain. If the growth of the chain were to be faster or slower than the projections underlying this system then the costs and configuration it presents will never become a reality. Attempting to determine the correctness of the output by a comparison with actual results becomes a meaningless effort.

Design Principle 2.3: Systems abandonment is to be expected upon realization of the strategic goal. Some strategic decisions are recurring; some are made just once. But in supporting both of these, the systems developed for Venus Chocolates were expected to outlive their usefulness at some point. While the life span of any particular system could not be anticipated in advance, its usefulness would cease whenever the strategy for the retail chain had been realized or discarded, or the stream of strategic decisions rendered a system no longer useful.

This design principle is contrary to the perspective of Truex et al. (1999) that for emergent organizations the life cycle of a system can be extended indefinitely by continuous development. They held that systems that were not continuously redeveloped would hinder emergent organizations and become too expensive to maintain. Venus Chocolates meets the criteria of an emergent organization defined by Truex et al. – one without a stable organizational structure and one that must make new assumptions about its environment in order to succeed. Management continued to scan the environment to consider a wide range of opportunities and werewilling to embark on strategies that were discontinuous. In the case of Venus Chocolates this occurred as the company turned their strategy to one of acquisition; consequently all of the strategic decision systems were abandoned. The timing of this new system and the following systems was unpredictable, just as were the distinct shifts and strategic decisions requiring individual systems to be abandoned throughout the expansion of the retail chain. However, it could be expected that each of these systems would be abandoned at some point.

An example of a particular system used to make decisions and then abandoned is one for decisions regarding storage needs for raw and packaging materials. A sample of the output from this system is shown in the figure below taken from an internal memo. It shows the on-site (vertical bars) and off-site (plotted line with annual seasonal peaks) storage requirements pallets need for the company to realize its strategic objectives, and reveals the need for enormous growth in the capacity of the on-site facility from 5,000 to 25,000 pallet spaces within three years.
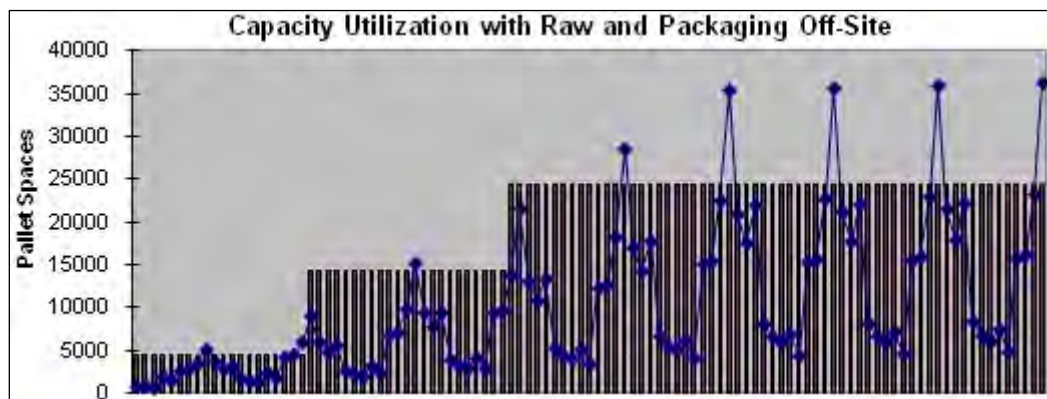
Figure 6: Project storage capacity required to support retail expansion

This system was a key for top management's decision to go ahead with a significant expansion of their facility within days after the system was completed. Given the highly seasonal nature of the company's products coupled with lead times for construction and replenishing retail stores in sufficient time for the looming peak season, the timeframes to build systems and complete construction were very tight. Therefore, land adjacent to the company's property was acquired and an engineering firm was hired to design and oversee construction. The expansion of storage capacity for raw and packaging material was coordinated with bringing a new production line into the manufacturing plant, introducing new products into the stores, and a new store distribution network.

Decommissioning this system was neither surprising nor unexpected. Ultimately, the entire suite of strategic decision systems was abandoned when Venus Chocolates decided to acquire another company to expand even more rapidly. What could be not be predicted when this system was first developed was its life span; what could be predicted and expected was there would be a distinct cut-off point for abandonment.

Design Principle 3.1: Expect that user training will be limited or non-existent. The strategic decisions made by Venus Chocolates had enormous implications for the success of their strategy and they used strategic decision systems to drive decisions for new store rollouts, manufacturing and distribution infrastructure, and the supply chain. Yet when presented with these systems, management generally accepted the offer of a brief walk-through but declined offers of further explanation or training in favor of moving forward and using the system. The extent of training accepted by top managers for the systems they relied on so much was extremely limited.

Design Principle 3.2: Anticipate few opportunities for user acceptance testing. Management was aware of the importance of user acceptance testing. The emergent nature of the strategic decisions and extremely tight deadlines are described in design principle 2.2; the company's strategic decisions were predicated on fixed completion dates for virtually all of the systems that were developed. In the trade-off between user acceptance testing and system completion, the need for quick completion outweighed the need for acceptance testing.

Design Principle 3.3: Expect limited opportunities to use prototyping. Prototypes have value both as a proof of concept and as a step in iterations of iterative development. The "proof of concept" prototype is a non-functional prototype in order to clarify requirements, and especially used during the requirements gathering phase and to understand how changing system requirements must be accommodated. Rapid-prototyping methodologies use this form of prototyping with the aim of delivering systems most closely aligned with the specified requirements (Schach, 2008). On the other hand, functional prototypes are integrated within iterations of incremental development. Each of the iterations of incremental development produces working software that requires testing and validation. Functional prototypes can be

used a means for this, and is incorporated directly into incremental methodologies based on the spiral life-cycle model (B. W. Boehm, 1984). Differently from non-functional prototyping beyond conducting tests and validation, the purpose of functional prototyping is to assess and mitigate risks and to set direction for the subsequent iteration (Schach, 2008).

From these advantages, it might be expected that Venus Chocolates would have made use of prototyping. As part of evaluating the evidence for their use, a text search was made through all project documents for variations of the word "prototype." This revealed just two occurrences; the first was in a memo discussing how a forecasting system might be implemented with a point-of-sale (POS) system the company was planning to purchase (but was never built), the second from a plan proposed for a proposed system that did not move forward.

Design Principle 3.4: Develop document and presentation compatible outputs from systems. Systems routinely outputted documents, a capability of many reporting tools. These outputs included charts, plots, images, and maps, often requiring programming code to handle. The management team valued outputs in this form because they could be incorporated directly in formal meetings and presentations.

DISCUSSION

There are no standardized or generally accepted guidelines for evaluating IS design theories (Winter, 2008), nor are there any that have been universally used. Bur regardless of method, the metrics used to evaluate a design theory should not be tied to the design theory itself and the criteria might be complex and partly pragmatic – a matter of what works(Hevner, et al., 2004). To that end, demonstrating a successful instantiation is considered essential. However, "success" can be as difficult to define in the same way as "quality:" in the eye of the beholder. Usage is a metric employed to measure the success in IS, including for design theories (e.g. Price, Beach, Muhlemann, Sharp, & Paterson (Price, Beach, Muhlemann, Sharp, & Paterson, 1998)). While system logs as quantitative data were not available in the case evidence for Venus Chocolates, there is no doubt of its extensive use throughout the expansion of the retail chain.

DeLone and McClean (W.H. DeLone & McLean, 1992) looked on information systems success more broadly with a model of success resting on six interrelated dimensions. That model consisted of factors for system quality and information quality as measures of technical success, use and user satisfaction as measures of semantic success, and individual and organizational impact as measures of effectiveness success. After their model was validated in many empirical studies, they made minor revisions to their model but kept the same groups of factors (W. H. DeLone & McLean, 2003).

There is no opportunity for controlled experimentation to measure the success of Venus Chocolate's systems; it is a historical case study. Nevertheless, the strategic systems had clear

impact. Individual top managers in each functional area utilized the systems extensively to make strategic decisions. Top management relied on these systems for decisions ranging from evaluating the potential market through marketing and financial decisions to evaluating transformations to their infrastructure. These are all indications that the strategic decision systems developed for Venus Chocolates were a success.

In addition to validating anew design theory by a successful instantiation, its relevance also needs to be evaluated in the context of its differences and contributions to existing design theories(Hevner, et al., 2004). There are relatively few existing design theories for systems specifically aimed at supporting strategic decisions, and therefore we compare ours with theories developed for related applications and processes.

Price, et al. (1998) proposed and tested a set of design principles for enhancing strategic flexibility by designing and building a strategic system for a UK manufacturing firm. As for Venus Chocolates, this firm was driven by shifting market pressures and rapid changes in the supply chain, and the goal for strategic systems was to increase the ability to evaluate and potentially implement a greater number of varying strategies. In the case of the manufacturing firm, the objectives were to be able to introduce new products more quickly, coordinate more with suppliers, and integrate disparate manufacturing systems. Like Venus Chocolates, to achieve strategic flexibility the development or acquisition of competencies in specific areas was a key issue.

Despite similar goals, principles from Price et al.'s research do not align with those found for Venus Chocolates. Among the design principles was that "the parameters of the DSS would be derived from field studies" and that "the DSS should be based on the notion of competencies." Although field studies and defining competencies might have been useful, Venus Chocolates had a very narrow window of opportunity to formulate and implement strategy and could not afford the time, and both design principles point to a much more structured decision making process than they used. Two other design principles were that "the DSS should be generic in the sense of being applicable to a wide variety of manufacturing industries" and that "the DSS should attempt to recognize the different needs of SMEs and companies that dominated their particular industries." Neither is applicable to Venus Chocolates and both seem more related to the manufacturing company's need to integrate disparate systems and increase coordination in the supply chain.

Brohman et al. (2009) proposed set of four design principles for strategic network-based customer service systems. Similar to Venus Chocolates, these design principles were based on a system built for a company needing to respond to a dynamic environment that was changing quickly. Although for strategic systems, none of the proposed design principles were related to those found in this research and were much more application-specific. For example, two of the

design principles were to "design for the co-creation of value by enabling customers to share, under their control, relevant data from their customer data warehouses" and "design to enable a customer to create a customized solution from a (potentially unlimited) choice of products and services"; neither applicable to Venus Chocolate's strategic decision systems.

Executive Information Systems (EISs) are also systems used in strategic decision-making processes; dashboards are frequently used for this purpose (Eckerson, 2010). From surveying executives Marx, Mayer, and Winter(2011) identified several key gaps for EISs needed to fill. Venus Chocolate had many of the same issues for strategic systems and these authors found for EISs, including incomplete information, inaccuracy and inconsistency, and the need for high design, implementation, and maintenance effort. After analyzing these gaps, Marx et al. proposed a set of design principles for EIS redesign and were able to test them by developing a prototype.

Among the design principles they proposed were to "tailor EIS functions to better analyze and process information", "design a comprehensive information model", and "design for more reliable information with a proper information management." As discussed along with the design principles, a thorough design was not feasible for Venus Chocolates, and much of the information that their strategic decisions hinged on, such as market size or retail costs, was simply not available.

This lack of fit with existing theories for strategic decisions may be a consequence of the highly unstructured nature of those strategic decisions that faced Venus Chocolates. We therefore compared our design theory with respect to another developed specifically for a class of highly unstructured problems, emergent knowledge processes. While not for strategic decisions per se, most notable is the design theory developed for emergent knowledge processes (EKPs) by Markus et al. (2002).

The strategic decisions for Venus Chocolates have all the earmarks of EKPs defined by these authors, which are 1) "an emergent process of deliberations with no best structure or sequence", 2) "an actor set that is unpredictable in terms of job roles or prior knowledge," and 3) "knowledge requirements for general and specific distributed expertise."Each describes characteristics of strategic decision making for Venus Chocolates.

Several of the design principles Markus et al. developed for EKPs align well with ours. In particular, "Design for offline action" fits because as for the system supporting EKPs, Venus Chocolate did not base decisions solely on system outputs and reports but rather incorporated those as one part of their decision-making process. The principle to "design for customer engagement by seeking out naïve users" applies virtually by definition because Venus

Chocolates users, primarily top management, had scant experience with a retail channel of distribution or the infrastructure needed to support it.

However, other design principles for EKPs are only partially applicable or even run counter to those found for strategic-decision systems. One example is the principle to "componentize everything, including the knowledge base." Component architecture facilitates reuse and improves extensibility in addition to the robustness of a system. Markus et al. found it was both desirable and feasible to componentize "virtually every aspect of the system." By examining source code, we were able to ascertain that to some degree componentization was used in Venus Chocolate's systems. However, we found only a handful of components in their software, and very few modules that could be readily modified for reuse as components. Further, componentization did not emerge in any of our design principles derived from the case evidence. We believe the potential opportunities for componentization and the overall net benefits for reuse were limited, and that this is because their software was developed under such unstable conditions of ambiguous and rapidly changing system requirements. Regardless, Venus Chocolates did use a small degree of componentization, and therefore this design principle applies, but only very partially.

"Radical iteration" was described by Markus et al. as an approach based on building functional, rather than non-functional, prototypes during a project. In this way, radical iteration and Boehm's spiral model (B. Boehm, 2002)are alike. Functional prototyping was used because non-functional prototyping wasn't providing useful feedback, and users saw non-functional prototypes as largely hypothetical. Markus et al. ultimately built over 70 functional prototypes during an 18 month period. However, as described for design principle 3.3, functional prototyping was not employed by Venus Chocolates. The exceedingly tight deadlines to deliver completed systems meant that prototyping, while potentially desirable, was not practical.

We were struck by the degree to which the observations from this case did not match existing design theory for strategic systems with goals related to Venus Chocolates, or for systems supporting highly unstructured processes such as EKPs. Based on this we conclude that the design theory developed in our study is different from existing design theories.

CONCLUSIONS

This research presents the results of analyzing a case study and developing an IS design theory for systems built to support strategic decisions. The evidence for this case was from a multi-national company seeking to expand its presence in the United States and to accomplish this within a window of opportunity they perceived to be very narrow. Their strategy was based on introducing a channel of distribution that was entirely new to the company: retail stores, a channel quite different from their only existing channel of wholesale trade.

The company was well aware that this strategy would require transforming their existing infrastructure along with developing completely new organizational competencies. However, strategies involving disruptive change and the need to acquire new competencies are far from unique, and especially so with the increasing emphasis on strategic flexibility and organizational agility.

Following a carefully designed process based on a grounded methodology for case studies, we developed a design theory from evidence that had accumulated during the initiation and expansion of the company's chain of retail stores. We found many differences between this design theory and existing design theories, and that none was entirely applicable, indicating the relevance of this design theory and contribution of this research as a new design theory and one potentially applicable to a class of problems for which no design theory yet exists.

The design theory from our research was developed and evaluated in the context of one company. The next step for theories reaching this point is to add to the rigor by testing it in subsequent instantiations. Therefore, future research should confirm or disconfirm our design theory from tests in further applications.

One difficulty of any case study of a single organization is that the generalization of findings can be difficult. We believe that these results are at least applicable to international companies seeking to open retail stores in U.S. or internationally. However, the strategic decisions from this case are representative of highly unstructured strategic decisions stimulated by new opportunities, and we believe the design theory proposed here may be applicable to many strategic decision support systems.

Future research should be directed at testing the design theory developed here to determine how well it could be applied to other systems supporting strategic decisions. Such research could confirm or disconfirm this design theory and help find the range of strategic decisions to which it can be applied. As a first iteration of an IS design theory based on a single case, we do not speculate on different types of strategies where it could be relevant. Future research can also help find the range of strategies and strategic decisions to which it can be applied.

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THE RELATIONSHIP BETWEEN INFORMATION SECURITY INVESTMENT AND ORGANIZATIONAL PERFORMANCE: A CRITICAL REVIEW

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ABSTRACT

While IT investment payoff has been widely studied within the last decade, research in IT security investment has gained interest only recently. Diverging from previous studies that have generally focused on IT investments in regard to firm performance, this study attempts to investigate how investment on information security would influence organizational performance and sustainability. The study aims to present a comprehensive perspective on IT investment and propose a research foundation specifically for information security investment versus organizational performance for further investigations.

INTRODUCTION

Payoffs from information security investment has recently become a critical area of study due to the increasing demand for providing security of information and systems at all levels of business organizations. Information security – which relates to the activities that are designed to protect the confidentiality of private information, ensure the availability of information to authorized users, and protect the integrity of information – is one of the major concerns for top managers of organizations that conduct their businesses electronically. The results from a recent survey, conducted by Forrester and administered to 410 information technology (IT) decision makers, indicated about 75 percent reported that IT security has become critical to their business planning and over 80 percent reported that they are concerned about financial losses from it.

Since the advent of e-commerce, businesses have witnessed an unparalleled growth in investment in IT applications. Both researchers and business managers consider investment in IT as an enabler for improved organizational efficiency and competitiveness. The value added from these investments are obtained from the automation of business processes, better information for more effective decision making, and the refinement of business processes and business models resulting in new forms of value creation. Information systems research literature reports numerous studies that examine the relationship between investments in IT and payoffs realized in terms of enhanced organizational performance.

Increasing and frequent malicious security attacks on enterprise IT infrastructures today pose a serious threat which require organizations to implement the necessary safeguards to ensure the confidentiality, integrity, and availability of information. Failure to do so makes them vulnerable to heavy monetary penalties and loss of customer base and goodwill. Enterprises today are forced to take a proactive approach to information security planning and governance. It has thus become imperative that the governance of information security be integrated with the governance of the enterprise so as to address the issues of information security from a corporate governance perspective utilizing its leadership, organizational structures and processes for the protection of informational assets. Additionally to mitigate risks associated with security attacks, enterprises are forced to increase their investments in security technologies such as firewalls, intrusion detection systems, encryption, biometric and other authentication devices, and access control systems among others.

Security breaches have both short- and long-term impact on performance. Some of the common types of security breaches include virus, unauthorized access, theft of proprietary information, denial of service, sabotage, and Web site defacement. Assessing the impact of security breaches is very difficult because costs of security breaches are not ease to quantify. Short term costs include cost of repairs, cost of replacement of the system, lost business due to the disruption of business operations, and lost productivity of employees. Long-term costs include the loss of existing customers due to loss of trust, failing to attract potential future customers due to negative reputation from the breach, loss of business partners due to loss of trust, and potential legal liabilities from the breach. The short term costs are mostly tangible while the long term costs are mostly intangible.

Business managers continue to grapple to find optimal response for the following questions: (1) what proportion of the IT budget should their organization spend on information security, and (2) how should their organization allocate their information security budget to specific security activities? Determining the appropriate level of IT security investment is the most critical decision faced today by chief security officers (CIOs). Due to the wide range of types of security breaches that could possibly take place and their cost impact on an organization, the focus of attention in security management has changed from what is technically possible to what is economically efficient. The security investment decision will be based on the premise that the cost of the investment is less than the risk of loss or if the investment itself has a positive return for the organization. Therefore each organization must look for an appropriate balance between its risk exposure and the opportunity to mitigate the risk through investments in security.

While IT investment payoff has been widely studied within the last decade, research in IT security investment has gained interest only recently. Our study will attempt to investigate how investment on information security would influence organizational performance and sustainability. Despite the increasing level of investigative active focusing on IT investment and firm performance, relatively little effort has been devoted to specifically providing a systematic view on information security investment versus organizational performance. Diverging from previous studies that have generally focused on IT investments in regard to firm performance,

this study endeavors to present a comprehensive perspective on IT investment and, more importantly, proposes a research foundation specifically for information security investment versus organizational performance for further investigations. As such, this study provides a blueprint to guide future research and facilitate knowledge accumulation and creation concerning the organizational performance and sustainability impacts of information security investment.

LITERATURE ON SECURITY INVESTMENT

The research studies that have been performed in the last decade to determine the effective level of security investment fall into basically two approaches: game-theoretic to model strategic interactions between organizations and attackers, or decision-theoretic which is based on traditional risk/decision analysis frameworks.

Gordon and Loeb [11] provide an economic modeling framework for assessing the optimal amount to invest in information security based on the principle of equating the marginal financial benefits of information security to the marginal financial costs of such security. While this framework is widely referenced, it falls short to consider qualitative or nonfinancial criteria. Since security investments compete for funds that could be used elsewhere, Chief financial officers (CFOs) increasingly demand a rational economic approach to such expenditures. Over the past few years, substantial work has been done in adapting principles and metrics of investment theory for security investment. The most prominent metric for capturing the cost-benefit aspect of information security is the return on information security investments, also known as return on security investments, or ROSI. CIOs and CFOs are embracing it, but its strengths and weaknesses aren't fully understood yet, which has led to confusion and misuse.

Bordin et al. [4] report that analytic hierarchy process (AHP) has proven to be a useful tool to successfully assist organizations in making information security investment decisions, but the tool does not replace the human decision-maker. The tool provides a mechanism to effectively compare criteria, sub-criteria, and alternatives. In their study, they have used the ratings method variant of AHP to determine the optimal allocation of a budget for maintaining and enhancing the security of an organization's information system.

Cavusoglu et al. [5] propose a game-theoretic approach to determine IT security investment over the more traditional decision-theoretic approach. They compared these two approaches on several dimensions such as the investment levels, vulnerability, and payoff from investments. The limitation of the decision-theoretic approaches, when applied to analyze IT security problems is that they do not allow a firm's security investment to influence the behavior of hackers. They argue that information security can be treated as a game between organizations and attackers. While organizations try to cover vulnerabilities in their systems, attackers race to exploit them. Security investments not only prevent security incidents by reducing vulnerabilities that attackers can exploit, but also act as a deterrent for attackers by making attacks less

attractive. When choosing a security investment level, firms cannot treat the risk environment to be static. Security investment increases the attacker's cost and when the attacker's cost becomes larger than its benefits, the attacker may be forced not to attack the firm. Consequently, to accurately analyze the IT security investment decisions, threats and vulnerabilities need to be modeled as well, which are determined by the strategic interactions between organizations and attackers.

LITERATURE ON ORGANIZATIONAL PERFORMANCE

The studies on IT business value have used various approaches and output measurements to examine the impact of IT investments on firm performance. Empirical studies provide evidence that IT investments are associated with increased firm output and productivity. Mithas et al. [18] based their study on a proprietary data set. They present interesting new results of a positive and significant link between IT investment and firm profitability, mediated more through revenue enhancement than through cost savings.

Besides from the studies that investigate the impact of IT investment on average profitability, there are yet rich and open research questions to be answered about the specific mechanisms by which firms might capture the value created from IT investments. It is worth investigating how the impact of IT investments on firm performance might vary with firm characteristics and strategic choices, and the managerial implications such results would entail.

IT payoff has been widely examined by Devaraj and Kohli [6]. The following table summarizes the studies related to investments in IT and firm performance till date.

Table 1: A Summary of Firm-Level IT Payoff Studies

Studies	Variables used	Duration	Key findings
Weill (1992) [29]	Total sales, IT investment, perceptual data	6-year period	Heavy use of transactional IT investment associates with strong firm performance
Diewert and Smith (1994) [9]	Inventory holding costs, growth rate, purchases, sales, inventory levels	Quarterly over 6 quarters	IT led to large productivity gains

Barua, Kriebel, and Mukhopadhyay (1995) [1]	Capacity utilization, inventory turnover, quality, relative price, and new product introduction	Annually over 3 years	IT was positively related to some intermediate measures of profitability, but that the effect was generally too small to measurably affect final output
Hitt and Brynjolfsson (1995) [12]	Value added, IT stock, non-computer capital, ROA, labor expense, ROE, shareholder return, IT stock/employee, capital investment, sales growth, market share, debt, R&D stock firm	Annually over 5 years	IT leads to increased productivity and consumer surplus, but not higher profitability
Prasad and Harker (1997) [20]	IT capital, non-IT capital, IS labor expense, non-IS labor expense	Annually over 3 years	Additional capital investment in IT may not have real benefits
Dewan and Min (1997) [8]	IT capital, non-IT capital, labor expense, value added, sales, number of employees	Annually over 5 years	IT capital is a net substitute for ordinary capital and labor; i.e., IT investment leads to higher returns
Mukhopadhyay, Rajiv, and Srinivasan (1997) [19]	Total output, on-time output, labor hours, machine hours, level of automation, absenteeism rate, degree of supervision	39 accounting periods over 3 years	IT investment leads to higher productivity and quality
Prattipati and Mensah (1997) [21]	Number of years CIO in the position, proportion of software resources spent on client server applications, percentage of software budget spent on new development	1 year	Highly productive firms spent more on client-server and less on in-house application development

Rai et al.(1997) [22]	IT capital, IT budget, client/server expenditure, IS staff expenditure, hardware expenditure, software expenditure, telecom expenditure	1 year	IT investments for improving the effectiveness of management require a simplification and redesign of management process
Tam (1998) [27]	TSR, ROE, ROA, ROS, computer capital, book value of asset	Annually over 8 years	IT investment is not correlated with shareholder's return
Francalanci and Galal (1998) [10]	IT investments; clerical, managerial, and professional composition; income per employee; total operating expense	10-year period	Increases in IT expenses are associated with productivity benefits when accompanied by changes in worker composition
Li and Ye (1999) [15]	Dynamism, strategy, CIO/CEO distance, IT investment, munificence, debt equity ratio, size, ROA, ROS	3 years	IT investment positively impacts on financial performance with greater environmental changes, more proactive company strategy, and closer CEO/CIO ties.
Bharadwaj et al.(1999) [3]	Financial market-based measures	5 years	IT investments contributes to a firm's future performance potential
Menon, Lee, and Eldenburg (2000) [17]	IT capital, medical capital, medical capital	Annual for 19 years	IT contributes positively to the production of services in the healthcare industry
Devaraj and Kohli (2000) [7]	Revenue, number of BPR initiatives, quality indicators, IT capital, labor, support investment	Monthly over 3 years	IT investment contributes to higher revenue, but the effect is more pronounced when combined with BPR initiatives

Sircar et al. (2000) [25]	MIS budget, computer capital, PCs per employee, non-IS labor, noncomputer capital, sales, assets, market	6 years	IT and corporate investments have a strong positive relationship with sales, assets, and equity but not with net income. Spending on IS staff and staff training is positively correlated with firm performance
Bharadwaj (2000) [2]	Sales, assets, related entropy, number of employees, average growth, mean log sale, mean risk, mean ROA, mean relative market to book value, number of firms	4 years	Firms with high IT capability tend out outperform firms on a variety of profit and cost-based performance measures
Stratopoulos and Dehning (2000) [26]	Profitability measures, efficiency measures, total assets, sales	5 years	Successful users of IT have superior financial performance relative to less successful users of IT
Santhanam and Hartono (2003) [24]	ROA, ROS, operating income to asset, operating income to sales, operating income to employees, cost of goods sold to sales, selling and general administration expense to sales, operating expenses to sales	4 years	Firms with superior IT capability exhibit superior current and sustained firm performance
Hitt et al. (2002) [13]	Sales, pretax income, cost of goods sold, ROA, inventory turnover, ROE, profit margin, asset utilization, collection efficiency, leverage debt	3 years	Firms that invest in ERP show higher performance
Melville et al. (2004) [16]	Technological IT resources, human IT resources,	NA	IT is valuable but dependent on internal and external factors

	complementary organizational resources, business processes, performance, industry characteristics, trading partner resources and business processes, country characteristics		
Tanriverdi (2005) [28]	IT relatedness, KM capability, firm performance	1 year	IT relatedness enhances KM capability of the firm. IT relatedness has significant indirect effects on firm performance through the mediation of KM capability
Ravichandran and Lertwongsatien (2005) [23]	IS human capital, IT infrastructure flexibility, IS partnership quality, IS capability, IS support for core competencies, firm performance	3 years	Variation in firm performance is explained by the extent to which IT is used to support and enhance a firm's core competencies
Huang et al. (2006) [14]	IT investment, IT infrastructure, IT-enabled intangible assets, human-IT resource, ROA, ROS	1 year	IT investments can make a positive contribution to firm IT infrastructure. IT investments do not have a positive relationship with human-IT resources and IT-enabled intangibles. IT-enabled intangibles are the key factor to affect the business performance. Human-IT resource is a driving force for the IT-enabled intangibles

CONCLUDING REMARK AND FUTURE STUDY

Prior studies are divergent and their findings have been analogous to multiple but separate streams where IT exerts an impact on organizational performance. Yet the lack of a systematic view on more specific IT artifacts, IT security investment, in regard to organizational performance and sustainability is vital to IS practitioners, public policy makers, and the IT industry as a whole. Our approach, therefore, strives to focus on the context of information security investment where IT and human factors should be understood and analyzed simultaneously. By identifying several key IT and non-IT constructs which are related to firm performance, this study synthesizes what is known about IT business value and applies it to the domain of information security research.

It is imperative for firms allocating resources to information security to keep their valuable information secure and to prevent damages stemming from IT vulnerabilities. A follow-up study is currently in progress which attempts to formulate the relationship between tangible and intangible information security investments and organizational performance. A big part of information security relates to qualitative and nonfinancial concerns, hence the traditional economic approaches are severely constrained. There is a need to simultaneously look at both the quantitative measures including financial measures and qualitative concerns such as security policy, governance, organizational culture or environmental factors related to security. Considering the above requirement, our future study will assess the influence of information security investments on firm performance. Through the collection of appropriate data, the follow-up study will be validated using statistical analyses. We envision that this study will assist researchers and business managers in setting and evaluating firm-level security strategy.

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Knowledge Sharing and the Dynamic Evolution of Organizational Culture: Impact of Incentives and Information Technology

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Research in Progress

Abstract

We present a dynamic model of knowledge management in which knowledge sharing influences organizational culture. Employees' fit with the organizational culture improves with the sharing and learning of common organizational practices. We analyze the impact of providing incentives for knowledge sharing as well as the investment of information technology in shaping knowledge sharing. Using analytical models, we study the evolution of organizational culture in a multi-period setting under appropriately designed incentives and optimal IT investment.

Key words: incentives; information technology; knowledge management; knowledge sharing; organizational culture.

Introduction

In the information era, knowledge management (KM) has been enhanced by the latest developments of information technology. For instance, the recent explosion in social software technologies has created a new paradigm that allows knowledge workers to collaborate and share knowledge with relative ease. The continuous downward trend in the price of data storage and other information technologies enables organizations to capture and store valuable information and knowledge with lower costs. XML-based data structures and services facilitate the codification and extraction of knowledge and streamline the flow of information and knowledge within organizations.

Nevertheless, technology is only one of the many factors impacting knowledge management. Other factors affecting knowledge sharing and learning include learning capacity (Simonin 1999), perceivable organizational support (Wayne, Shore, and Liden 1997), innovative work behavior (Janssen 2000), social status (Thomas-Hunt, Ogden, and Neale 2003), value of knowledge (Cummings 2004), and participation inequality and conversational interactivity (Kuk 2006). Prior studies (Davenport and Prusak 1998, Jarvenpaa and Staples 2000) have noted that most knowledge workers are reluctant to share their knowledge in organizations that lack the appropriate culture. Put differently, Knowledge sharing and learning will not happen automatically if a firm does not have a culture favoring these activities.

Organizational culture can be regarded as "a system of shared values and norms that define appropriate attitudes and behaviors for its members", which should be managed effectively for firms to remain innovative and gain competitive advantage (Tushman and O'Reilly 2002). In particular, the organizational culture may encourage or deter sharing knowledge and learning. For instance, symptoms such as knowledge hoarding, apprehension about failures, and the "Not-invented-here" syndrome are hostile to knowledge sharing (Michailova and Husted 2001). As incentives related to knowledge-management efforts are essential in creating a knowledge-sharing culture (Szulanski 1996), organizations need to offer incentives to motivate workers to share knowledge so as to promote the organizational culture for knowledge sharing.

Although prior research has identified the critical role of organizational culture, incentives, and information technology in knowledge management, few studies have investigated their combined effect on knowledge sharing and learning. Our study addresses this gap by exploring the inter-dependencies of organizational culture, incentives, and information technology for knowledge management in organizations.

Specifically, we study the following questions in this research. First, how can incentives be designed to motivate knowledge sharing so that organizational culture can be improved and organizational benefits maximized? Second, what is the appropriate level of information technology that facilitates optimal knowledge sharing and learning? Third, what is the inter-relationship among organizational culture, incentives, and information technology in enabling knowledge sharing and learning and achieving best organizational benefit? Fourth, under appropriately designed incentives and optimal IT investment, how does organizational culture evolve in a multi-period setting?

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The rest of the paper proceeds as follows. Next section reviews related literature. The third section presents our model of knowledge management and organization culture and outlines our analysis. The last section concludes the paper.

Related Literature

In this section, we first review prior literature by focusing on three streams of research in knowledge management: (1) knowledge management and organizational culture, (2) incentives for knowledge sharing, and (2) the role of information technology in knowledge management, and then highlight the contribution of our research.

Many studies have examined the implications and effects of organizational culture on knowledge management. For instance, Park, Ribiere, and Schulte-Jr (2004) identify the critical organizational attributes facilitate knowledge sharing and help implement knowledge management technologies. Lemken, Kahler, and Rittenbruch (2000) argue that developing an organizational culture that promotes knowledge sharing enables organizations to adapt to changing environments. Donate and Guadamillas (2010) find that organizational culture has different moderating effects when firms adopt different knowledge management initiatives on storing and transferring organizational knowledge. Leidner, Alavi, and Kayworth (2006) investigate the influence of organizational culture on two KM approaches (organizing communities and knowledge management processes) and show that knowledge initiatives can result in either an information repository or electronic communities. While prior studies have focused on the impact of organizational culture on knowledge management, we want to also examine how knowledge sharing in turn influences organizational culture.

Incentive is an important element in facilitating knowledge sharing and learning via knowledge management systems (Argote, McEvily, and Reagans 2003, Ba, Stallaert, and Whinston 2001). Researchers have studied the incentives for knowledge sharing in organizations. For instance, Lee and Ahn (2007) analyze how to design a reward system for knowledge sharing and compare an individual-based reward system with that of a group-based system. Sundaresan and Zhang (2010) explore the joint role of incentives and information systems in knowledge sharing and learning in organizations, and extend their model to a setting of knowledge in two independent dimensions with individual rewards. However, none of these papers considers the effect of organizational culture on knowledge sharing and learning.

Information technology plays a crucial role in growing and managing organizational knowledge (Borghoff and Pareschi 1997). For instance, information technology provides extremely important support to the community of practice (Baird and Henderson 2001) and can help develop effective knowledge markets within organizations (Davenport and Prusak 1998). In addition, information technology creates a friendly environment for knowledge management and help achieve knowledge management goals. For example, Stenmark (2002) finds that IT can support the interaction between information and knowledge, leading to a useful and people-centric KM environment (Stenmark 2002). Markus, Majchrzak, and Gasser (2002) argue that IT can be appropriately utilized to support emerging knowledge processes (EKPs). Neverthe-

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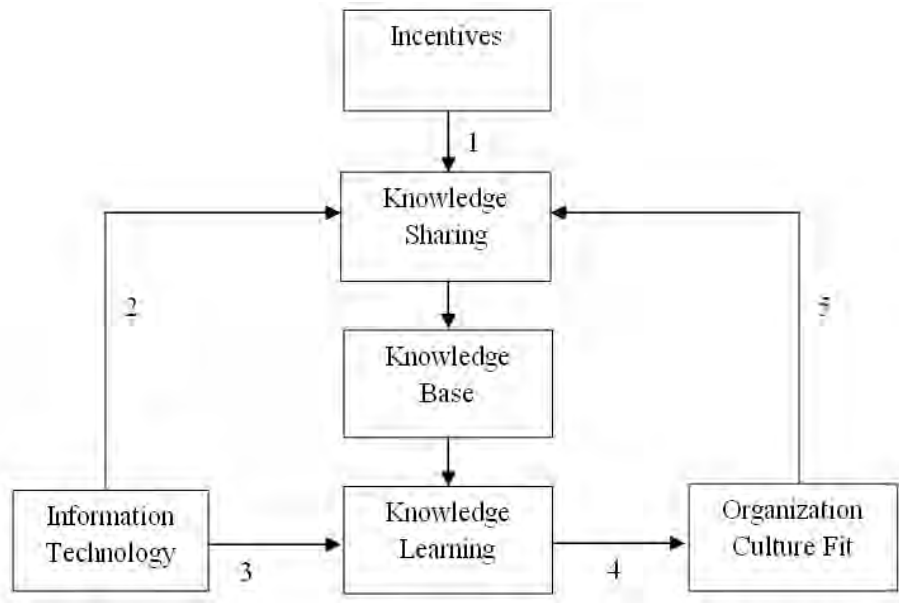
Figure 1: Model

less, prior research in this stream does not consider the joint impact of other factors such as incentives and organizational culture.

In summary, none of the prior research has explicitly studied the design of incentives and the role of information technology against the backdrop of organizational culture. We investigate these important issues in our research by extending the concept of organizational culture fit (Carrillo and Gromb 1999). In particular, we model incentives and information technology to facilitate knowledge sharing and learning, thus improving a firm's cultural fit. Hence, the firm seeks the best design of incentives and support of information technology to leverage knowledge assets within organizations to increase organizational cultural fit, maximizing organizational benefit.

Outline of Model and Analysis

In this section, we present a preliminary model of knowledge management and organizational culture. We discuss the mutual relationships among the three components (incentives, information technology, organizational culture) in our model, the business setting, and the organizational decision problem.

We consider a model in which a firm seeks the best design of incentives and the level of information technology of its knowledge management system (KMS) to facilitate knowledge sharing and learning within organizations to promote organizational cultural fit, maximizing organizational profit. The major component of the KMS is a centralized knowledge base that stores organizational information and knowledge. Figure 1 captures the mutual interactions among incentives, information technology, and organizational culture fit.

We next describe the business setting of the model, in which a firm operates for n number of

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periods. In each period, the firm employs knowledge workers from a labor market, where only κ_0 proportion of the recruited workers are congruent ("fit") with the firm's current organization culture. During each period, workers generate an output X_H when they fit the culture and $X_L = X_H - D$ otherwise. All the workers (both fit and misfit) will get a fixed wage payment w in each period. We assume that the output produced by each worker is always greater than the wage payment (i.e., $X_L > w$). We model the dynamic changes in the worker pool by considering that each worker may voluntarily leave the firm with the probability $1 - q$. In addition, the firm evaluates workers at the end of each period; with the probability ϕ, those who are misfit will be replaced with new hires from the labor market.

The firm announces a knowledge-sharing incentive $s(k_s)$ to motivate knowledge sharing from culturally fit workers (Line 1 in Figure 1). The incentive rewards knowledge sharing based on the amount of knowledge k_s shared by a worker and is applicable throughout all periods. The knowledge shared by a worker will be captured and stored in the centralized knowledge base. Hence, the volume of the knowledge base at the time period t is

$$V_t = V_{t-1} + k_s \cdot p(\kappa_{t-1}, T) \tag{1}$$

where p is the probability of a worker being willing to share knowledge parameterized by κ_{t-1} and T. We denote κ_{t-1} as the organizational culture fit at the beginning of the time period t and T the level of information technology supporting knowledge sharing and learning. p is a concavely increasing function in both κ_{t-1} and T, which implies that when the firm's culture fit is higher, more workers will be willing to share knowledge and contribute to the knowledge base (Line 5 in Figure 1), and when the firm's IT infrastructure for knowledge sharing is more advanced, workers will find it easier to share knowledge (Line 2 in Figure 1).

The central knowledge base stores the valuable knowledge that can potentially improve the culturally fit of workers. We use $\rho_t(v_{t-1}, T)$ to represent the proportion of culturally misfit workers who learn and align themselves to the firm's current culture, in which $\rho_t(v_{t-1}, T)$ concavely increases in both v_{t-1} and T, implying that (1) when the volume of the knowledge base increases, it will contain more useful knowledge that facilitates workers' learning; therefore, more workers may become culturally fit (Line 4 in Figure 1), and (2) when the IT level T is higher, workers will find it easier to search the knowledge base and obtain their desired knowledge (Line 3 in Figure 1).

During the process of knowledge sharing and learning, the total payoff that a culturally fit knowledge worker can obtain from knowledge sharing in each period will be

$$\pi_i = s(k_s) - c(k_s, T). \tag{2}$$

We assume that only culturally fit workers have the useful knowledge to share that improves organizational culture. Knowledge shared by culturally misfit workers will not be rewarded as it does not help improve the organizational culture fit.

Consequently, the firm's decision problem [P] is to determine the best design of incentive

<div align="center">4</div>

β	discount rate
$c(T)$	cost of IT infrastructure at level T
D	difference of revenues between culturally fit and misfit workers
κ_0	probability of a worker being fit with the firm's culture on the labor market
κ_t	organizational cultural fit in time period t
p	probability of a worker sharing knowledge
ϕ	probability of a worker being identified as misfit in each period
q	probability of a worker staying in the firm in each period
ρ_t	probability of a culturally misfit workers being transformed into fit in time period t
t	index for time periods
V_t	volume of knowledge base in time period t
w	fixed wage payment for workers in each period
X_L	output from culturally misfit workers
X_H	output from culturally fit workers

Table 1: Summary of Notation

$s(\cdot)$ and the IT level T to maximize its total payoff at the end of time period n, which is

$$\max_{s(\cdot),T} \quad \pi_n = \sum_{t=1}^{n} \beta^{i-1}\{(X_L - w) + \kappa_t \cdot D - s(k_s) - c(T)\}. \tag{3}$$

subject to

$$k_s^* \quad \in \quad \underset{k_s}{argmax} \quad \pi_i, \tag{4}$$

$$\pi_i \quad \geq \quad 0, \tag{5}$$

where β is the discount rate and $c(T)$ is the firm's cost of maintaining an IT level T in (3). We assume that $c(T)$ convexly increase in the level T, which indicates that the firm needs more investment in maintaining a more sophisticated IT infrastructure. In addition, constraint (4) denotes workers' incentive-compatibility constraints that ensure workers will choose the sharing amount to maximize their totaly payoff. Constraint (5) represents workers' individual rationality constraints that guarantee a non-negative total payoff for workers.

Conclusion

There is a plethora of research investigating the important role of IT, incentives, and organization culture in KM. However, prior studies have not considered the joint interactions among these three elements in facilitating knowledge sharing and learning in organizations. We address these issues in our model and investigate their inter-relationship as well as the dynamic evolution of organizational culture. Specifically, we solve the organizational decision problem and then examine the critical factors affecting the firm's optimal decision—the design of in-

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centive for knowledge sharing and the level of IT infrastructure. Importantly, we explore the mutual relationship among IT, incentives and organizational culture for supporting knowledge sharing and learning. We investigate the effects of organizational culture on the firm's decision on incentive and the IT level. In addition, we study how the incentive and IT level indirectly impact the organizational culture fit through facilitating knowledge sharing and learning. We map the evolution of organizational culture in a multi-period setting under appropriately designed incentives and optimal IT investment. In summary, our research presents a formal model of knowledge management by capturing the interactions between IT, incentives, and organizational culture, and develops valuable insights for practitioners to effectively manage knowledge assets.

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PERSPECTIVES ON THE USE OF MOBILE DEVICES FOR EMERGENCY NOTIFICATIONS VIA SHORT MESSAGE SERVICE (SMS)

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ABSTRACT
 The adoption of mobile devices is a global phenomenon. These devices serve a variety of functions in both personal and professional environments. As part of public safety mobile devices are also used to inform individuals about emergency situations. This paper examines the use of mobile devices, specifically cellular phones, to notify individuals about emergencies via short message service (SMS). This paper represents an exploratory work-in-progress that is part of a larger research study. This study has two primary research questions: 1.What kinds of emergency messages are appropriate for mobile devices and 2.What value do users place on emergency text messages? We propose a theoretical model, and initially test the model through a series of semi-structured interviews. Our preliminary findings indicate that users value SMS for emergency notifications under specific conditions, but are cognizant of inherent challenges that exist.

KEYWORDS
Mobile devices, emergency notifications, emergency management, short message service, SMS

INTRODUCTION
In the United States approximately 83%of the adult population owned some kind of cellular device in 2011 [1]. This high rate of penetration of cellular devices delivers access to innovations ranging from communication, advertising and location based services. Many individuals are foregoing the use of land-lines and opting to only using mobile devices for voice, text, and internet activities. In this paper we focus on the use of mobile devices for the delivery of emergency messages. In the above referenced Pew study it also revealed that 92% of smart phone users used the device for sending and receiving text messages. This proliferation of such devices for text messages makes it uniquely positioned to examine the specific nuances, value, and potential pitfalls associated with emergency message delivery.

In this paper we first examine the broad area of emergency management and then focus on the area of emergency notification. The paper then develops by reviewing the literature on how SMS is used for the delivery of such messages. We adopt a user perspective and propose a theoretical model informed by the protection motivation theory to examine two primary questions: 1.What kinds of emergency messages are appropriate for mobile devices and 2.What value do uses place on emergency text messages? Lastly we present our results and discuss implications, limitations and future directions of this research.

EMERGENCY MANAGEMENT

Emergency management involves a variety of systems, organizations and individuals. In the United States the 911 system is an integral part of emergency management. In the event of an emergency the caller dials 911 to inform a dispatcher about the event. The 911 dispatcher then notifies the relevant authorities with the details of the emergency. The efficiency of a disaster response is affected by the disaster severity, response strategies, available resources, and the number of jurisdictions involved [2]. As first responders are notified, so too must the broader community especially if the incident affects a specific population and is not isolated to an individual or a few individuals.

Catastrophic events can result in the collapse of technical, social, and economic infrastructure in the affected area [2]. As a result of the far reaching effects of disasters, early notification to affected entities can potentially mitigate the impact of the disaster. Emergency notification systems represent a critical step in informing individuals about an oncoming or recent disaster. Multiple options for notification such as radio, television, internet, and mobile devices provide an opportunity to communicate with a larger number of affected individuals.

SHORT MESSAGE SERVICE (SMS) NOTIFICATIONS

Short message service (SMS) is the use of limited strings of characters to communicate information via mobile devices. SMS can be a maximum of 160 characters and are transmitted from the sender to the recipients via SMS centers. The limit of 160 characters was derived from analysis of postcards, random sentences, telegraph messages, and concerns about bandwidth [3]. Since its introduction in the 1980's the use of SMS has grown exponentially. SMS is used globally for a range of activities including retail, banking, calendar reminders and others, and is expected to generate 8.7 trillion messages annually by 2015 [4]. Another area of recent growth is in the use of SMS for emergency notifications.

Mobile emergency notifications have become more popular largely because of the increased adoption and use of mobile devices such as cell phones, smart phones, personal digital assistants, tablet computers, and electronic readers. The mobile device allows the message to be directly delivered to the intended recipient. Schools, colleges and universities have been early adopters of mobile emergency notification systems. A recent U.S. study conducted on a college campus, showed that 52% of the faculty surveyed felt that receiving a text message on their cellular phone was the best way for them to be notified about an emergency while teaching a class [5]. University and college level systems have voluntary enrollment where individuals can subscribe to the systems to receive emergency notifications. Once the messages are delivered three response outcomes exist: comply immediately, verify the message through other sources and then comply, or ignore [6]. Careful evaluation of situations before sending out messages is needed to increase the likelihood of compliance.

Captive audiences such as college campuses, sporting events and movie theatres can be breeding grounds for random and horrific acts of violence. Effective strategies for communicating danger events to individuals are critical. In addition to colleges and universities, global governments

have also implemented emergency notifications via a mobile platform. In 2006, the government in the Fujian province of China sent out 18 million messages (SMS) to inform citizens about approaching typhoons [7].

Additionally, government agencies utilize SMS for emergency messages because they are fast and they deliver time sensitive information such as terror alerts and weather updates to citizens [8]. Other advantages of mobile delivery of messages include cost effectiveness, easy support of bulk messaging, and its occurrence in real time [9]. Overall both public and private institutions can reap benefits as outlined above from the use of SMS to deliver time sensitive emergency notifications.

However the use of mobile devices to communicate emergency information is not without its own challenges and risks. Since SMS messages are limited to 160 characters important details about the event may be omitted given the restrictions on the length of messages. Further, SMS messaging lacks reliability since false messages can be delivered, and there can be compromised delivery speeds ranging from 15 minutes to one hour delays, when a high number of messages are generated [10]. SMS messaging can also be vulnerable to other network based challenges such as spam, viruses, and phishing [11]. In fact, in India it is estimated that more than half of all SMS messaging is spam [12]. These challenges can have far reaching consequences and can compromise efforts to harness the power of this technology as an effective tool to disseminate emergency information. Recipients of SMS may also feel frustration if messages do not seem relevant, are too frequent, or omit actionable information.

THEORETICAL MODEL

To address SMS for the delivery of emergency notifications to mobile devices, we develop a theoretical model informed by some constructs presented in the protection motivation theory. The underlying premise of the protection motivation theory is that given a fearful situation, the source of the information affects user cognitive processes and ultimately the user's coping methods for dealing with the specific event [13]. Information about the threat can be shared in a variety of ways including verbal, observational, and from experience [14, 15]. The cognitive processes that the user encounters include appraisal of the threat and the level of protection needed base on the expectancy of the threat [13, 14]. In effect the user assesses the information about a fearful situation, and takes different degrees of action based on the evaluation of both internal and external factors.

From an emergency perspective, there are indeed varying levels of fear, and the goal to seek protection is based on the type of situation presented. More recent studies using protection motivation theory have focused on areas such as security compliance [16] and anti-plagiarism [17]. In these situations the primary focus has been on the user response.

In this paper we are focused on the way the information is delivered and how the information is processed by the user. As a result we use a proxy to convey information about the fearful event or emergency: referred to as the agency. The agency presenting the information can convey different types of information about the severity of the information. Secondly we consider the type of emergency and the level of threat associated with the emergency, as key determinants affecting the recipient's cognitive processing. Our model proposes that the type of emergency,

level of threat, and agency sharing information can all affect the user's response level and how the user evaluates the threat (Figure 1). Each of the variables included in the theoretical model are expanded further below.

Figure 1: Factors Influencing User Reaction to Emergency Text Message
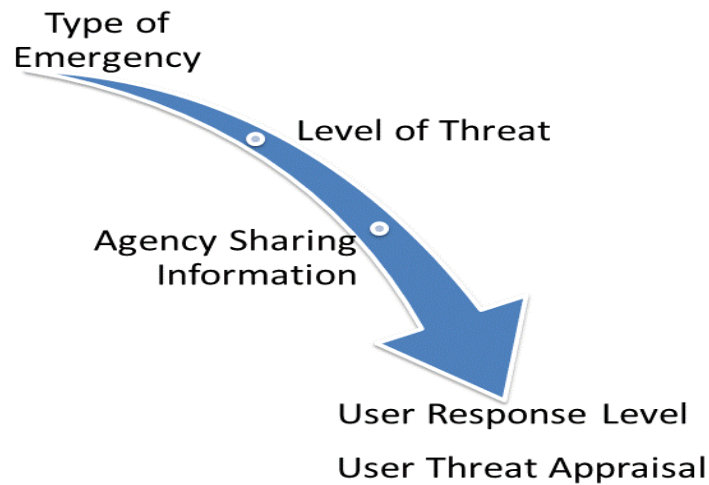
Different organizations have classified emergencies in a variety of ways. For example the Federal Emergency Management Agency (FEMA) has the following main emergency categories on its website: natural disaster, pandemic, home fire, technical and accidental hazards, terrorist hazards [18]; and the American Red Cross identifies the following main areas: hurricane, tornado, flood, fire, earthquake [19]. To account for the different types of emergencies we present a unified list as presented in Table 1. Following the 2001 terror attack in New York City, the Department of Homeland Security implemented a terror alert color code systems to inform citizens about different levels of threats; a more recent system has eliminated the color-coded alerts [20].

The determination of threat level categories will vary from one institution to another. For example, Texas City, Texas uses a four level emergency notification system (I, II, III, IV) indicating the severity of the situation [21]. We present an example of a High –Low schema to indicate the threat level in the SMS. An agency can be a business, government, educational institution or other. Based on the emergency type, threat level, and agency issuing the SMS, the recipient can respond in different ways, and assess the threat as either significant or insignificant.

Table 1: Emergency Response Factors

Emergency Type	Threat Level	Agency	User Response	User Threat Appraisal
1. Natural Disaster: Hurricane, Tornado, Earthquake, Storm, Flood 2. Traffic 3. Fire 4. Accidental hazard 5. Technical hazard 6. Pandemic 7. Terrorism 8. Other	1. High 2. Medium 3. Low	1. Business 2. Government: local, state, federal 3. Educational Institution: primary, secondary, tertiary 4. Other	1. Comply Immediately 2. Verify then Comply 3. Ignore	1. Significant Threat 2. Insignificant Threat

METHODOLOGY

To test the theoretical model presented above we propose a two-phase methodology. The first phase of the study involves the use of structured interviews to examine our initial components included in the model. The results from the first phase are intended to provide a more robust basis for development of the second phase of the project. Phase 2 would be a larger quantitative study, using a survey instrument to empirically test our variables.

For phase 1 of this project we conducted semi-structured interviews with faculty and staff at a college in northeast United States. Twenty individuals were interviewed for this preliminary study (see Appendix A – interview questions). The participants were not required to share personal information such as age, or income. The primary purpose of these interviews was to solicit salient input from individuals in a population that were already exposed to the use of mobile delivery of emergency text messages. This way, we would be able to gather data from different perspectives on the research topic.

FINDINGS AND DATA ANALYSIS

All interviews were audio recorded and transcribed into Microsoft Word. The data was then analyzed using both Nvivo and Excel. We examined the data to identify any common themes or emerging topics from the responses provided by the participants.

The first question in the survey was the initial benchmark item to determine if the participant owned/used a mobile device. All the responses were "yes", with some participants providing more specific information about the devices that they used. We analyzed the word frequency on this question to see if some products were trending higher than other. The data showed that the majority of the participants were using smart phones, with a bias towards iphones (table 2). Interestingly one individual described his phone as "*archaic*", but it still had the capability of sending and receiving text messages. This information was useful because it confirms that individuals have devices with the functionality to support SMS.

Table 2 - Term Frequency for Device Description
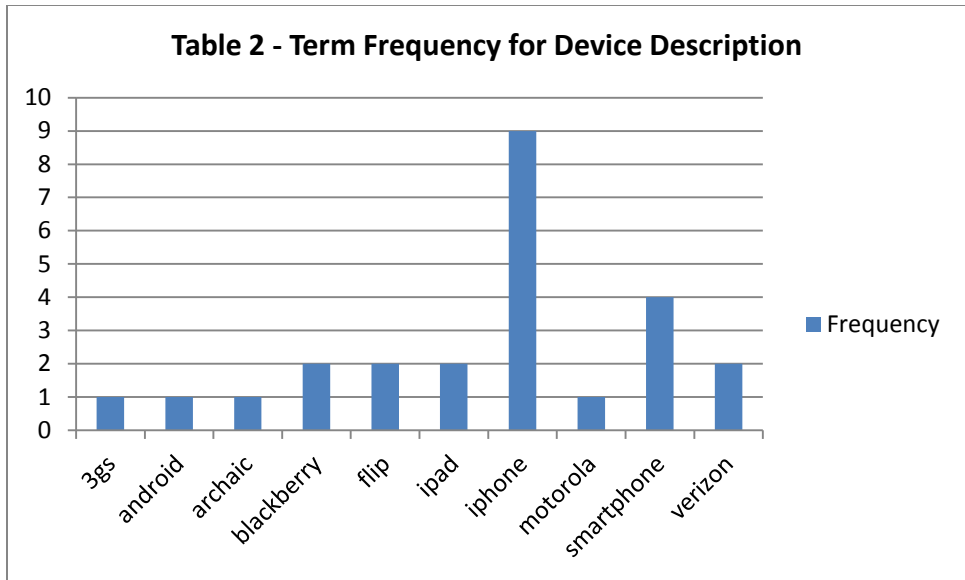
Given the convenience sample of subjects selected for the study all of them indicated that they were aware of different agencies using text messages to delivery emergency notifications. However, we saw a variety of responses pertaining to agencies that send out messages, what types of emergency notifications they were aware of, and their perceptions about the value of such messages.

All the study participants indicated that they had heard about using text messages for emergences at the educational institution where they all worked. Further 90% of the interviewees indicated that they were subscribers to the system. Some indicated that they had subscribed to other systems such as their children's school and a local TV station for weather emergencies. Participants indicated a degree of comfort with receiving emergency text messages from agencies they were familiar with. However, we heard the word "*panic*" mentioned a few times regarding improper dissemination of messages from agencies. One respondent also indicated that he would be concerned about the agency distribution his cell-phone number without permission. This introduced a trust factor, specifically regarding the agency sharing the emergency message.

Regarding the value of receiving SMS for emergency notifications there was a general consensus that in theory it was a good idea. However one respondent cautioned that it should only be "*used judiciously,*" highlighting concerns about perceived potential for abuse. Other respondent indicated the specific conditions under which SMS emergency alerts would be acceptable: "*Dangerous situations, such as active shooter situations or traffic emergencies on commuting routes*" and "*nuclear power plant, natural disasters, some kind of public emergency.*" Another participant succinctly described the value of SMS for emergency notifications as follows: "*They are short and to the point. That is what is important.*"

In addition to the perceived value of the use of mobile delivery of emergency notifications, specific challenges countering its value were identified. One respondent indicated the following: "*I do not like receiving unsolicited test messages and spam, and I don't like the fact that I have to pay every time I receive a text message.*" This comment addressed two important areas: spam

and costs. Indeed, globally spam is a huge problem associated with the delivery of SMS. Additionally, some cell phone uses per pay message and are unwilling to pay for services that they do not recognize as valuable.

LIMITATIONS OF STUDY

The first limitation of the study is the sample size. Generalizing to a population based on a sample of twenty interview participants is not possible. However, this study provides very useful information about individuals currently working at an institution that already has an emergency text alert system in place. Users in this environment also seem more receptive to the use of text message alerts from other types of agencies. A different sample of individuals that have no knowledge of any mobile or computer based emergency systems may present different results.

Secondly, the scope of the questions in the study excluded key demographic data that could provide an explanation of differences. Factors such as age and education may impact perceptions about mobile devices. The questions were limited to the use of mobile devices and text messaging. In a broader context specific questions related to overall technology usage might provide more insights. Thirdly, users were not questioned about their perceptions on trust with respect to the agency delivering the message, or the credibility of the message.

IMPLICATIONS

The study has implications for developers, users, and researchers involved in deploying SMS and the broader area of utilization of mobile technology. User perceptions can also inform agencies that are sending out SMS on strategies to improve compliance with distributed messages. Identifying methods to improve delivery efficiency will also increase rates of user adoption, and can ultimately serve to improve emergency management.

It is clear that there is significant perceived value associated with the use of SMS for emergency notification. This value is evident both from the findings of this study and recent initiatives by governments. In May 2012 the wireless emergency alert (WEA) system was launched to alert individuals about weather emergencies [22]. WEA is a partnership with a variety of private and public entities including FEMA and the Department of Homeland Security. However the real challenges with using SMS for emergency notifications cannot be ignored.

FUTURE DIRECTIONS

In the short term we will expand this research and conduct phase two of the study. As stated earlier, this will involve a more in-depth quantitative survey methodology with a set of testable hypotheses. More research is also needed in order to better understand the critical factors that influence an individual's intention to comply with emergency notifications. Under what conditions are individuals more likely to take action associated with a message, or simply ignore the message? A better understanding of the critical success factors will aid in facilitating timely response to emergency situations. Alternative perspectives for this research can also focus on the agencies that are sending the message out. What factors do they consider before sending out the SMS? Is there any follow-up information provided to the recipient of the message, and how can other deliver methods be used to complement SMS?

CONCLUSION

This study examined user perceptions of the use of SMS for the delivery of emergency notifications. We presented a theoretical model showing that three main types of factors: 1. type of emergency, 2. level of threat, and 3. agency sharing the information; would affect user response level and user threat appraisal with the delivery of a SMS emergency notification. The goals of paper are to expand the research in the areas of emergency management and mobile technologies; and provide a foundation for more in-depth research in these areas.

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KNOWLEDGE MANAGEMENT IMPLEMENTATION IN THE HEALTHCARE INDUSTRY

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ABSTRACT

The advancements in health informatics along with knowledge management practices present challenges in terms of adoption. This paper discusses the role of KM and issues of KM implementation in healthcare industry. KM practices have benefited many industries ranging from banking to retailing. It is widely believed that KM will also benefit the healthcare industry if KM implementation is properly planned and executed. KM will change the way in which hospitals, doctors, and patients interact. KM can be applied to meet the demand for care that is growing with the increase of population and the gradual retirement of baby boomers.

Keywords: Knowledge Management, Healthcare, Health Informatics, Electronic Patient Record

INTRODUCTION

In the United States, the rising rate of the population coupled with the increase in life expectancy, is 11% from 2000 to 2012 [32] and 2% from 2000 to 2009 [9], respectively. The rapid growth of population is placing a mounting demand and burden upon the current healthcare industry. As a result of this growing influx, doctors, hospitals, and insurance companies are required to accommodate more patients for preventive and end of life needs. Additionally, not only are faced with capacity issues, doctors have to consider risk management, where poor information sharing amongst doctors and testing facilities can result in errors in medical diagnosis and treatment [15]. Therefore, medical institutions (e.g., hospitals, rehabilitation facilities, and nursing homes) are currently or will be faced with growing amount of unstructured and unorganized data [6], impeding the ability of doctors to make well informed decisions, and for medical facilities to make strategic decisions for operations and expansion.

The health care industry is currently at a handicap stage in terms of meeting the growing demand of the general population [30]. In order for the healthcare industry to become efficient and effective organizations in meeting demand, it is predictable that they must adopt knowledge management principles. Through the development of information technology (IT), current and future medical data and information can be leveraged to develop knowledge-based solutions that facilitate collaboration amongst institutions and address the demand for healthcare by improving

record management, and the development of more efficient methodologies to diagnose and treat patients in a timely manner.

THE ROLE OF KNOWLEDGE MANAGEMENT

Knowledge includes data, information, and experience. It is the combination of facts, analysis, trainings, and lessons learned that comprise knowledge for an individual. The concept of knowledge management provides individuals and organizations with practices and methodologies that utilize a combination of intellectual capital, business processes, and IT solutions to provide organizations with more efficient and effective operational means. Through the capture, organization, codification (conversion of knowledge), distribution, and utilization of knowledge, companies can leverage and embrace knowledge management practices that enable employees to conduct positive operations. Additionally, the repository of various types of knowledge within an organization allows future generations to learn from past mistakes and to devise innovative solutions for business needs [5].

Generally speaking, knowledge is divided into two distinct categories called explicit and tacit knowledge. Explicit knowledge is information that is easy to capture, structure, and share with individuals. For example, explicit knowledge can be the documentations like hospital policies and procedures and clinic diagnostic methodologies. Alternatively, tacit knowledge is comprised of experience and skills that an individual can acquire overtime and apply to problems. The exposure to events over time can evolve a person's thought process. Tacit knowledge is difficulty to capture, structure, and transfer to other individuals [5]. Furthermore, [22] defines tacit knowledge as the understanding of how and why with regard to a particular subject area. Due to the degree of complexity, objectivity, and subjectivity, tacit knowledge is difficult to capture and transfer without dedicating significant resources to codify the knowledge into an explicit form that can be utilized by others.

TTYPES OF HEALTHCARE KNOWLEDGE

From a micro level, knowledge can be further refined. In the healthcare industry, further examination helps to define the various aspects of the healthcare industry and domain that can be taken into consideration with regard to the integration of knowledge management practices. [1] has defined eight different types of knowledge within healthcare. However, only three will be expounded on below because of their correlation with the subject matter at hand.

Provider Knowledge

Provider knowledge is also called practitioner knowledge. It is the most obvious type of knowledge that comes to mind. Medical professionals in this capacity possess both explicit and tacit knowledge. For example, doctors are required to know standard medical information that is easily comprehended from reference materials like text books (e.g., human anatomy). However, some may consider the most important type of knowledge of providers is of tacit form. Years of medical practice and experience with numerous patients' help, doctors develop an internal

knowledge base of symptoms and facts about patients and medical conditions that are used in addressing needs for preventative maintenance and illnesses.

Patient Knowledge

On the other side of the medical spectrum, it consists of tacit knowledge in patients. This type of information is considered ―health status" by [2]. Patients own complex knowledge in current and past medical conditions that practitioners may not know about. However, such knowledge is vital for practitioners to know, especially when it comes to the diagnoses and prescription treatments for illnesses.

Organizational Knowledge

Medical institutions consist of other knowledge-based resources that are available for patients and doctors to access. This domain of knowledge can be comprised of a variety of knowledge from medical diagnostic systems, text-based materials, and other medical professionals with medical specialties. Moreover, this domain could contain medical land treatment process knowledge that is recommended by an institution or medical society (e.g., American Medical Association).

HEALTHCARE KNOWLEDGE MANAGEMENT IMPLEMENTATION

Knowledge management practices have been adopted in many businesses. However, the healthcare industries have been slow to adopt such principles and concepts [13]. Companies that seek to become knowledge centric have been integrating knowledge management concepts with IT and business practices. Since the development and commercialization of the Internet during the 1990s, IT has played a greater role to facilitate knowledge management within organizations [6]. IT is a tool that leverages technology and information to increase the productivity of processes. Since being defined in the 1960s, IT systems have gone from be used as a tool to manage data and fulfill management reporting needs, to provide mechanisms for strategic management decisions, and promote collaboration amongst internal and external entities [27].

The integration of healthcare and IT is commonly referred to as health informatics. Health informatics is becoming a popular topic among the healthcare industry [7]. Similar to the concept of knowledge management, both do not involve business process engineering. Rather, the purpose behind health informatics is to automate existing processes to increase efficiencies. Healthcare informatics aim to provide growths in the value of care and services that institutions deliver to patients [33].

HEALTHCARE INFORMATION SYSTEMS

As a result of the health informatics, some knowledge management IT solutions have been implemented within the healthcare industry, similar to those of the general business world. For example, medical institutions have been implementing content management tools such as

medical knowledge base repositories and lessons learned. In addition, web-based learning management systems have been deployed consisting of online classes and educational videos to further the education of medical professionals. Finally, a varying degree of unified communication systems have been utilized to promote the transference of knowledge via socialization and collaboration techniques facilitated by text-based and video chat [12], [15], [35].

In recent years, a popular type of healthcare information system is being implemented by large hospitals. Electronic medical record (EMR) systems and personal healthcare records (PHR) have been developed and deployed transforming the customary patient paper-based record system. Patient's diagnostic data and treatment information have been converted into an electronic format that can be accessed by medical staff within a hospital and other partners for the purposes of assessing a variety of test results and providing treatments. The types of data that can be fed into and stored in an EMR or a PHR are extensive. When taken in their aggregate, these data can be analyzed and organized into meaningful information. Both EMR and PHR can be shared among the various health care providers offering a more holistic patient profile than can the individual pieces of data. Typical examples of the data feeding into a PHR are lab results, medication history, allergies, chronic diseases, imaging reports, healthcare claims information, hospitalizations, etc. [3], [8].

In 2004, President George W. Bush instituted a new government office, the Office of the National Coordinator for Health Information Technology to support the development of healthcare IT within the United States. The purpose behind such an endeavor is to attempt to reduce healthcare costs and errors from information gathering. The Office of NCHIT is to increase the ease of use in which medical information can be transferred to patients and other medical providers [31].

As noted by [14], the healthcare system within the United States cannot comply with a universal concept as defined by the Office of the NCHIT because of the disparities that currently exist among healthcare providers. Without the standardization of healthcare practices such as terms used, reporting format, and system processes, the ability for IT systems to work seamlessly together with multiple internal and external systems will fail. The availability or flow of information may become a bottleneck of the deployment of a healthcare system [14]. Medical facilities like hospitals are independently owned and operated. They must abide by some medical terms and regulations such as HIPAA are dictated by government agencies [17]. However, there appears to be no degree of urgency with regards to standardizing the healthcare industry. The Health Information Technology Standards Panel is working on the standards of the healthcare industry. Furthermore, without any mandate by the U.S. government, a dominate industry architecture will never be developed. Hospitals will be required to continue to bear the burden of the lack of advancement in collaborative information sharing [10].

HEALTHCARE DECISION SYSTEMS

The advents of electronic medical record systems are only address one aspect of the healthcare IT and knowledge management practices being implemented in the medical community today.

Currently, institutions that have established electronic medical record systems have been further refining their knowledge by codifying and transferring explicit and tacit knowledge like medical practices, processes, and experience into health care decision support systems [16], [26].

While healthcare decision support systems can be developed to meet various needs. [2] defines the overall intention behind the implementation of clinical support systems is to increase the efficiency of operations by leveraging observational knowledge. By leveraging observational knowledge, practitioners amongst other staff can make strategic decisions with regard to the treatment of a patient, forecasting diseases, and addressing operational business concerns like healthcare cost through data mining techniques [2], [26].

Recently, insurance companies and federal and state funded programs within the United States like MassHealth have started to implement a degree of decision support systems. For example, MassHealth utilizes a pharmacy benefit management programs called MedMetrics. Created by the University of Massachusetts Medical School. UMass Medical School is a third party used by MassHealth to review prescriptions issued to subscribers by practitioners to make sure that their subscribers were prescribed the appropriate cost-effective medication for their respective medical condition. If a prescription falls outside of the organization's specified treatment, subscribers are required to submit a prior authorization form that gathers specific medical details and they are either denied or approved coverage based upon review [23].

The development of a healthcare decision support system of this nature has been successful because the organization has developed a structured repository of knowledge pertaining to drug classification systems, usage, and other information like reactive relationships from pharmacies and federal institutions. Additionally, the organization is able to develop a knowledge base of prescription usage based on drug for purpose cost and audit analysis to its customers. However, based on usage of such a program, it has been observed that the development of such a system has neglected patients that required expensive drugs due to other unsuccessful treatments or other criteria that are built into the logic reasoning of the system. Therefore, it is plausible that the codification process in developing the logic reasoning requires continuous modification by knowledge experts. As information and data is continuously submitted by medical institutions for coverage evaluation, the healthcare decision support systems should be constantly updated with appropriate logic reasoning.

CODIFICATION OF HEALTHCARE KNOWLEDGE

The implementation of knowledge management practices and IT-related systems in healthcare industry is unlike other KM practices in other businesses [24]. However, the methods in which knowledge is codified, meaning the organization and conversion of tacit knowledge into a usable format differs according to the type of solution that is being sought. For example, to develop knowledge bases that facilitate experience-based sharing and medical cases, [1] suggests existing knowledge and information must be modeled in order to develop a structure for which a knowledge base can be developed. Some suggests classifications are medical stages of specialty versus acute versus chronic illness [1], [34].

In order to codify and transfer this type of clinical knowledge, [1] leverages practices that are used in other industries that leverage knowledge management. For example, the elicitation of tacit knowledge can be derived from knowledge experts via interviews. Alternatively, knowledge developers can develop a model and define the system requirements based on evaluation of clinical practices to understand common medical elements and relationships. Furthermore, in order to develop decision-based support systems, knowledge developers require a clear understanding of both explicit and tacit knowledge in terms of the relationships and outcomes between medical conditions and treatments. Therefore, existing logical decision-based rules need to be developed following clinical procedures, practices, and the knowledge expert's experiences [1], [28].

Conversely, the current implementation of most electronic medical record systems contains unstructured and redundant information. The decision-based system with these types of information becomes difficult to leverage electronic medical record information. [21] suggest that rather than modeling logic decisions and processes, data and decision models should be used to develop knowledge medical standards through the use of knowledge acquisition tools to aid in the extraction, conversion, and definition of tacit knowledge for use in the creation of lessons learned knowledge bases [21].

BARRIERS TO THE ADOPTION AND ACCEPTANCE

As with any IT project, the implementation of knowledge management healthcare IT systems requires the support of top management and a champion. Champion is someone who understands existing business processes, resources and contacts within organization. Champion believes the KM project will bring benefits to the organization and is willing to secure the organizational resources for a new KM system from inception to deployment [13], [20]. Furthermore, the limitations of an institution's IT infrastructure can limit the scope of knowledge management system implementations. However, IT should act in a supportive and facilitator role while knowledge management initiatives are filed by the business side of operation [24].

The greatest barrier to the success of any knowledge management solution is the organizations culture [22]. This barrier is comprised of both organizational perspective and individual perspective. For example, if the management of a hospital or medical facility deploys knowledge management practices and systems without the consideration of its users, the overall success of the initiative can be impeded severely. Therefore, a champion must be present along with management support to engage user involvement in the knowledge management system development life cycle. Building a KM system is like the formation of community of best practices [4]. Need handle with care. With regard to IT-based solutions, knowledge experts and workers should be engaged for system requirements and knowledge elicitation to make sure the system is not only developed accordingly with regard to its indented purpose, but to educate, familiarize, and promote the importance of such practices and tools [13].

The composition of an institution's culture consists of doctors, nurses and other administrative staff. Knowledge experts exercising knowledge sharing may have conflict with individual mindsets [4], [11]. [13] has elaborated on this topic and reached the conclusion that some

practitioners do not necessarily believe in the sharing of knowledge may present a challenge to the success of KM practices. Customary medical practices have relied upon practitioners as knowledge experts providing diagnoses and treatments. With little documentation or information for reasoning, practitioners are placed in a position to defend practices and reasoning [13]. Therefore, the creation of decision-based systems amongst other IT-based solutions may encounter hurdles depending on the receptive nature of individual. Organizational culture in operation is strongly tied to long standing medical practices and methodologies.

IMPACT OF KNOWLEDGE MANAGEMENT

The implementation of knowledge management practices and systems within the healthcare industry can become a success or failure. As with any project, just because a system has been put in place utilizing the appropriate methodologies and practices, does not mean that it will become successful in terms of adoption and utilization. Unfortunately, this is an unavoidable risk. However, the underlying principles of knowledge management implementation are directed at facilitating collaboration, increasing operational efficiencies, protecting company's intellectual capital, and avoiding high rate of attrition.

While the direct impact upon healthcare institutions is difficult to measure [19]. The Office of the National Coordinator for Health and Information Technology provides a few elements for which performance metrics can be defined. Based on the mission of the Office the following elements align with those benefits of knowledge management defined by [15]: improvement in quality of care and service, reduction in healthcare costs, and the improvement in the coordination of information amongst facilities, institutions, and personnel within healthcare industry [31].

The Commonwealth Fund Committee presents an interesting summary of the U.S healthcare systems from 2006 to 2009. The metrics mentioned previously use 42 different elements focusing on health lives, quality of healthcare, access to healthcare, and hospital efficiency for the Committee's 2011 scorecard. Based on results from these key performance indicators, the Committee has concluded that the overall performance of the U.S. healthcare system has declined 3% during the three-year time period. In the same time period, the overall quality of health care declined but the average spending on health per capital increased 15%. Besides, the Committee found that the adoption of electronic medical record systems increased among primary care physicians to 46% in 2009 which is lower than the European counterparts who are at or above 60% [29].

Interestingly, the statistics presented by the CFC support the results of a journal article published in the New England Journal of Medicine in 2009. It reported that only 7.6% of U.S. hospitals have a basic electronic management system implementation in place [19]. Further, the survey assessment affirms the barriers of entry for knowledge management systems for the healthcare industry. Specifically, hospitals present a significant burden to implement KMS at this time [19].

CONCLUSION

Overall, the implementation of knowledge management practices and systems is topic of great interest amongst the healthcare community and the business world. There are numerous articles being published every year on these KM issues in healthcare. However, there appears to be a lack of detailed analysis on actual implementation and lessons learned with existing IT-based knowledge management implementations in the healthcare industry. A majority of the studies and other resources about knowledge management, healthcare, and informatics appear to focus on the theories and practices. While the development and creation of electronic medical record systems appear to be of interest now. It lays the foundation of a standard healthcare information system. Research of this subject matter provides interesting insights into the possibilities of KM practices in future healthcare systems.

Common issue of information overload has been reported in the healthcare community [24]. This is understandable considering the differentiation and the vast nature of the medical profession. It appears that health information solutions like electronic medical record management systems are become much popular with hospitals. They have capital and resources to afford such undertaking. For example, Partners Healthcare Incorporated manages some of the top rated hospitals of the east cost of the United States such as Massachusetts General Hospital and Brigham and Women's Hospital. In 1994, Partners initiated an electronic management records system via InterSystems Ensemble. InterSystems, a web-based solution, provided Partners with the ability to integrate multiple electronic medical record systems and existing data repositories that contained patient information. Overall, this venture resulted in hospital expenditure savings and a reduction in prescribed medication drug reactions [18]. However, the development of electronic medical record IT solutions appears to be a constantly evolving platform. During May of 2012, Partners announced a new ten year health informatics venture with EPIC to advance the organization's IT infrastructure and provide not only doctors, but also patients with greater access to medical record information like examination notes, lab results, financials, and other medical knowledge from best practices and knowledge-based resources [25].

It is foreseeable that health care industry is into adopting knowledge management practices and IT-based solutions in an effort to maintain operational efficiencies and to operate collaboratively to share information and knowledge with partners and patients. The implementation of a well-designed knowledge management system is aimed to alleviate the risks associated with medical diagnoses and treatments in the future. It is quite possible that the customary healthcare KMS will allow people with medical needs to access professional healthcare knowledge and advice virtually. Patients are able to see a doctor or a nurse practitioner remotely. They no longer need to physically drive to see a doctor. Since the advent of the Internet, there appears to be a shift in the medical knowledge with regards to where people seek further insight into various medical questions and disorders. Online knowledge base repositories like WebMD have been extensively developed to provide visitors with explicit knowledge that is easy to comprehend. Educational videos help to transfer tacit knowledge into a format that is digestible. The further advancements of cloud-based medical information systems and knowledge-based repositories will no doubt lead patients to take a greater participation in their healthcare decision as medical knowledge becomes structured and available.

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A GENERAL STRUCTURE OF APPLIED DESIGN RESEARCH STUDIES

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ABSTRACT

Several years ago, the MIS community has called for a return to design research which underlies the MIS discipline. In comparison with behavioral research, the methodologies of design research have not been established. This paper proposes a general structure for applied design research studies.

Keywords: Design research, applied design research studies, research methodology.

1. INTRODUCTION

An increasing interest calls for a return to design research that underlies all MIS research (Vaishnavi and Kuechler 2004). Design research is becoming a fruitful line of research which has long been under-emphasized in the MIS field (Kuechler and Vaishnavi 2008; Peffers et al. 2008; Pries-Heje and Baskerville 2008). Hevner et al. (2004) made serious critiques on the lack of balance between the behavioral-science research paradigm and the design-science research paradigm in the MIS research, and proposed the framework for design research which includes seven guidelines for design research: design as an artifact, problem relevance, design evaluation, research contributions, research rigor, design as a search process, and communication of research. A tremendous effort of design research is to specify design theory for MIS (Gregor 2006).

While the MIS community has asserted that business needs are the driving force for design research, countless design research reports in technology-oriented journals place focal points on new IT that can be applied to business. In fact, extremely successful designs related to the new IT enterprises, such as Google, Yahoo!, facebook, YouTube, and countless others, invented by young IT enthusiasts did not seem to be driven solely by defined business needs, but were activated mainly by perceived grand new IT opportunities for business. These designs did not seem to need behavioral-science-based rigorous tests before they were well accepted by the society. This fact supports the premise of design research in MIS that IT innovation beyond the standard applications of IT to business is an essential component of design research. This premise has been justified by the design research literature (Conlon 2008; Wang and Wang 2010).

There are several types of research themes in design research in MIS. *Applied design research* emphasizes design of artifacts (see, e.g., Vaishnavi and Kuechler 2004)). *Empirical design research* concentrates on the theme of empirical tests of designed artifacts (e.g., see (Montazemi and Wang 1988)). *Theoretical design research* develops theories of design science based on applied design research and empirical design research (e.g., (Hevner et al. 2004)). Applied design research provides the foundation of the design research, but has not been highly regarded in the MIS research community. The shortage of applied design research in MIS has diminished empirical design research which was fairly active in the 1970s and 1980s, and will eventually make theoretical design research empty.

Based on design research literature, Vaishnavi and Kuechler (2004) have proposed a general model of design research process steps: awareness of problem, suggestion, development, evaluation, and conclusion. The development step is the core of applied research process, but has not been fully discussed in the literature. This paper is to propose a general structure for applied design research studies to guide artifact development.

2. RELATED WORK: A BRIEF REVIEW OF DESIGN RESEARCH

Dubin's (1978) concept of natural science theories and Simon's (1981; 1996) concept of design theories have been the foundation of design theories in all disciplines. In the MIS field, Walls et al. (1992) made a critical initial endeavor to establish design theory. They defined that design theory is "a prescriptive theory which integrates normative and descriptive theories into design paths intended to produce more effective information systems." Walls et al.'s design theory includes two aspects: design product and design process; and seven components: meta-requirements, meta-design, kernel theories for design product, testable design product hypotheses, design method, kernel theory for design process, testable design process hypotheses. Surprisingly, the MIS field seemed not to echo with their work as expected (Walls et al. 2004). More recently, Gregor and Jones (2007) revised Walls et al.'s design theory based primarily on the Dubin's (1978) general design theory. They suggested that design theory should have eight components: purpose and scope, constructs, principle of form and function, artifact mutability, testable propositions, justificatory knowledge, principles of implementation, and expository instantiation. They argued that the separation of design product and design process, as Walls et al. suggested, was unnecessary.

Design research emerged as a field of study in the 1960's and the design research Society was founded in 1966. However, the fact is that the nature of design in individual disciplines could be very different. For example, design in mechanical engineering is quite different from design in visual arts. Hence, a discipline must have its version of design research framework to represent its unique nature of design. The most influential design research framework for the MIS field is Hevner et al. (2004) proposed in 2004. The framework includes two loops: design research relevance and design research rigor. In their framework, people, organization, and technology are three components of the environment of design research. Business needs are the drive force for design research so that design research can be relevant. design research must add knowledge to the knowledge base so that design research can be rigor. Hevner et al. also proposed seven guidelines for design research: design as an artifact, problem relevance, design evaluation,

research contributions, research rigor, design as a search process, and communication of research. More importantly, Hevner et al. made serious critiques on the lack of balance between the behavioral-science research paradigm and the design-science research paradigm in the MIS research.

In summary, in the existing design research frameworks and design theories, IT is regarded as a component of the environment of MIS (Henver et al. 2004; Pries-Heje and Baskerville 2008). This view might be appropriate if design research is standard applications of IT to business, but it restricts the scope and the role of design research. Research (Wang and Wang 2010) has argued that IT innovation relative to business ought to be a research subject of design research in MIS. Accordingly, the structure of applied design research studies must emphasize IT innovation.

3. A GENERAL STRUCTURE OF APPLIED DESIGN RESEARCH STUDIES

Structure of applied design research studies refers to a set of specific guidelines and methods for the process of creation, construction, and validation of an artifact in the IT innovation context. We propose a structure of applied design research studies that includes the following elements.

(1) Inner core;
(2) Stage in the iterative and incremental development process;
(3) Architecture of artifact;
(4) Prototype; and
(5) Validation and contribution.

3.1. Inner core

Any newly designed artifact for IT innovation is an extension of the existing artifacts. The inner core of a design refers to the artifact or computational model that the newly designed artifact is built on. The inner core of an applied design research study can be an existing software system (e.g., a social network), a computational method (e.g., wavelet-based data summarization), or a concept (e.g., a cognition theory).

3.2. Stage in the iterative and incremental development process

Iterative and incremental development has been applied to design for a long time (Larman and Basili 2003). The basic idea behind the iterative and incremental development process is to develop an artifact through repeated cycles (iterative) and in smaller portions at a time (incremental), allowing the designer and the users to learn during the development of earlier versions as well as the use of the interim artifacts.

The iterative and incremental development process is significantly different from the traditional water-fall development process for standard IT applications, and is particularly relevant to the development of IT innovation artifacts. First, the application context of an IT innovation request is usually more complicated than that of standard IT applications, and can change over the time.

Refining and continuous improvement are necessary. Second, IT innovation artifact designs are supported by a variety of advanced techniques. The performance of an advanced technique can vary depending upon the application environment which may not be known until the technique is applied to the specific IT innovation artifact. Iterative development is inevitable to make the optimal performance. Third, more importantly, an IT innovation artifact is a new design, and the development process is a knowledge acquisition process, and should be constructed incrementally by using a concept formation framework and accepting one source of concept at a time (Fisher 1987). The iterative and incremental development process for developing an IT innovation artifact is depicted in Figure 1. An applied design research study is a particular stage of the entire iterative and incremental development process.
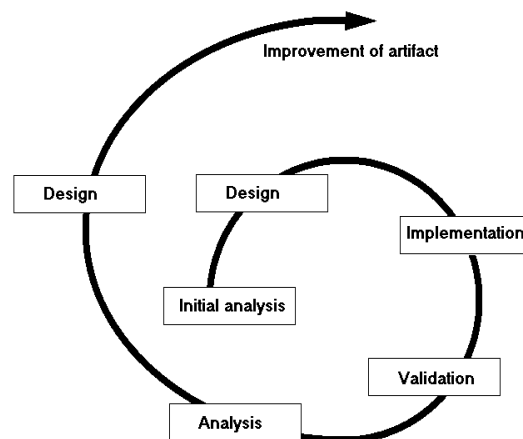
Figure 1. Iterative and Incremental Development Process

3.3. Architecture of artifact

The architecture of a computing artifact includes high-level artifact layers and low-level component specifications. Design of a high-level artifact layer is more application specific in comparison with that of low-level components. In this section, we present a guideline for designing IT innovation artifacts at the three levels: layers, module, and object.

3.3.1. Layers
In the computer MIS field, the layered architectural design has been well established (Clements *et al.* 2010). It is a commonly accepted design principle that a computing artifact has a central domain-specific layer and other service layers such as presentation layer, application layer, and foundation layer (Bass *et al.* 2003; Taylor *et al.* 2009). The central domain specific layer provides the IT innovation functionality based on the inner core of the design. A general layer structure is depicted in Figure 2. Clearly, it is possible to have the application layer on the top of the central layer, depending on the nature of innovative artifact.
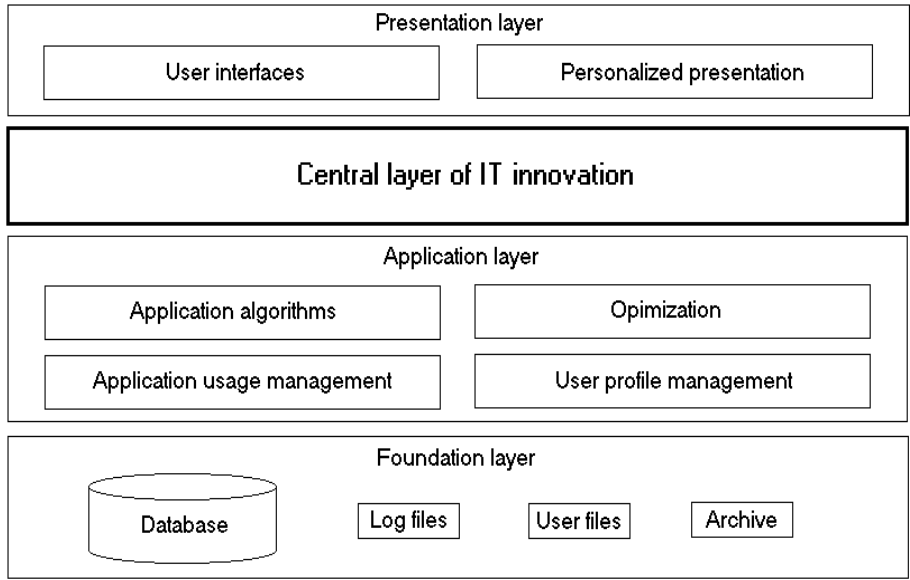
Figure 2. Layers of Artifact

The behavioral relationships between the layers can be represented in a sequence diagram. Figure 3 sketches general behavioral relationships.
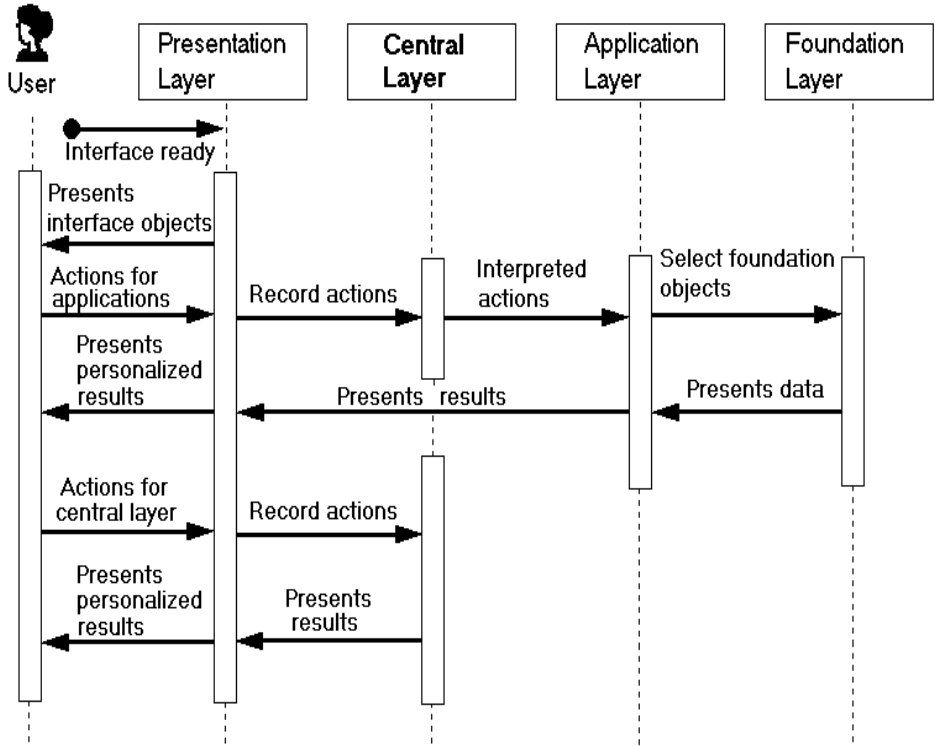
Figure 3. Behavioral Relationships of Layers - Sequence Diagram

3.3.2. Modules in each layer

A module in a layer is a group of objects. The design of modules implies the corresponding design processes for the artifact. Here we present the general structure of descriptions of modules in each layer, as shown in Table 1.

Module	Description
User interfaces	Visualized objects that trigger other objects to facilitate operations.
Personalized presentation	Visualized objects that are presented to specific types of users based on the individual user's preferences.
Modules of Central Layer	**(The central set of objects that implement the artifact.)**
Application algorithms	The set of objects that provide application service results.
Optimization	The set of objects that optimize the performance of the artifact.
Application usage management	The set of objects that record, control, and predict the application usage based on the user profile management.
User profile management	The set of objects that facilitate the user profile management.
Database	The database used for the artifact.
Log file	The file that records access logs.
User profiles	The set objects that specify the users' profiles.
Archive	The storage of historical records.

Table 1. Modules in Each Layers Considered in Design

3.3.3. Objects of the central layer

The central layer needs to be detailed at the object level. The generic semantics between the objects are represented by inheritance (for static relationships such as "*Is_a*" and "*Has_a*") or message sending (for dynamic relationships). The important methods of each object are also defined. A general format of objects is illustrated in Figure 4.
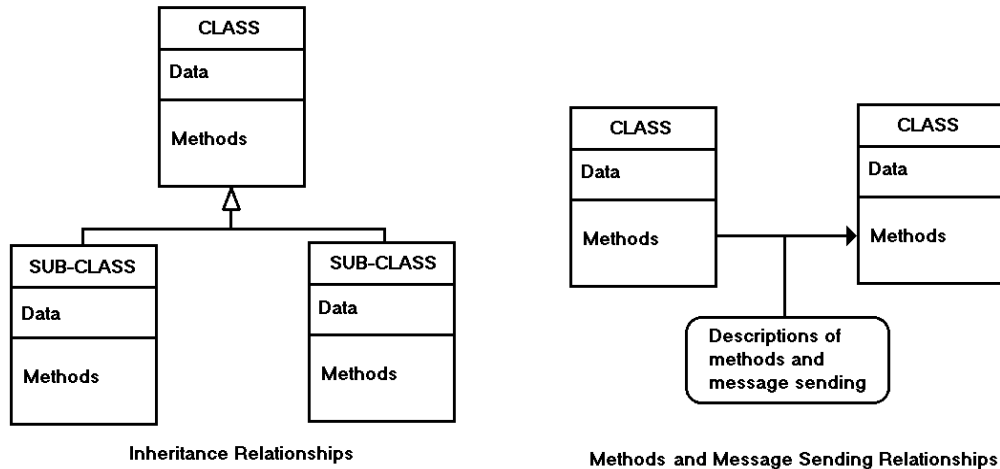
Figure 4. Design of Objects for the Central Layer

3.4. Prototype

3.4.1. Major consideration of implementation

Major consideration of implementation is important to explain in the design. Examples of major consideration of implementation include the properties of the software development tools, the users' specific needs, the computational environment, the designer's internal view, etc.

3.4.2. Presentation of prototype

To demonstrate the design of IT innovation artifact, a prototype must be presented. The presentation of prototype includes the following major items.

● Tools and computational platform used for the prototype;
● Scope of the prototype;
● Screenshots of the major functionalities, along with brief operations; and
● The place where the reader can access the prototype.

3.5. Validation and contribution

3.5.1. Validation

Validation of a design artifact includes two parts: usability test and verification. Usability refers to the ease of use and the ease to learning of a human-made artifact (Gould and Lewis 1985). Verification is the process of determining that a designed artifact accurately represents the designer's conceptual specifications and objectives (Andriole 1986).

Needless to say, to fully validate a designed artifact, independent through tests are necessary. On the other hand, it would be unreasonable to demand a rigorous validation before disseminating an innovative applied design. It would be acceptable that a preliminary experiment of validation of the design of artifact for knowledge sharing within the research community. The preliminary experiment may not intend to establish any statistically significant results; rather, it is merely to show that the designed artifact can be useful and the design meets the design objectives.

The presentation of preliminary experiment must cover the following major items.

● The data used in the experiment;
● The users of the designed artifact (prototype);
● The setting of experiment; and
● Samples of objective and subjective experimental outcomes.

3.5.2. Contribution of the applied design research study

The contribution of an applied design study in the MIS field is to build up information technology innovation beyond theories of standard applications of information technology to business (Wang and Wang 2010). Thus, alignment of design research and IT innovation is used to justify the contribution of an applied design research study. Specifically, the contribution of applied design research is assessed by the following four criteria.

(1) *A novel layer of the existing IT inner core* – The design artifact must be a novel layer that is built on the IT inner core.
(2) *A request for improving existing IT applications* – The design artifact demands an improvement of existing IT applications.
(3) *A request for improving business practice by using IT* – The artifact must initiate new business practices in using IT.
(4) *A satisfactory innovative instantiation* – The design artifact must demonstrate its merit of IT innovation and be worth further rigorous and independent tests.

4. CONCLUSION

This article discusses the importance of design research in the MIS field. It proposes a general structure of artifact development for applied design research studies. This structure includes the inner core of study, stage of the iterative and incremental development process, architecture of artifact, prototype, and validation and contribution. Clearly, this proposed structure for applied design research studies is an initial formation based on the literature and our observations, and needs to be tested. In our view, the formation of a general structure for applied design research is a kind of design research study. Thus, an iterative and incremental development process must be applied as well to this case. We believe that this initial formation has its merit for design research and be worth further rigorous and independent tests.

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INFORMATION AND COMMUNICATION TECHNOLOGY AND DELIGHT: A FRAMEWORK FOR RESEARCH AND APPLICATIONS

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ABSTRACT

This analysis explores the concept of delight as it applies to the role of Information and Communication Technology's **(ICT)** in eliciting, sustaining and enhancing delight for customers. Delight, which is defined in the marketing literature as a non-linear increase over mere satisfaction, has been shown by researchers to produce greater customer loyalty and profitability to organizations that can provide it. ICT has experienced non-linear increases in processing power, storage capacity and telecommunications bandwidth, and these enhanced abilities provide a starting point for using ICT to delight customers. Two other concepts are added to extend the theory of delight, involvement—which addresses whether a product service or experience is relevant and meaningful to a consumer, and authenticity—which addresses whether a product, service or experience is real or fake, also moderate the degree of delight a customer experiences.   A nine part taxonomy for further research and potential applications for leveraging ICT to produce delight emerges from the analysis.

Keywords: Authenticity, Customer Relationship Management, Delight, Involvement, Outrage.

INTRODUCTION: THE EMERGENCE OF DELIGHT AS A FIELD Of STUDY

This analysis will examine the concept of delight and the role of Information and Communication Technology **(ICT)** in providing it. Delight is defined by marketing researchers as, "a mixture of joy and surprise," [3, p. 2], and "an emotional response that commits a customer to the product," [3, p. 2]. During the past four decades, ICT has experienced non-linear increases in processing power, storage capacity and telecommunications bandwidth, along with non-linear decreases in costs. These enhanced abilities provide a starting point for developing applications to delight customers. ICT has the potential to play a major role in helping organizations elicit, enhance, and sustain delight in their customers and be rewarded for it with their customers' attention, commitment and consumer dollars. A nine part taxonomy for providing delight and measuring its impacts is developed to guide ICT researchers and application developers of emerging technology.

Delight is distinct from mere satisfaction and is defined and measured differently [3]. Satisfaction is experienced cognitively and can be measured on linear, Likert-type scales that range from complete dissatisfaction to complete satisfaction. Providing satisfaction can be compared to fulfilling the terms of a contract. Research indicates however, that satisfied customers still often defect [10], challenging marketers to venture beyond mere satisfaction. Delight is defined in the marketing literature as a non-linear increase in satisfaction that is experienced emotionally, and produces unforgettable, rather than merely pleasant, internal states [3]. Individuals who have experienced delight frequently share what caused the experience with their peers, becoming "apostles."

At the other end of the spectrum, outrage, rather than mere dissatisfaction, is the opposite of delight. Outrage is a non-linear decrease in satisfaction, also usually accompanied by surprise. Outrage occurs when individuals, organizations or governments fail to provide even the basic satisfaction that their customers or stakeholders were lead to believe they could expect. Outrage produces alienated angry individuals who frequently vent their frustration to their peers, becoming "terrorists."

Marketing research has examined how to delight customers and avoid outraging them, the difference in the degree of loyalty between satisfied and delighted customers, whether delight requires continual surprise [13], and whether delight will result in customer commitment and long term profitability [3], [10], [13].

Two other concepts from the marketing disciplines of consumer behavior and psychology, *involvement,* and *authenticity* are introduced to extend the concept of delight. Involvement answers the question: Is this product, service or experience meaningful and relevant to me? Authenticity answers the question is the product, service or experience real or fake? Current research on these topics will also be examined to provide further insight into providing delight. Finally, theoretical perspectives from Customer Relationship Management **(CRM)** will contribute to the analysis.

THE ROLE OF ICT IN DELIGHT

ICT has experienced non-linear improvements in processing power, storage capacity and communications range and bandwidth since its inception. These improvements have allowed

massive increases in the amount of information that can be processed, stored, and transmitted. Non-linear decreases in costs have also occurred. Examples of ICT based innovations that have provided non-linear functional improvements over their predecessors include: 1) the Internet which has provided non-linear increases in the reach of telecommunication as well as non-linear increases in the richness of the information provided, 2) digital photography which has provided non-linear increases in picture quantity and quality through the use of high density storage devices and photo processing software, and 3) iPods and other portable music devices that provide non-linear increases in the amount of music stored and in the flexibility with which the music can be selected. The quick adoption and commercial success of these products are an indication that they produced non-linear increases in satisfaction in their users.

To provide suggestions and guidance for new innovations a nine part framework will categorize ways that ICT can provide non-linear increases in the quality of customers' lives, and assure the adoption and continued use of the technologies that provide them.

DELIGHT AND CONSUMER INVOLVEMENT

One challenge in providing delight is that it is more personal and emotional than satisfaction and that different people enjoy different things. Delight appears to be moderated by the degree of involvement a customer has in a product, service, or experience. Since delight *happens within the customer*, characteristics of the customer play a role in whether delight is experienced or not. *Involvement theory* from consumer behavior research contributes insight into how and when consumers will experience delight. A consumer's involvement with a product can be defined in terms of, "the degree of personal relevance that the product holds for the consumer. Under this definition, high involvement purchases are those that are very important to the consumer and thus provoke extensive information processing," [17, p. 186]. Andrews, Durvasula, and Akhter [2] define involvement as "an individual, internal state of arousal with intensity, direction, and persistence properties." High involvement endures over time so that even if a consumer is not planning an immediate purchase, they enjoy learning more about the product, service or experience, discussing it with others, and experiencing it virtually through magazines and web sites. The term "hedonic value" is used to refer to pleasurable experiences from high involvement goods even when immediate consumption is not involved. Retail outlets and Web sites for high involvement products provide hedonic value for users by engaging their thought processes and as many of their senses as possible [11].

Consumer behavior further distinguishes between *intrinsic involvement,* which occurs when an individual finds the product personally relevant, inherently meaningful, and enjoyable, and *situational involvement*, which occurs when an individual is in a risky situation such as making an expensive purchase, or facing a life threatening emergency [6]. *Low involvement* products tend to be commodities which consumers find neither fascinating nor risky.

DELIGHT AND AUTHENTICITY

Since delight is such a personal and emotional experience, providers of delight must also aim for *authenticity*, by making the product, service or experience as real and genuine as possible. "The consumer sensibility for authenticity evidences itself whenever informed individuals independently purchase any item with which they are personally involved," [8, p. 4].

Highly involved customers are both knowledgeable and emotionally attached to their product, service or experience. They become more discerning about their favorite goods over time and willing to pay a premium for high quality. On the other hand, if they are promised "the real thing," and do not get it, they are more likely than customers with low involvement to be able to spot a fraud and go beyond mere dissatisfaction to outrage. When jewelry claiming to be Tiffany was offered on Ebay, and discovered to be fake, customers were outraged. The challenge, then, is to provide high quality authentic products, services and experiences that customers will be willing to pay a premium for because of the extraordinary delight and personal fulfillment they provide. Providing delight requires providing a non-linear improvement over the individual's current baseline experience. Therefore, the customer's current state of satisfaction and expectations for what is likely to happen next is an important factor as to whether they will be delighted.

CUSTOMER RELATIONSHIP MANAGEMENT AND DELIGHT

Customer Relationship Management **(CRM)** is a field of ICT research that seeks to "create and maintain through the introduction of reliable systems, processes and procedures, lasting relationships with customers…to attract potential customers and create customer loyalty." Valachich and Snyder [18, p. 378]. CRM applications focus on: 1) *Widening* the customer base by attracting new customers, 2) *Lengthening* the relationship by keeping customers longer and 3) *Deepening* the relationship by transforming casual customers into major profitable ones.

THE DANGERS OF DELIGHTING THE WRONG CUSTOMERS

Mittal, Sarkees, and Murshed [15] caution organizations against acquiring too many high maintenance, low profitability customers and then being put in a position of "firing" them. Jones and Sasser caution [10, p 90], some customers just cannot be delighted and organizations must choose customers it can profitably serve:

> Having the wrong customers is the result of a flawed process for attracting or obtaining customers. The company that retains difficult to serve, chronically unhappy customers is making an expensive long-term mistake. Such customers will continually utilize a disproportionate amount of the company's resources, will hurt the morale of frontline employees, and will disparage the company to other potential customers. Managers should actively discourage such people or organizations from remaining customers and should do their best not to attract others like them.

Bertini, Wathieu, Sigman, and Norton [4, p. 140] also caution against the use of Social Couponing Web sites to attract customers, "No customer values an experience that is 50% off." They describe the users of couponing sites as:

> The worst kind of customers, ones with no loyalty. They are like a flash mob of coupon clippers. They overburden merchants, create shortages, annoy the staff and erode the experience for other customers.

Therefore, targeting customers who can afford the product, service or experience and who will appreciate and reward extraordinary efforts to delight them by delight providers, appears an essential part of a profitable strategy based on delight.

A NINE PART TAXONOMY OF DELIGHT

The following nine part model elaborates how ICT can be used to delight customers and suggests ways for measuring delight and its impacts on delight providers.

SIMULATIONS GIVE PEOPLE A TASTE OF DELIGHT

ICT can give individuals an initial exposure via simulated experiences for involving but potentially risky experiences to let an individual see if they worth pursuing in reality. Individuals can practice flying an airplane, performing surgery, engaging in combat, or piloting a ship, without the fear of real world repercussions for failures. These simulations can be used for serious professional training or entertainment.

TRANSFORMATIONS GET PEOPLE INVOLVED

On the most profound level, organizations can provide customers with a new experience they have never had before that delights them, gets them involved, and makes them willing to pay for even more fulfilling experiences. As comedian George Carlin said, "We don't experience déjà vu, but vu ja de- those rare moments when we have the uncanny sense that what we are experiencing has never happened before," [5, p. 84]. Gilmore and Pine II [8] call this experience a *transformation*, they consider it the highest form of authentic experience and liken it to a religious conversion:—"Calling human beings to a higher goal and providing a foretaste of a better way," [8, p.50]. Examples include: 1) hearing Bach for the first time and deciding to become a classical musician or music enthusiast, 2) going to a baseball game and deciding to become a baseball player or fan, or 3) discovering a new favorite author or artist.

THE LONG TAIL

Once customers have developed a high degree of involvement in a particular type of product, service, or experience, organizations can provide more of it, and ICT can help through CRM software, search engines and databases. This phenomenon is known in the ICT literature as "The Long Tail" [1] where individuals can explore beyond the "Top Ten" in their areas of high involvement. Although there is some disagreement as to the degree of demand that can be generated for more obscure products, marketing analysts agree that once consumer involvement has been generated for a category of products, services, or experiences, the long tail can help provide more examples of what will delight. For example, if a movie buff loves Akira Kurasowa's masterpieces like "The Seven Samurai," "Iruku", and "Roshoman," they will be happy to learn that he made more than a dozen other excellent movies, many with the same cast members, dramatic themes, and stunning photography of his best known works.

IMMERSING CUSTOMERS IN DELIGHT WITH CONTENT ANYTIME, ANYWHERE

Not only can IT provide rich information on almost any subject, it can now deliver it almost anytime and anywhere. Prior to the evolution of the Internet, organizations had to choose between providing *information range*, sending simple messages to large audiences, and *information richness,* sending information intensive messages to a few individuals at a time. The Internet has allowed non-linear increases in information richness to be distributed to large numbers of people. High definition TV allows users to experience travel and sports in a more visceral way. Advances in wireless technology have made information rich experiences possible across the globe.

ENHANCING CREATIVE PERFORMANCE

Once individuals develop a high degree of involvement in an experience as a spectator or consumer, they often wish to perform or practice it in reality. ICT can enhance their performance. Photoshop does for photographers what anabolic steroids do for athletes, only it is safe and legal. The software allows photographers to transcend the physical limitations under which the photograph was taken and create a more idyllic version of the scene they envisioned. The experience of creative fulfillment is worth the relatively high cost of the software and high learning curve of -- if someone is highly involved in photography.

SOCIAL NETWORKING TO SHARE DELIGHT

The Internet can provide a forum for enthusiasts to share their delight (and outrage) over recent developments in favorite subjects. Social networking sites allow opinion leaders to broadcast their reviews of new products. These subjects range from lightweight topics like sports, fashion and celebrity gossip, to serious subjects like individuals maintaining and preserving their culture after disasters like Hurricane Katrina and the wars in Afghanistan [12]. Marketers are currently researching methods for using these sites to generate enthusiasm and sales for related products.

AVOIDING OUTRAGE—SUPPORT HIGH SITUATIONAL INVOLVEMENT DECISIONS

Another way to achieve a non-linear increase in satisfaction is to greatly improve the availability and quality of information available when making a major purchase such as a house or car. Information providers can decrease the *information asymmetry* (the seller knows more than the buyer and uses the buyer's enforced ignorance to command a higher than market price) that buyers are often subjected to when making important decisions. As a result, buyers are better informed, make better quality decisions, and can avoid outrage later. An example is a potential buyer paying $300 for a house inspector who discovers major leaks in the basement and who then uses his report to take an additional $30,000 off the price of the house.

AVOIDING ENNUI:—ELIMINATE THE BORING AND MUNDANE

Even in situations that are low involvement, ICT can provide delight. Systems that automate routine transactions can minimize the costs of time and money spent doing unfulfilling tasks, allowing individuals to get back to what delights them. An example is being able to renew automobile registration online. Compared to a baseline experience of standing online for two hours at the Department of Motor Vehicles (or even sitting there), spending five minutes on a website and completing the process, is a non-linear improvement. A photographer can then get back to creating beautiful images with Photoshop and provide themselves and others with delight.

ENTERTAIN

Finally, ICT can also provide entertainment to fill life's empty spaces. Airports provide generic entertainment such as popular music, news, or light comedy programs. But mere entertainment may sometimes hint seductively at new forms of delight. An example is waiting to watch a summer blockbuster movie, suddenly hearing Andrea Bocelli's voice over the speakers, finding oneself weeping into one's popcorn, and rushing home to buy everything he ever recorded on Amazon, putting it on your iPod to listen to in your car, and transforming the experience of sitting in a traffic jam to one of transcendent beauty.

ICT AND THE EVER RISING BAR OF DELIGHT

ICT has both delighted and outraged us, and become a major part of individuals' and organizations' lives and budgets. Evidence of delight is provided when new technologies such as PCs, the World Wide Web, and iPods are embraced, purchased and used so widely they quickly become ubiquitous. Time and money is spent acquiring and learning the technology to achieve the delight. Technologies that delight rapidly replace their predecessors.

But developers must face the "dilemma of delight"—that the bar constantly rises, that delight becomes the new satisfaction, and that consumers will just keep expecting more. As Marcel Proust wrote in 1907 about the telephone [7, p. 101], "A supernatural instrument before whose miracle we used to stand amazed, and which we now employ without giving it a thought, to summon our tailor or to order and ice cream."

However if, like Apple, organizations attune themselves to their customers' desires, promise them that they will never stop innovating, never stop trying to find new ways of using technology to make their customer's lives more fulfilling, they will earn their attention and keep them coming back to see what new things they have done. Just as Disney never stops trying to make its parks better a continued stated commitment to enhancing the quality of life of customers, can earn their continued attention and respect.

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(Research Proposal)

IT PROFESSIONALS' TIME MANAGEMENT STRATEGIES FOR VALUE-ADDED KNOWLEDGE CREATION IN PROJECTS

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ABSTRACT

This research will explore the connections between knowledge management and project management, with a specific focus on how time management impacts this connection. We aim to investigate how IT professionals utilize time management strategies to be more productive when working on projects. Projects are often broken down into smaller manageable pieces associated with milestones that require learning, knowledge creation and knowledge capture throughout different project phases. Adopting a knowledge-based perspective on time management will enable an in-depth understanding of how IT professionals manage knowledge to create operational efficiencies in the project they execute.

Keywords: knowledge creation, project, project management, knowledge management, time strategies

Introduction

As the most precious asset of an organization, time has long been a key resource to plan, measure and evaluate project performance, such as project deadlines, milestones and project goals. However, a project success can also be measured by the amount of new knowledge and learning that it generates (or preserves) rather than simply by its product/service outcomes (Reich et al., 2008). Indeed, effective knowledge creation may be the most important project output for any business operating in a highly competitive environment. Organizational knowledge is difficult to replicate and is a driver of long-term competitive advantages. We explore the connections between knowledge management and project management, with a specific focus on how time management impacts this connection.

Research Project Goals & Background

The proposed research investigates whether IT professionals' time management strategies effectively foster value-added knowledge creation in projects. Extant research highlights that project knowledge losses occur at multiple project phases (Reich et al., 2008) thus missing opportunities for competitive differentiation through learning, knowledge creation and capture (Nonaka, 1994; Nonaka & Takeuchi, 1995). Adopting a knowledge-based perspective on time management will enable mapping how often IT professionals capture, store, transfer and apply knowledge during project execution. This mapping process could reveal inefficiencies and thus open a debate for improvement. We focus on the following research questions:

Research Question 1: What types of time management strategies do IT professionals employ when working on projects?
Research Question 2: Do IT professionals' time management strategies contribute to knowledge creation, storage, transfer and application in projects?
Research Question 3: What types of time management approaches contribute to value-added knowledge construction in projects?

We have completed a preliminary research at two US academic institutions through interviewing and observing time management activities with 40 knowledge workers including staff, faculty and administrators. Even in contexts where knowledge creation is part of the organizational mission and employees are rather flexible in self-determining project goals and deadlines, the majority of the time is spent on knowledge application and executing tasks, rather than on creating and capturing new knowledge. In a US research institution, over fifty percent of individual's time is about "doing" rather than reflection and idea generation. What would the percentage be for organizations faced by delivering challenges and creeping client-needs? Paying attention to time management with the objectives of increasing knowledge creation makes this research valuable to both theory and practice.

Brief Literature Review

The connections between time management and project management are relatively well-grounded in the core aspects of the project management discipline. The definition of a "project"

itself embeds the notion of time, with a project being a temporary endeavor that presupposes a beginning and an end (PMBOK, 2008). Time management is crucial to execute various project activities, and actively engages actors. These actors exhibit various temporal perceptions (e.g., different experiences on the speed of time passing) and temporal personality (e.g., different time urgency orientation) that impact the planning, execution and coordination of various project activities (Waller et al., 2001). Understanding how the temporal perceptions shape individual and project activities is essential to increasing the efficiency and the effectiveness of projects (Blount & Janicik, 2001). Thoms and Pinto (1999) closely link the notion of project leadership to individual temporal perceptions and argue that the alignment between project needs and individual temporal perceptions may lead to better project outcomes.

The connections between project management and knowledge management also deserve further investigation. Reich et al. (2008) assert the urgency of adopting a knowledge-based perspective in project management because lack of attention to new learning leads to knowledge-loss at multiple phases of a project. The failure points (or knowledge loss points) could be, for example, the inability to use lessons learned as part of the project inputs; and/or incomplete knowledge integration and transfer in the planning stages of the project, including knowledge dissipation among project phases due to volatility and turnover among the governance team and project team members (Grundspenkis, 2007). Such losses are also affected by a temporal dimension. Reich et al. (2008) use a mapping technique with a focus on temporal states, e.g., project initiation (past resources focus), execution (present), and outputs (future products and learning achieved). While their model connects project performance with project learning based on knowledge creation processes, they call for further research in this area. By linking time management, project management and knowledge management practices, this research tries to address such a call.

Proposed Research Design and Methodology

We will use an interpretive approach based on qualitative data collection. Semi-structured interviews and field observations will be conducted in business organizations. We plan to interview and observe a sample of forty IT professionals working in information technology enterprises, and their time management strategies will also be compared with the forty knowledge workers we have interviewed at academic institutions. The interviewees will be selected through collaboration with IT organizations in the East and West of the United States. The authors have been involved with these organizations in multiple ways, and will be able to reach out to their membership to solicit study participation. The interviews will focus on recording self-reported descriptions of time management practices in projects. The observations will center on validating the individual self-reports as well as identifying patterns and decision making processes in action.

Preliminary Data Analysis Plan

To analyze the data collected, we plan to conduct an in-depth coding analysis based on Alavi and Leidner (1999 & 2001)'s knowledge management taxonomies which help stratify activities based on type (e.g., explicit, tacit), actors, knowledge creation processes, and purpose/use of time categories. Four independent coders (the researchers and two research assistants) will classify the interview data and assess the outcomes. Cohen's Kappa analysis (Kraemer, 1982) will be run to

examine the inter-coder reliability. Field observation notes will be extracted to further interpret the interview findings. Individual time management profiles will be identified to describe examples of successful models and practices.

Current Status of This Study

Based on literature review we have done so far, we are currently designing our research instruments for this proposed research. By the time we present this work at NEDSI 2013, we would expect to have some preliminary data results ready to share with the conference participants.

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ROLE OF INTEREPENDENCE, SOCIAL INTEGRATION & BEHAVIORAL INTEGRATION IN SHAPING SOFTWARE DEVELOPMENT PROCESS

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Introduction

As organizations seek to improve software development process and performance, it becomes important to analyze some of the non-technical and behavioral aspects of the process. Prior research has examined some of the major problems in the software development process including coordination (Kraut and Streeter, 1995), interdependence (Symon, 1998), communication (Krasner et al, 1987), knowledge acquisition and integration (Walz et al., 1993), organizational structure and training (Rasch and Tosi, 1992), power and control (Henderson and Lee, 1992), and conflict (Sawyer, 2001). Research into these areas provides evidence of the intricate and complex nature of software development and the role of group dynamics. The complexity of software development makes it more susceptible to failure, for example almost 68 percent of all software projects fail in the United States accounting for a loss of over $60 billion dollars (McCafferty, 2010). While much of the failure is attributed to factors beyond the software development team, e.g. lack of user involvement, poor requirements, unrealistic expectations, lack of executive support, and poor testing, much of the theoretical insight has not examined relationships and social interactions of the developers.

Aladwani (2002) explored the question of the impact of social integration in the software development process and found reasonable evidence suggesting the positive relationship between social integration and software development performance. Social integration, a sense of being bound together, has been shown to be a significant determinant of work performance outcomes, including higher involvement, lower absenteeism, lower conflict, higher coordination, and higher job satisfaction (Shaw, 1981; McGrath, 1984). While social integration was shown to have a positive effect on software performance, Aladwani (2002) only focused on two support strategies, i.e. integration rewards and integration training. These two indicators may not be sufficient to fully understand the importance of social integration; furthermore, social integration may not be sufficient to fully predict success software development process.

A critical aspect of social integration is cohesion construct and was expanded to factors including attraction to the group, satisfaction with the group, and social interaction among the group (O'Reilly et al., 1989). However the inclusion of the cohesion construct is problematic in that increased cohesion in any form has not always been found to lead to successful outcomes (Janis, 1972). Also, task-related processes must also be relevant in examining the role of social interaction among developers (Schweiger, Sandberg, & Rechner, 1989). Combining task related processes with social

integration provides the foundation for behavioral integration, which combines one social dimension and two task dimensions (Hambrick, 1994). In addition, software developers rarely work in isolation. There may be various levels of interdependence between the developers. Thus, understanding social interactions among developers and examining its role in software project performance will likely benefit by exploring the nature of social integration, behavioral integration, and interdependence. This leads us to the research question: *"How does interdependence shape social and behavioral integration in software development?"* To address this question, we conduct a qualitative study.

Theoretical Background
Interdependence

The essence of interdependence theory relies on the notion that group members are made interdependent through the establishment and achievement of goals (Johnson and Johnson, 2005). Interdependence theory analyzes how the structure of the goals of participants in a situation determines how they interact and the patterns of interaction determine the situational outcomes (Deutsch, 1949a, Johnson and Johnson, 2005). These goal structures specify the type of interdependence toward individual and collective goals, and through this interaction they can promote or obstruct the goals of others (Johnson and Johnson, 2005).

In a software development environment, goal clarity was found to be a positive significant predictor of performance for software development as was individual characteristics such as effort, ability and locus of control (Rasche and Tossi, 1992). The latter factor, locus of control, i.e. the level of perceived control an individual possesses, was shown specifically to be a significant positive predictor of performance. Antecedents of interdependence include a variety of attributes, such as technology attributes, task requirements, environmental uncertainty, roles and responsibilities, skills of individuals, goal definition and achievement, performance rewards and feedback (Van der Vegt and Van de Vliert, 2001). These antecedents allow for interdependence to be structured as, task interdependence, which represents the structural and interactive nature of actions, and goal interdependence, which defines the related outcomes (Van der Vegt and Van de Vliert, 2001).

Even defining a structure of interdependence in this manner is limiting because much of the work in interdependence fails to fully integrate the situational context, nature of interaction, and the complex nature of participants engaged in the interdependent activity (Johnson and Johnson, 2005). The use of a situational structure aids in understanding the specific interpersonal reality that social cognitive activity is about, i.e. allowing for dimensional analysis of the social situations in which these interactions occur (Rusbult and VanLange, 2002). This situation structure enables a deeper understanding of the situations or the specific problems and opportunities presented, and the person with whom the interaction occurs and their goals and motives (Rusbult and VanLange, 2002). Furthermore, due to the dynamic nature of the interdependence structure, the structure must specify the present reality of the situation and historical perspectives of interaction (Rusbult and VanLange, 2002).

There are a number of attributes that help classify interdependence structure for software developers. First, software developers' *level of dependence'* may vary in the perception of the degree to which they rely on another developer or stakeholder. A

developer named John may have a higher degree of dependence on Mary if she can cause "pleasure or pain" (Rusbult and VanLange, 2002) toward John, and if she has more control over her actions. If Mary can unilaterally dismiss John's contributions or rate the contributions of John, then she would exhibit a lower level of dependence on John, while John would exhibit a higher level of dependence on Mary.

Mutuality of dependence describes the degree to which two people are equally dependent on one another (Rusbult and VanLange, 2002). When workers posses a high degree of mutual dependence, the results are the benefits achieved from a balance of power, reduction of the threats and coercion and less reliance on norms and contracts leading to higher stability and positive work satisfaction (Rusbult and VanLange, 2002). Control theory states that controls are created to align the divergent interests of a controller and controlee, and such controls are used to counter opportunistic behavior by the controlee and that these controls can be formal or informal (Tiwana and Keil, 2010). When a team exhibits high mutuality of dependence, informal controls might be prevalent.

Basis of dependence describes how partner's outcomes affect another partner's outcome, i.e. dependence derived from partner's outcomes. There are two types of control that are found in the basis of dependence, partner control and joint control (Rusbult and VanLange, 2002). Assume that Mary's outcomes are reliant on John's code, as might be the case in an outsourced component or service, the performance and output of the dependent service could be considered a partner control, because the outcome of John's service has a direct and considerable impact on Mary's outcomes. Whereas if Mary and John are working more closely, and each of their outcomes are inextricably tied together, as might be the case if they are jointly responsible for the service development, then their collective responsibility for a successful outcome is joined.

Covariation of interests describes the degree to which partners' outcomes correspond (Rusbult and VanLange, 2002). When John's activities in developing a software service benefit Mary in a similar manner, then their outcomes are considered to be perfectly corresponding. A high degree of covariation helps to define the interaction between the participants based on predispositions to help them ascertain whether a current situation is good or bad. Conversely, when situations with conflicting interests occur, e.g. when John's activities are perfectly conflicting with Mary's, the situation activates emotions such as greed and fear, and thus Mary might examine the situation questioning whether the situation is competitive or cooperative.

Finally, *information sharing* between software developers can greatly impact the level and nature of interaction (Rusbult and VanLange, 2002). Incomplete information can create an environment of uncertainty and misunderstanding, leading to interaction difficulties (Kelley et al. 2002). In the presence of incomplete information, participants may be unable to effectively interact with others on their team. Software developers might be unable to determine outcomes for combinations of behavior. Further, incomplete information may hinder one's ability to determine others goals and motives.

In summary, interdependence theory could be used to provide a theoretical foundation for understanding the combination of social interaction among developers as well as the task-oriented nature. The goal is to understand how the role of each of the dimensions plays an important part in the interactions among software developers which could be further used to explore outcomes.

Social Integration

Software development functions are complex and require a significant amount of coordination among key stakeholders. Software development methodologies such as agile aim to mitigate the risks of complex projects by focusing on 1) collaborative and empowered teams unfettered by rigorous processes, 2) simplicity of design and minimal critical specifications, 3) active involvement of, preferably, co-located customers, and 4) focusing on understanding that change is inevitable ad may be leveraged through rapid iterations, feedback, and constant reflection on the consequences of actions (Cockburn 2002; Highsmith and Cockburn 2001). Agile methodologies are therefore heavily reliant on the collaboration and the effectiveness of teams to organize and prioritize and execute as a unit with a common goal (Cockburn 2002). Thus, social aspects play a role in how software development teams interact and perform. Aladwani (2002) posited that social integration could play a significant role in predicting successful outcomes.

Social integration focuses on the emotional perception of the bond between workers, in this case developers and stakeholders. Aladwani (2002) found support for the premise that higher levels of social integration in software teams yield better outcomes; however, it was contingent upon level of system complexity. As noted in the prior section, interdependence may play a factor in assessing the effectiveness of social integration on performance; however, it is clear that social integration does play role in projects that require higher levels of communication, coordination and collaboration between project members (Tait & Vessey, 1988; Kraut & Streeter, 1995).

Behavioral Integration

While social integration appears to have a positive impact on software development process (Aladwani, 2002), it may not explain the entire story. Social integration focuses on the psychological affective aspects such as feelings and emotions toward other members of the software development team, thus, positive emotions toward other members of the team lead to increased communication and collaboration. Behavioral integration, on the other hand, may provide additional insight into collaboration of software developers. Software developers may exchange information in many different ways and formats (Herschieb, 2003). In addition, various control mechanisms are put in place, which can either be formal, such as written documentation and processes, or informal, such as expected norms and behaviors of the group. Finally, decision-making represents a critical group activity of software development. Behavioral integration, i.e. the degree to which the group engages in mutual and collective interaction (Hambrick, 1994), focuses on the quality and quantity of the information exchanged and the collaborative nature of the group. Understanding the role of behavioral integration may provide us a more well-rounded understanding of the interactions among developers.

Specifically, software development teams are considered to have high behavioral integration if they provide information in a timely fashion and are open with positive and negative information (Berg et al., 1982; Faraj and Sproull, 2000). Under an "open" style of communication and collaboration teams are able to identify the right resources, obtain the necessary information for decision-making and collaborate more effectively with team members (Magni et al., 2009). Software development teams are normally faced

with unexpected challenges and dilemmas (Grudin, 1994). Teams characterized by high levels of behavioral integration are able to adapt more quickly to these situations and quickly coordinate responses to crises especially in highly interdependent teams with high levels of uncertainty (Magni et al., 2009).

In summary, we argue that the six dimensions of interdependence can help gain insights into social interactions processes in software development projects by examining the role of social and behavioral integration. With the exception of Aladwani (2002), the complex set of structures that include behavioral integration and interdependence in this context has been largely unexplored. A richer understanding of how software developers on a team interact will help us understand the relationship between such interactions and outcomes.

This study examines interdependence across a multi-dimensional structure proposed by Rusbult and VanLange (2002). The result should yield a framework for future researchers to examine more closely the interaction; communication and collaboration in software development teams examine the benefits of this interdependence in terms of outcomes.

Research Methodology

Examining the interdependence dimensions and software development project outcomes requires an exploratory approach such as a case study (Yin, 2003), due to the lack of a framework surrounding these dimensions. The case study approach allows researchers to examine to complex constructs and problems more broadly and develop richer conclusions that are more informative and robust. Yin (2003) defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident."

Studying interdependence and the relationship between software developers and outcomes, are not clearly evident and thus it is believed that this phenomenon meets the aforementioned criteria. Furthermore, extensive theoretical review has been used as a guide to analyze the rich data collected in the case. These elements of prior theory are considered helpful in targeting the research efforts (Pare, 2004). Finally, these initial dimensions postulated above will allow the exploration of possible new constructs that may emerge as the data is collected and analyzed (Eisenhardt, 1989).

Site Selection

We selected a software development project in a healthcare organization as our focal case study site. The project is an ongoing study of healthcare information technology practices. The study is based on a development team from a mid-sized hospital in the US, affiliated with a major university. Our informants are from a team responsible for the development and implementation of clinical systems for the hospital including but not limited to the Electronic Health Record (EHR) system. The team consists of registered nurses or physical therapists, programmers both consultants and in house, as well as other members of information technology responsible for hardware, networking and security (Figure 1 summarizes the structure of the team).

Primarily, the focus of the study was to interview members of the team to discuss the numerous projects currently in progress that are part of the EHR system and the

federal requirement of meeting the regulatory requirements known as 'meaningful use'. 'Meaningful use' describes the level of compliance of EHR implementation as mandated by American Recovery and Reinvestment Act passed by congress in 2009. One of the provisions of this bill provides $19B of incentives over a five-year period beginning in 2011 for hospitals and providers implementing EHR systems that meet the stated requirements under the 'meaningful use' provision. Our interviews focused on examining the social interaction processes in the team to gain insights into the various dimensions of interdependence in the team, and the social and behavior integration of team members.
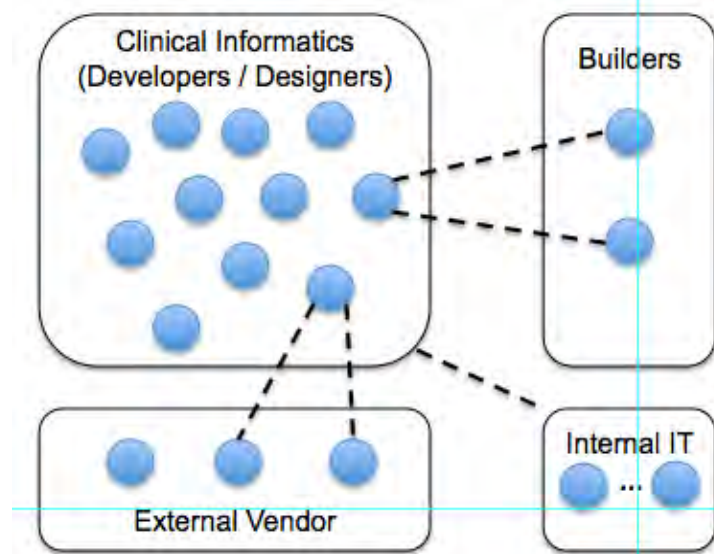
Figure 1: Structure of Organization

Data Collection

        Qualitative data are being collected at the hospital through semi-structured interviews with informants. Data collection is ongoing and will proceed for the next several months. Data collection and analysis will proceed in a progressively iterative fashion. The first set of discussions, which were not recorded, simply identified the personnel who would be best suited to respond to questions regarding how the teams interacted with each other. We followed snow-ball sampling in that key members of the team helped identify participants who were intricately involved in the development of the EHR system. These participants through their interviews also identified additional participants. Interviews focused on the nature of interaction between participants (please see Appendix for an excerpt of the interview protocol). Each interview lasted approximately one hour and was recorded and then transcribed. While the interview was being performed, the interviewer also wrote down specific notes and later checked them with the recording.

        Each participant had worked on at least one project for the hospital that involved more than three members. Projects that involved three team members or more were chosen so that the teams provide adequate opportunities to examine social interaction which might be difficult and different from those in a dyad as opposed to those in larger teams. Data will be collected till theoretical saturation is reached in that data collection will proceed till no new additional insights are provided by new data collected.

Additional data in the form of documentation and communications among team members will also be examined to enable triangulation.

Data Analysis

The primary data for the study consists of the interview transcripts. Preliminary coding involved aligning the dimensions of interdependence identified from the literature review to themes observed from our interviews. Identifiers were placed on the transcripts to identify which dimensions may have been referenced. Additionally, items that were considered part of social integration and behavioral integration were also identified. One researcher analyzed the transcripts in detail. Concepts identified will be debated with the 2nd researcher till consensus is reached. Data analysis will continue using open, selective, and axial coding recommended by Strauss and Corbin (1990).

No attempt was made to statistically evaluate the strength of concepts in the framework (Strauss and Corbin 1990). It is hoped that with further interviews, theoretical relevance of concepts will be achieved by repeated presence or notable absence of concepts when comparing statements by team members (Strauss and Corbin 1990). These statements can be used to help provide an explanation of the results (Eisenhardt 1989, Orlikowski 1993) through analytic generalization (Yin, 2003).

Findings

We organize our findings into the following categories consistent with those identified by Orlikowski (1993): Environmental context, organizational context, and IS project context. We then connect these to social and behavioral integration, and various dimensions of interdependence. The following sections present our preliminary analysis of the data. These findings will be refined further based on ongoing data collection and analysis.

Context 1: Environmental context

Much of the work conducted in this organization revolves around three environmental factors. First, each interview stressed the importance of patients in their work, and the importance of the patient as a driving force. Second, government regulation plays an important role in driving activities for the organization, and finally, technology impacts the quality of care for patients and the implementation of technology is regulated by policies.

> *"One of our driving forces for implementing this application and process was meaningful use. ...The driving force is when those measures had to be met. So our timeline was based on those requirements." - Clinical Informatics 2*

Context 2: Organizational context

The organizational strategy is driven by executive management's directive to provide the highest quality care and the regulations imposed on it by state and local governments. In addition, the structure and leadership appears to have been created to meet these goals, and therefore, the structure has to have been created to support the overall strategy, i.e. the structure is driven to support the quality of patient care, which may run contrary to generally accepted best-practices in IT.

"Team members include myself, my boss and other nursing informatics people, we are the 'developers' and 'designers' of this documentation [module]. The rest of the team aren't clinical and those people are our 'builders' and then [there is] our 'IT people'" - Clinical Informatics 1

Context 3: IS Project Context
The organization has dispersed its IS activities among three different and distinct groups each with a different level of technical expertise, domain expertise and responsibility. These different groups, while working toward the same goal, do not necessarily interact at optimum levels. Furthermore, each of the groups has a different set of operations and a different set of policies and procedures, if they exist for the group.

"We do the spreadsheet, and specifications. I list all of the documentation items on the spreadsheet, status... But once again the spreadsheet is out there, [and] I need feedback, and it's still not done [by the other group]. I remember manager X telling them to fill in the spreadsheet but nothing is done. There are no consequences, so it doesn't matter." - Clinical Informatics 1

Our findings provide insights on how the group interacts with each other and the role of various interdependence dimensions in shaping social and behavioral integration prcoesses.

Social Integration & Behavioral Integration
The group recognizes the reliance of each other on delivering a successful product. Each member realizes the significance of the project to the hospital and the importance of delivering it in a timely manner, and thus there is an alignment of activities, which are coordinated to achieve a defined goal, i.e., completion of the project. Overall the department shares the same goal of delivering a quality product, however, there is a discrepancy in the emotions of group members.

"I think we do all share the same goal, but not with the same intensity. One of the words we use is a sense of urgency. What we are developing is to take care of patients. When the IT team suggests things otherwise or workarounds because they don't want to do something, we can't compromise in that and that's where we get into some contention at times." - Clinical Informatics 1

This lack of a shared intensity leads to increased contention between groups of different departments. The interviews indicated that conflicts begin to emerge between the groups directly related to the purpose of stated goals; however, such conflicts are relegated to between group interactions and not within group interactions.

"Groups form when problems arise. It's kind of like us [Clinical Informatics] versus them [Builders and IT]; [however] we are all relatively collegial... They don't understand from our point of view. They don't want to go back and rework things. One of the builders said once 'When I am done with project, I want to be done with it'. I said to another manager ... [the builder] shouldn't work in healthcare. " - Clinical Informatics 1

"[In one conflict] we have an interface error that has nothing to do with the [core system]. Sometimes, it involves a workflow issue with a user sometimes not. A user enters more than one set of vital signs for a patient and depending on how they time it, one set of vitals may get stored and the other rejected by the interface. When we brought this up in our meeting, and we said that there was a need to amend the patient profile. This is what the medical records department recommended; nursing said 'absolutely not'. We kind of agreed it's a cumbersome process and a lot to expect of the user and it's not their fault this is happening...Ultimately if we can't work it out ... it will be the Chief Medical Information Officer's call as to what the expectation is." - Clinical Informatics 2

While there is a shared goal and a shared task/process, i.e. the completion of the project and the process to deliver the system, the 'urgency' differs and as such increased conflict can arise. It can be seen that although three groups work very closely together and their outcome is tied, the clinical informatics group is more tightly integrated.

Engagement in mutual and collective interaction is the essence of behavioral integration. By examining the process and interactions between various members we find the level of behavioral integration may also linked to levels of interdependence.

> *"As far as cooperation, we started with a documentation [module] pilot in February, and leading up to that it was a horrendous time of non communication and bad interactions. So we have this project going, which is a continuation of this project. Where as I would email things to the guys and put stuff on the spreadsheet and never hear anything back from them, and then I would hear later on the next week that one of them happened to respond to me, 'I did that and its in Test', well how am I supposed to know that? I have a billion things on my plate; so we sat down with a manager and I said 'I can't work this way. If I am going to continue, things have to change'. As a senior leader, things are better, [but] we still have issues they still don't respond to emails in a timely manner." - Clinical Informatics 1*

Beyond the development work for the developers/designers and builders, there exists a set of activities around keeping information current in a knowledge repository. This information is a critical means to communicate project status and updates; however interactions through the repository differ between groups. Further, the different interests and integration levels between groups could influence different preferences in communication methods.

> *"The manager supposedly spoke to the builders. This is how you will communicate and this is how it will work from now on. But once again the spreadsheet is out there I need feedback, and it's still not done. I remember them [being told] to fill in the spreadsheet but nothing is done. There is no consequences so it doesn't matter." - Clinical Informatics 1*

> *"Actually I wasn't on Instant Messaging, the builders said this as a good way to communicate for us to communicate quickly. The only thing I don't like about it is that it doesn't record a history and that bothers me. They like it." - Clinical Informatics 1*

Mutual respect among team members and the trust and support they seek from each other were critical enablers of social and behavioral integration in the team.

> *"Most of the projects we work pretty collegially, most of them. Having the [builders] guys on site every other week [helps]. Our builders meeting, our change control meeting. Everything like that is very positive. We got better with each project. The way my team [Clinical Informatics]...we all pull together when we need to pull together. That is very positive here...Because we are all nurses, and a PA. We respect each other,[and] we know each other. No one feels like I have more work than anyone else. They way my team pulls together for support is really good." - Clinical Informatics 1*

Even when the parties are not necessarily bound together socially, behavioral integration and extrinsic benefits may become a source of dependency. On another project the vendor and client relationship affect the levels of integration toward a common solution that benefited both parties.

> *"I would have to say our collaboration, bringing the cart [that collects vitals at the patients bed] to a point where we feel its acceptable was very positive. We basically worked with IT, nursing and the vendor; they've been on site taking pictures, and we had a suggestion to make the carts better, we brainstormed things to make it better, such as the location of a reel cord that was*

causing the cords to wrap up around the cart causing the pins of the cables to bend. We went through so many revisions, collaborating between nursing, IT and the vendor and they came up with a solution and have a version of the product they sell, and they admitted they are selling a lot more carts after they implemented the changes we recommended. We are at a point where we like the cart; it's been a positive collaboration." - Clinical Informatics 2

Dimensions of interdependence

Teams that have a high level of dependence experience a higher perception of the degree to which they rely on other developers or team members. In this case, there may be a higher level of dependence within the clinical informatics group than between other groups.

> *"We all cooperate together, but on that side [builders]...there is a feeling that 'we are doing all the work, and all you have to do is develop' and we do [build] the code." - Clinical Informatics 1*

> *"In general, our department [Clinical Informatics] we have do not have very formal interaction. It's more casual." - Clinical Informatics 2*

The basis of the dependence can be found in the perceptions of the goals described. While the goal may be the same, completion of the project, this may be an antecedent for a higher order intrinsic goal. The focus on and different perceptions of intrinsic goals played a critical role. For example, the clinical informatics team viewed the project as vital to patient quality, because of their background as nurses, or clinicians; whereas, the builders' intrinsic rewards were not aligned with a focus on completion of the project.

> *"I don't think the builders sense the urgency like clinical informatics because we are all nurses and a physicians assistant; we are used to dealing with patient situations where things have changed [quickly]... We have had many times builders say in meetings, 'why would we do it that way. It doesn't make any sense'. It doesn't make sense to you because you want to go home. It is a patient safety feature." - Clinical Informatics 1*

> *"Within the group [Clinical Informatics], everyone contributes. In the very initial stages of our implementation we had from the IT perspective a project leader that was leading the interface component. He accessed the share drive. Now that things are established there is no need [for his involvement." - Clinical Informatics 2*

> *"We collectively [with the builders] share the reward. I'm not sure if they feel the same way" - Clinical Informatics 1*

The importance of information between the parties involved also provides some insight into the use of the collaborative nature of software development outcomes. Incomplete information between parties decreases the efficiency by which team members can operate. The establishment of the share drive and the contributions are indicative of higher levels of dependence based on this dimension.

> *"Clinical informatics, we contribute, builders don't. It's important because we have so much going on. We really have a small department, and a very important way for us to keep track of everything going on in any given project." - Clinical Informatics 1*

"Mostly its clinical informatics that adds items to the share drive. Because we are the ones who for the most part, the information pertains to...They [other groups] don't see a need to access the share drive... within our group, everyone contributes...[The spreadsheets are] up to date and we have a project status sheet that has different components...[including] our pending rollout, status, distributed, pending distribution, purchase orders have been sent out. It is up to date."-Clinical Informatics 2

"When I first started here there was no communication. In the last couple of years we started doing more in project management, but now we are doing more with spreadsheets. We have a spreadsheet that I develop and maintain. There are a lot of questions that come from the spreadsheet... Any of the work that is done completed or testing has to be on that spreadsheet." - Clinical Informatics 1

The contributions to the shared workspace for documenting knowledge required for the project appeared to come primarily from the same group - clinical informatics. The uniform nature of the contributions and the importance of the contributions indicate an imbalance in the knowledge contributions by various members of the team playing different roles. Despite the disparity in contributions, members viewed the knowledge in the repository as of reasonable quality.

"Its up to date and we have ... our pending rollout, status, distributed, pending distribution, purchase orders have been sent out. I would say a 9 [out of 10 on accuracy]. Its usually pretty updated" - Clinical Informatics 2

"[I am] somewhat confident, 6 out of 10. The reason is because I have never been to project management school. I was a nursing manager for 11 years. I manage project very well, but the forms, the spreadsheet, I am not well versed in that. I am doing things to keep track and I am sure I could be doing it better. Only project related information is in the repository." - Clinical Informatics 1.

In summary, our findings indicate an interesting interplay between the various contextual elements, different nuanced variations in integration processes, and changes in dimensions of interdependence. Figure 2 summarizes the above findings in a preliminary research framework.
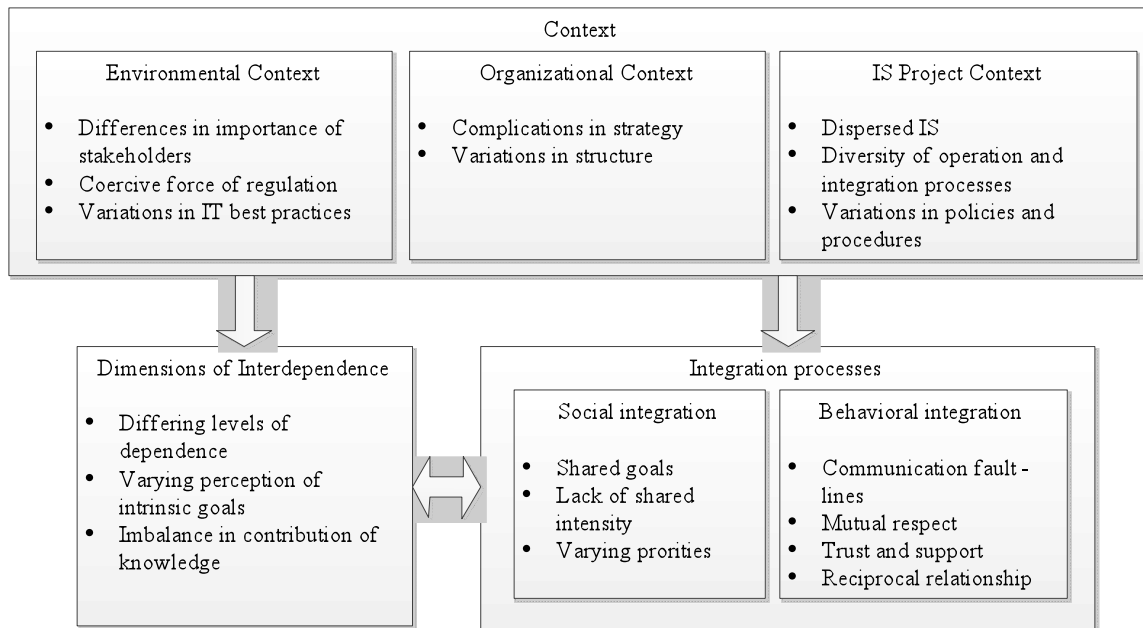
Figure 2: Preliminary Research Framework

Discussion

Our findings provide insights on the importance of social and behavioral integration, and interdependence in shaping software development processes. Our findings highlight the role of alignment of goals and a binding sense of integration that connects social integration and behavioral integration to interdependence and various contextual factors in shaping operations of software development teams. Our preliminary research framework aims at providing a richer understanding of the complex and multidimensional nature of the roles of social and behavioral integration, as well as interdependence.

Two key elements of our findings warrant further discussion – (i) differences in integration processes, and (ii) lack of a clear alignment with pre-established dimensions of interdependence. Although our framework is based on our preliminary analysis of data, and will likely change as we further collect and analyze data, it does yield some interesting insights into variations in well understood processes from prior literature. Social and behavioral integration processes that are captured in our framework highlight key differences from their analysis in prior research. For example, despite an emotional connection to the project by some stakeholders and a sense of shared goals across the team, there were misalignments in prioritizing and in the commitment and intensity shown by different project team members towards certain aspects of the project. Similarly, despite mutual respect and propensity to trust team members, communication fault-lines created mixed reactions among team members shaping nuanced variations in social and behavioral integration. Our findings also present variations in the different dimensions of interdependence that may provide the foundation for developing causal questions and further empirical studies.

Limitations, Implications, and Future Research

While our findings may be particularistic to the organization and project we studied, they can be cautiously applied in various contexts through analytic generalization. Our research framework provides important groundwork to bring the concept of a multidimensional construct of interdependence and how it is connected to social and behavioral integration. Relationships between team members are very complex and rarely isolated, and thus exploring interdependence in this manner provides new insights for other research of this type.

Our research expects to contribute to two streams of literature: (i) software development – Much of the work in particular areas of software development such as projects that use agile methods are largely underdeveloped in providing theoretical foundations. Our framework could be adapted to provide the much needed theoretical foundation for such areas of software development, (ii) Social interaction process: By examining social interaction in the context of software development, our work presents nuanced variations in interdependence and its role in shaping social and behavioral integration.

Our framework presents the basis for various directions for future work. Examining social and behavioral integration, along with interdependences, considering the use of social media technologies, presents an interesting direction for future work. Further studies could explore how social media increases integration through mechanisms such as development of interpersonal rapport, enhanced coordination, increase of quantity and frequency of information delivery, and social contagion (Thompson and Nadler, 2004).

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Appendix: Initial Interview Questions
1. Describe the structure of your development team, or the team you work with?
2. How does interaction among the team members occur?
3. Can you describe the nature of the relationship among the key members of the team.
4. How are initial requirements for a software project communicated among team members?
5. When problems arise in the development process what are the roles of the members and how do they get resolved?
6. If you use consultants, how are the integrated into the development team?
7. What policies and processes are used through development to ensure the project is being delivered on time, requirements are being met and the team is functioning at an expected level?
8. What tools do you use to increase communication and collaboration among team members?
9. In your experience, what were some of the problems in the project that were not resolved and can you explain why you think they weren't

Internationalizing and Innovating the Business Curriculum at a Historically Black University: The 'Global Logistics and International Business (G-LIB)' Experience

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Internationalizing and Innovating the Business Curriculum at a Historically Black University: The 'Global Logistics and International Business (G-LIB)' Experience

Abstract

In response to the challenges of globalization, many universities have adopted the strategy of "internationalizing the curriculum" for developing leaders that drive global problem solving with all stakeholders, rather than "simply" training skilled professionals for business. This article presents a case study about internationalization and introduction of an innovative curriculum in 'Global Logistics' at a business school in Historically Black College and University (HBCU) in the State of Georgia, United States. In order to provide students with a complete global experience and capability for employment in the global economy, the business school introduced a new program with emphasis on Logistics and Supply Chain Management (SCM), and International Business Environment called – 'Global Logistics and International Business (G-LIB)'. In this study, we discuss the need of having an international business logistics program at a HBCU, the corresponding challenges and benefits of developing an innovative curriculum, and above all, forming international collaborations and alliances with universities and companies worldwide that focus on international business logistics and SCM. This paper provides practical and academic implications for similar HBCUs and other universities interested in internationalizing their curriculum.

Keywords: Internationalization, Global Logistics, International Business, Globalization, Higher Education

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INTRODUCTION

The last two decades have witnessed the development and continuing evolution of a number of related disciplines including supply chain management (SCM), marketing, distribution channels, logistics, and purchasing, and very importantly, how these disciplines interact with each other during global operations. The effect of globalization is far-reaching and profound. Reflective of both academic development and managerial innovation, advances occurring within the business fields and across them have yielded considerable insights and furthered business knowledge and practice, thus altering the scholarly landscape and managerial practice. This academic change and innovation has affected the governance and management of universities (Peters and Roberts, 2000; Pratt and Poole, 2000). Among all the elements of an internationalized campus, curriculum stands out as the most important part of internationalizing efforts because all students have to experience it (Green and Olson, 2008). SCM education needs to be implemented with a focus on international business as supply chain strategy is an integral part of international business strategy.

Supply chain strategy in strategic and effective supply chain management (SCM) can be viewed as the pattern of decisions related to sourcing products, capacity planning, conversion of raw materials, demand management, communication across the supply chain, and delivery of products and services (Narasimhan, Kim, and Tan, 2006); thereby linking SCM strategy with the business and corporate level strategy. The origin of the term "supply chain management" is thought to reside in the work of consultants during the early 1980s (Oliver and Webber, 1982). A review of the supply chain management literature during the late 1980s and the early 1990s reveals the interchangeable use of neologisms: logistics management, network sourcing, supplier-base reduction, and inter-organizational integration. In the late 1990s, to some extent, supply chain management supplanted the term "logistics" (Rogers and Leuschner, 2004). In an attempt to clarify confusion surrounding the term, the Council of

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Supply Chain Management Professionals (CSCMP) announced a modified definition of SCM and a statement that clarified its scope and boundaries. Council of Supply Chain Management Professionals (CSCMP) defines SCM (see www.cscmp.org): "Supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities." Importantly, SCM also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, and customers. In essence, SCM integrates supply and demand management within and across companies worldwide. Today, while some researchers still continue with the pursuit of a definitional consensus, others have followed a shift in SCM research emphasis to developing management models to guide SCM implementation globally.

This managerial SCM global evolution has fundamentally altered the scholarly landscape addressing the related fields of logistics and SCM, and globalization, and created a need for introducing these interdisciplinary business areas as a part of academic curriculum in universities worldwide. This research paper presents a case study focusing on the challenges faced by College of Business Administration (COBA) at a Historically Black College and University (HBCU) located in the state of Georgia, USA, in an attempt to innovate the logistics and supply chain management (SCM) program and internationalize its business curriculum by introducing a new 'Major' and 'Minor' in Global Logistics and International Business (G-LIB) for the undergraduate business students. This paper addresses the following research questions:

- Is there a need for internationalization of the curriculum at the business school under study? What benefits will this HBCU have by integrating the local industries with the internationalized logistics and SCM curriculum developed?
- What are the organizational challenges faced due to the introduction of Global Logistics and International Business program?
- What are the challenges and benefits of having collaborations with international companies and universities?

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LITERATURE REVIEW

Curriculum internationalization is a multidimensional concept, which could be defined and approached in several ways. There is a substantial literature on curriculum internationalization in schools of business. Some researches focus on the various dimensions of curriculum internationalization (Crosling and Martin, 2005; Crowther et al., 2000; Edwards et al., 2003; Whalley, 1997), some focus on external variables that influence its adoption (Beamish and Calof, 1989; Elahee and Norbis, 2009; Green, 2002; Parker and Heriot, 2009; Toyne, 1992) and many believe that curriculum should be internationalized by different business disciplines such as Economics (Fuess, 2001; Kedia et al., 2001), Management (Rezaee et al, 1997), Accounting (Rezaee et al, 1997), Business law (Murray, 2001; Roorda, 1993; Sanchez, 1997), Marketing (Tyagi, 2001) and quantitative methods/statistics (Krehbiel and McClure, 1993). Some scholars give specific guidance for curriculum internationalization. For example, Self and Self (2009) suggest that taking 10-15 students and spending 7-10 days in a country will be a good way for business schools to meet accreditation standards and internationalize their curriculum meanwhile.

'Global Logistics and International Business (G-LIB)' program as an academic goal for 'Curriculum Internationalization'

Many global manufacturers and supply chain partners on both upstream and downstream side of the supply chain have embraced SCM to improve product development, product / service quality and results in eliminating waste leading to effective, strategic and sustainable competitive advantage. Recognizing the importance of global supply chain consistency for overall corporate performance, firms have started to pay attention to the effect of functional level supply chain capabilities on the corporate performance and have attempted to reflect this effect while formulating the corporate level global supply chain strategy (Klassen and McLaughlin 1996). Similarly, the customers, end-users and business partners (distributors, dealers, retailers, etc.) from downstream side of the global supply chain contribute in the

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product design and product solutions and effective global supply chain management strategies. We feel that the supply chain partners on both upstream and downstream side of the supply chain should be referred to as "design partners", "collaborators", "integrators", "innovators", and "transformers" to the entire supply chain process and experience.

Global Supply chain strategy must be internally consistent with other functional and corporate strategies and externally with suppliers' capabilities. Limited attention is given to successfully integrate global supply chain management processes, designing and managing global supply chains, empirically testing these international supply chain models, and the performance expectations of successful global SCM program implementations (Lambert, Cooper, and Pagh 1998). Figure 1 (Ayers, 1999) illustrates the relationship of the supply chain management tasks. Supply chain design begins with strategy, so it is at the center of the figure (Ayers, 1999). The remaining tasks, including the collaboration, partnerships, and management and development of information, need to align with these strategies (Ayers, 1999).

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Insert Figure 1 about here

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While the alignment of the five SCM tasks (as shown in figure 1 above) need to be implemented globally for a successful SCM experience, these concepts are worth understanding from an academic viewpoint as well. The students of today are the 'global leaders' of tomorrow and sooner they understand these nitty-gritties of international business, the better they are prepared for the future. Academically, studying global logistics and international business is rewarding as it provides an added dimension of understanding logistics and SCM from an international perspective. In addition, organizational issues in implementing curriculum internationalization scholars have attracted a lot of researchers (Cavusgil, 1991; LeBlanc, 2007; Palmer, 2006; Scherer et al., 2000; Trevino and Melton,

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2002). Some researchers attempt to develop models and typologies of the curriculum internationalization process (Edwards et al., 2003; Kwok et al., 1994; Whalley, 1997). Carnall (1997) identifies three conditions for effective change: awareness, capability and inclusion. Three requirements for change identified by Dirks, Cummings and Pierce (1996) are self-initiated, evolutionary and additive. Edwards et al. (2003) states three levels of internationalization: international awareness; international competence; and international expertise. Many internationalizing programs provide training to student on the first two internationalization levels but not the third one.

At this HBCU under study, we focus on all three levels of internationalization as follows:

1. international logistics and SCM awareness;

2. international competence in understanding SCM processes globally; and

3. international expertise focusing on logistics and SCM as significant areas of international business and growth in the world economy.

CASE STUDY APPROACH FOR 'INTERNATIONALIZATION OF G-LIB CURRICULUM'

In this paper, we present a case study to illustrate the process of internationalizing curriculum at a HBCU in the State of Georgia, USA. Through this case study, we wish to provide academic guidance on curriculum internationalization for other HBCUs and other universities. We employ case study approach, because we think that the process of internationalization at this university is unique in two ways, although the process has been used in various universities: i) internationalization of curriculum is achieved through introduction of a new G-LIB program, and ii) providing mandatory internships to students in local companies with global presence.

From the case study perspective, the Yin (1994) approach was adopted as a guiding schema, whose components are listed below:

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- the case study's strategic questions – as illustrated by the need-gap analysis for business students, faculty and local businesses prior to internationalization,

- its proposition, if any – as depicted through three levels of internationalization,

- its unit(s) of analysis – as shown by the students' assessments and evolution of SCM thinking after the introduction of G-LIB curriculum,

- the logic linking of the data and the case study propositions – as illustrated through the results; and

- the criteria for interpreting the findings – through the students' preference for teaching strategies, effectiveness and overall feedback.

The case study approach is illustrated through the implementation of G-LIB innovative curriculum and is performed through the following distinct stages:

Pre-step

A survey was conducted to assess the needs of the internationalizing the curriculum. Students, faculty and business were asked questions about their interest in a new functional area -- Global Logistics and International Business (G-LIB).

Needs Survey on Business Students An online survey was administered to all College of Business Administration (COBA) students. The sample represents about 15% of the undergraduate population (one thousand COBA students currently). Table 1 below shows the means of the student responses to different questions relevant to internationalization.

<p align="center">=============================</p>

<p align="center">Insert Table 1 about here</p>

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The students realize that events outside of the US affect them and they clearly understand that the 'study abroad' educational overseas experiences gained through international travel can change their international and cultural perspective by going to a different country, meeting different people from different cultures and understanding the business needs of other countries.

<p align="center">8</p>

Needs Survey on Business Faculty COBA Faculty were surveyed to assess their international experience and capture attitudes about their IB skill set. A pen and paper survey was administered to all 24 faculty members of COBA with a 100% response rate. The faculty questionnaire provided COBA a direction of emphasis on the functional area of an International Business curriculum. Table 2 highlights the responses for International Business (IB) needs and requirements for COBA faculty.

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Insert Table 2 about here

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75% of the faculty felt a strong need to internationalize the undergraduate core curriculum. When asked about which functional areas of business will have globalization focus of utmost value with respect to growing trade in the region through the Port, the faculty chose the Logistics and SCM area along with Marketing. This input helped COBA to establish **Global Logistics and International Business Education and Research (G-LIBER)** Center, with a focus on International Business, Trade, Logistics, SCM, and Marketing in February 2011. The Center assists in improving the academic teaching of the G-LIB curriculum and to conduct outreach activities with the local business community to compete in the global arena. The G-LIBER center has support from around 40 industries and non-profit organizations. The center promotes international linkages between the HBCU and local businesses engaged in international economic activities with institutions of higher education and businesses in Asia with a focus on China, India, and South Korea.

Needs Survey on Local Area Businesses Business professionals from firms in the vicinity of the university were surveyed in order to assess: i) their awareness of international business opportunities, ii) their attitudes towards developing international business in the region, and iii) their attitudes towards the starting a new center and a new COBA program in Global Logistics and International Business (G-LIB),

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playing a lead role in the export assistance for these businesses. A pen and paper survey was administered to about 30 business executives representing 30 different companies attending a meeting on February 3, 2011 (100% response rate). The respondents were asked to rate the international business importance of the regions during the next ten years, as well as, familiarity using the same Likert scales as the COBA students and faculty.

The survey showed that local and state businesses agree that export assistance through the G-LIBER Center will benefit the businesses locally, and in the State of Georgia. The center can serve as a link for business networking. Local business professionals feel that Asia, Latin America and Europe are important regions for international business focus. 'Asia' is viewed as being the most important and familiar region during the next ten years due to growing Georgia port ties with China.

Pre-analysis

This step provides an analysis of the internationalization needs of students, faculty and local area businesses. Cavusgil and Cavusgil (2012) provides research-based reflections on international marketing. They suggest that the constant in the evolution of the business enterprise has been its relentless search for competitive advantage and a global landscape that defines the firm's opportunities and challenges. The global marketplace has always been dynamic and complex in terms of the changes it brings, but the last two decades have been exceptionally transformational. Cavusgil and Cavusgil (2012) research draws attention to major disruptions impacting international marketers and provides insights for appropriate firm responses.

While conceptualizing the G-LIB curriculum, we incorporated following courses in G-LIB curriculum - Global Business Logistics, Global Electronic Business, Global SCM, Transportation and Carrier Management, International Business Management, International Marketing and Export Management, International Trade Theory and Policy and Global Operations Management along with Internship and

Study Abroad courses. The basis of innovation in these courses was based on Cavusgil and Cavusgil (2012) model defining four forces in international marketing as follows.

a. Drastic volatility in the global economy impacting global logistics and SCM;

b. Strenuous engagement with turbulence of destructive shocks in economy and global SCM networks;

c. Development of morphing strategies to cope with shifting market forces; and

d. New understanding of marketing and SCM performance leading to new management assessment models and strategies across global business disciplines.

Main steps

In order to accommodate the above international marketing forces with a focus on global logistics and SCM, we establish G-LIBER center of excellence, introduce an innovative G-LIB curriculum for undergraduate students and subsequently, measure the challenges and the key student learning outcomes along with recommendations for further improvements.

Post steps

This is characterized by the "reflective G-LIB" case study inquiry method whereby the results are analyzed and three techniques of reflection (Mezirow, 1991) are utilized. Content reflection provides support on thinking about the important issues; process reflection aims at reflecting on the strategies, procedures and the way things are performed; and premise reflection critiques the underlying assumptions.

We conducted a post-survey on the business students and faculty after introducing G-LIB curriculum at the business school in HBCU. We posed them questions about globalization, impact of G-LIB on their lives and the future of G-LIB education. Here are some of the results.

i. About 77% students feel that the G-LIB focus on the bottom of the pyramid (i.e. developing and emerging countries like China and India) is highly needed in today's globalized economy.

ii. When asked about the critical success factors (CSFs) defining the success of a business school – 87% students and faculty that the most important factor is the "ability to adopt different perspectives and understanding the larger picture", followed by the second most favorite item preferred by 58% faculty and students who feel that "holistic decision-making skills, including the societal and environmental factors" are critical for success. The remaining felt that entrepreneurship and leadership skills are important CSFs for business school success.

iii. When asked about what the business schools should focus on in the future, we obtained the following responses:

   a. Develop leaders that drive global problem solving with all stakeholders (78%)

   b. Develop leaders/managers for all types of organizations like SMEs, MNEs, not-for-profit, government, entrepreneurial ventures, etc. (59%)

   c. Train skilled professionals for business (43%)

   d. Ensure literacy in comprehensive managing skills (37%)

iv. When asked what a business leader should look like – 79% feel that s/he should be an innovator able to create long-term sustainable value with high focus on ethics and responsibility; 63% favored a leader working with various stakeholders towards a better society and world with emphasis on critical reasoning and holistic decision-making; while 53% want a person connecting deeper values to the organizational context with emphasis on collaborative skills and strategic thinking.

v. When asked how such leaders should be developed, an enormous 95% feel that creative experiential learning situations by teaching interdisciplinary courses and curriculum like G-LIB

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help in developing value-based business leaders. Others feel hands-on learning situations, projects, cross-creating the curriculum with students, sharing the responsibility of learning, issue-centered learning, joint learning exercises and teaching functional area skills: marketing, finance, HRM, strategy, etc. are important for developing leaders of tomorrow.

THE CHALLENGES OF INTERNATIONALIZING G-LIB IN A HBCU

It is very clear that there might be several internationalization barriers facing the successful and sustainable G-LIB program. Fortunately at this HBCU, we have the support from the highest office in the University. We faced two key obstacles in the process of initializing G-LIB: i) competing and conflicting priorities, and ii) providing mandatory internships to G-LIB students.

Conflicting Priorities One of the challenges in introducing a new program in G-LIB for students of this University is the conflicting priorities. Three conflicts needed some attention, each of which has been addressed to some extent, including: i) introduction of new courses Vs. modifying the existing courses, ii) student study abroad program for two-four weeks Vs. one semester student exchange program, iii) same set of courses for a 'Minor' (a 'Minor' is optional set of courses that any student can opt, it is usually different from the 'Major', which is a required primary concentration of study) in G-LIB for business and Non-Business Students Vs. having different set of courses for 'Minor' in G-LIB for business and non-business students.

Determining the length of student study abroad program led to conflict and contrasting opinions. If the program is too short then the students may not get to learn about the business culture in the foreign country. If they stay for too long then the expenses for their boarding and lodging would increase significantly. The G-LIBER team decided to take the students abroad for a length of three weeks for the first couple years. Later it will be expanded into a semester long visit after the availability of funds for travel.

Internship In order to prepare business students to successfully secure jobs nationally and internationally, one of the important objectives and challenges of the G-LIB program is to provide students with internship. To achieve this objective, G-LIBER center takes three actions, firstly integrating G-LIB curriculum with the needs of organizations and industries; secondly, contacting national companies and organizations to make them aware of G-LIBER partnering network; and thirdly, establishing contact with international universities, businesses and organizations to build G-LIBER international partnering network. In addition, G-LIBER center offers a formal internship course. Students do not simply work as an intern in a company, but also get training for the whole process of job searching including resume writing, job searching, interview preparation, business negotiations, etc. All students who successfully find an intern position and work for some time (more than a month), are required to share their experiences with their peers.

CONCLUSION

A strategy of "internationalizing the curriculum" is one way for many universities to respond to the globalization opportunities and challenges. This paper provides a case study for how to internationalize the business curriculum at a HBCU. Three surveys were conducted targeting business students, faculty and local business professionals assessing the need of internationalization at this HBCU Business School. The results showed that all students, faculty and business professionals have a strong globalization need. Combining the requirements of students, faculty and local businesses, the business school decided to create a new G-LIB program at the undergraduate level.

During the implementation process, the school faced several challenges including conflicting academic priorities, providing internships to students and making study abroad trips to different world regions. The internationalization process in this university covers all the three levels of internationalization presented by Edwards et al. (2003). When we conducted the results' analysis from G-LIB curriculum

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implementation, we found that the following key topics need to be addressed by the future management research and education as identified by the business faculty, students and businesses.

1. Making global businesses responsible and sustainable (87%)

2. Developing globally responsible leaders (76%)

3. The role of business and its responsibility towards consumers, society and the planet (66%)

4. New measures for economic, social and environmental effectiveness of business (59%)

5. The role of business leaders in resolving global issues (54%)

We sincerely hope that the HBCU globalization experience will provide practical and academic implications for similar HBCUs and other universities interested in internationalizing their curriculum.

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FIGURES AND TABLES
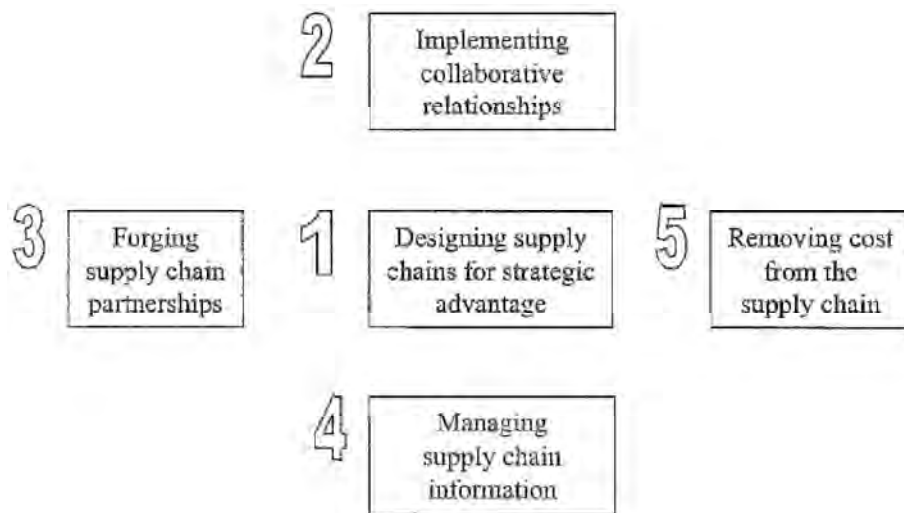
Figure 1: Supply Chain Management Tasks (Ayers, 1999)

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Table 1: Question Items of COBA Student Survey and Responses' Means

Question Items	Mean
1. The things that happen outside of the United States will affect me.	4.22
2. International Business Education will be beneficial for me.	4.40
3. Global education with emphasis on supply chain and logistics will improve my understanding of exports in relation to the Port of Savannah.	4.19
4. Participation in a study abroad program would add value to my college degree.	4.45
5. Participation in a study abroad program would allow me to advance in my career at a greater pace.	4.43
6. I do not have enough money to be involved in a study abroad program.	3.81
7. If I were to receive financial assistance, then I would be more inclined to participate in a study abroad program.	4.25
8. Study Abroad programs will be helpful in understanding the cultural dimensions of the countries.	4.54
9. Business language course will add a new dimension to my business career.	4.43
10. Study abroad programs with language and cultural understanding of the concerned country will add value.	4.40
11. I don't need any study abroad programs to enhance my career.	2.10
12. International Business education with emphasis on study abroad programs and new languages will enhance my business career.	4.34
13. Studying Korean Language will be an added asset to my International career and will prepare me professionally and globally.	3.73
14. Study Abroad provides an opportunity to travel while earning academic credit.	4.37
15. Studying Chinese Language will be an added asset to my International career and will prepare me professionally and globally.	4.03
16. Study Abroad will help me develop skills and give me an international practical experience, a classroom setting is unlikely to provide.	4.37
17. Study Abroad provides me an opportunity to make friends around the world.	4.34
18. Study Abroad expands my world view and global / cultural understanding of nations and cultures.	4.46
19. Study Abroad will help me gain a new perspective on my own country vis-à-vis the global perspective.	4.33
20. Study Abroad provides me an opportunity to become a full-time, active, global learner.	4.39

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Table 2: Mean Responses to Survey Questions for the COBA Faculty

Statements	Mean
I need development in international business both from the course content development perspective, and my(personal) professional development	4.00
An international business tour appears to be a good method for faculty to gain some international experience	4.54
I might be more inclined to participate as a visiting professor abroad if I were to gain international experience first via an international business tour	3.69
In order to bring in Internationalization in our undergraduate curriculum, I feel International Business Languages Component must be highlighted as an area of study for our undergraduate students.	3.94
Students gain more international experience if they visit the countries and see / explore the knowledge and business there.	4.47
I want to work with international faculty in my area of research.	3.87
I want to teach in a foreign country to learn more about other countries' cultures, as well as build relationships, and explore common research and teaching interests with colleagues outside the United States.	3.73
If I get an opportunity to go abroad, I feel I will be better prepared to internationalize my course content.	3.86
Globalization is everywhere and so, such study tours for students will not help. Students can be exposed to certain global case studies without touring the actual countries.	2.17

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CHALLENGES AND OPPORTUNITIES OF ONLINE AND HYBRID LEARNING

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WORKSHOP FORMAT

The focus of this workshop is on online and hybrid learning. As more higher education institutions move towards online course offerings, it becomes crucial to explore the issues related to this type of learning. We will address the opportunities this type of learning offers, strategies to maximize success, and the challenges that go along with it.

Three faculty members, two from private liberal arts colleges and one from a state university, will conduct this workshop. They will begin by briefly providing an overview of their experiences with online and hybrid marketing, management, and international business courses. The use of different technologies to enhance student learning and virtual collaboration will be highlighted. An example of how one of the faculty members uses Wimba live classroom and wikis in a hybrid teamwork course can be found in Appendix A.

In addition, workshop attendees will be encouraged to participate by sharing their experiences. We are envisioning an interactive and lively discussion around issues pertinent to online and hybrid learning such as:

• Use of teams in online formats
• Types of deliverables for online classes
• How to ensure that students are really 'learning'
• How to create a common culture
• Strategies to make the class interactive
• How to keep students engaged
• Different types of platforms and technology (e.g., blackboard, wimba, wikis, blogs)
• How to balance hybrid courses between in-class meetings and online time

APPENDIX A

In the course "Developing and Managing Work Teams," students work on a semester long community based service learning project. The course is taught as a hybrid course in order to give the students the opportunity to not only experience what it is like to work in a face-to-face team, but in a virtual team as well. The pedagogy involves integrating online learning tools, such as Wimba Live Classroom and wikis, into the course.

Wimba Live Classroom, which is a tool in the Blackboard platform, is used to hold virtual team meetings. Each team is required to hold at least four meetings on Wimba. Two of these online meetings include the professor, one to present the team's project proposal and one to present the team's progress report. PowerPoint presentations are presented online in the Wimba classroom at these meetings.

Wikis are utilized in the course as both a collaborative tool throughout the semester and as a final portfolio of each team's completed project. Each team is required to create a wiki where team members work together on project documents such as a team charter, project timeline, and communication plan. Meeting agendas and meeting minutes are uploaded to the wiki, as well as project photos and PowerPoint presentations.

In today's global information based world where more and more employees are working on virtual teams, it is imperative for students to become adept at this type of teamwork. The use of Wimba Live Classroom, and wikis in the course "Developing and Managing Work Teams," is enabling many students to do just that.

PEDAGOGICAL LURKING PROMPTS INNOVATION IN SOME STUDENTS, INTIMIDATION IN OTHERS

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ABSTRACT

The course under study's design prompted students to find answers to their writing challenges by examining posts of classmates who were not their teammates. Interviewees who submitted written excerpts and critiques of three teammates' excerpts to an online forum divulged that investigating posts of classmates on other teams facilitated innovative writing. Traces of students building upon ideas that a classmate originated were documented. Struggling students' awareness of the disparity between their work and the work of stronger writers was motivation for greater effort as well as reliance on shortcuts. Since evidence of the selectivity, prevalence and duration of students' lurking forays was so elusive this study focused upon lurkers' intentions.

1. INTRODUCTION

Testing and exchanging ideas via an online forum can prompt greater diligence, collaboration and creativity [6]. Realizing that in addition to the instructor an authentic audience of their peers will evaluate their writing may motivate students to devote more time and energy to their studies. Online forum participation can be mutually beneficial if students who gain insights by reading classmates' posts reciprocate by submitting comments of their own. This study examines the intentions and academic outcomes of students who peruse classmates' posts at great length without commenting. In the context of this study these students are called *pedagogical lurkers* [3]. According to several researchers, lurkers diminish their own learning opportunities by forgoing the opportunity to clarify and solidify thoughts by writing responses to interesting online posts. Not writing forum responses may however enable lurkers to conserve their energy by reflecting more upon new ideas, which results in more thoughtful writing of final projects that account for a greater contribution to the overall course grade than more casual forum responses [2,3].

Research study participants critiqued three teammates' written excerpts in two rounds of peer review. Interview testimony, final term papers, and forum transcripts provided evidence that ideas students encountered while lurking other teams' posts influenced their writing throughout the semester. The key objectives of this study were to determine: (1) whether participants who posted the requisite number of critiques and also lurked extensively had favorable term paper outcomes; (2) whether participants who lurked extensively but did not post the requisite number of critiques had favorable term paper outcomes; and (3) whether participants who posted the requisite number of critiques but did not lurk had favorable term paper outcomes.

2. METHODOLOGY

The eighty undergraduate students registered in a fall 2008 research methods class were assigned to four different lab sections taught by four different TAs. In the lab class sessions students learned how to write using the *Publication Manual of the American Psychological Association*. In each session specifications for how to write the next paragraph in the American Psychological Association sequence for three papers were covered. After the TA lectured on what should be contained in the next paragraph in the APA sequence, students were given an opportunity to receive feedback on paragraphs they had written the previous week. If a given student opted to present her paragraph(s) on the overhead projector, everyone present could comment upon or question her work.

Six supplemental forums designed to strengthen students' information literacy proficiency comprised the intervention reported upon in this study. Although the forums enabled students to conduct research for their term papers collaboratively, they composed and finalized their term papers individually. During the first lab section meeting, a 22 item multiple choice and multiple matching question assessment was administered via the BlackBoard assessment feature. Students were assigned teammates whose ethnic background and scores on the initial survey differed. Students completed the first forum by negotiating with teammates to select a topic for their team to research. Students completed the remaining five forums online at a time and place most convenient for them.

At the semester midpoint, 14 students were interviewed individually and in a focus group. There were a total of twenty-four individual interviews and six students participated in the focus group. The intent in this research study has been to get at the meaning each student attributed to his/her forum/term paper writing experiences. Interviews were used to find out how young people adapt to new, self-directed learning opportunities. The forum transcripts provided evidence of what they wrote but the impact of the students' lurking behavior would not have been revealed by any means other than interviewing [4,5].

Students' final term papers and teams' forum transcripts were obtained after the semester ended. Two evaluators ranked the term papers into three categories – beginner, proficient and advanced, guided by three anchor papers that exemplified the level of the information literacy proficiency for each category.

3. FINDINGS

Because the online forum provided such a privileged vantage point for observing the progression of their classmates' writing, interviewees had strong opinions about whether they should spend time investigating the online forums of classmates who were not their teammates. Table 1 lists the five members of three teams who were forthcoming about lurking:

Table 1 Participating students' team assignments	
Team Names	Teammates
Prophetic Wisdom	Alexis and Nina
Happy Campers	Alana and Lynn
Team School Daze	Bea

Transcripts captured subtle aspects of teammates' interactive work with ideas. For example, Lynn posed a question in a critique she wrote for her teammate Alana that was similar to the question Alexis and Nina were grappling with on a different team. The transcript showed that Lynn could have perused both rounds of peer review for Alexis and Nina's team before she posted her critique.

Alexis's critique of Nina's round-one peer review excerpt points out that Nina does not clearly state the premise of the excerpted article. The premise could have been that racial bias that African American teenage girls encounter compounds the obesity stigma they also encounter. Conversely, the premise could have been to compare how teenage girls who were either African American or Caucasian experience obesity stigma. In the second round of critiquing, Alexis reiterated her question because although Nina posted a second excerpt of the same article, she neither answered nor acknowledged Alexis's question. It is worth noting that Nina did not provide clarification in her term paper either.

Alana followed her teammate Lynn's suggestion; she included a clarifying sentence in the revised excerpt that she embedded in her term paper. Alana may have also witnessed Alexis's repeated requests for more in-depth information regarding race and obesity stigma. In her interview Alana divulged that she was keenly aware of how race significantly influenced outcomes in a number of psychological studies:

> The term paper was about obesity. It was basically a general overview of obesity. My focus was on parent reinforcement and how parents deal with their kids. I wanted to do a separation of race. But that was typical of me. Because I do it all the time.

The example above shows how Lynn stirred up interest in a topic that was already significant to Alana. Providing highly relevant commentary on aspects of a teammate's work heightened both the giver's and the receiver's interest in a critique. Lynn not only caught Alana's attention but also strengthened her own ability to discern and make judgments autonomously. Lynn's efforts were beneficial to Alana in the sense that Alana became more aware of her audience. The clarification Alana added showed that she recognized that an oversight she had made in her initial excerpt warranted the revision of the excerpt she embedded in her term paper. Even if the article upon which she based her excerpt provided only cursory treatment of the issue, as a scholar Alana needed to explicate what had taken place.

4. DISCUSSION

Students contributed to the information literacy forums for eight weeks. If teammates were responsive to one another and met the other prerequisites, then prospects for knowledge building were good. However, prospects for knowledge building were not uniform among all the teams. If a student desired more in-depth forum involvement than her team collaboration provided, she could lurk. Since forums were accessible to students after the eight weeks that they were actively making contributions, students had an archived repository of readily accessible and copious ideas from the entire semester. Work the eighty students posted to the repository could inform each of them because they were all working on similar assignments. Each student was endeavoring to design an intervention to address a social problem. Perusing the ideas that such a diverse group of people was sharing via the forum could help some students expand, clarify, and write their own thoughts.

Lynn recognized a great wealth of writing examples that could clarify some of the term paper matters that were otherwise confusing to her. There was evidence that lurking another team's forum enabled Lynn to pose an insightful question to her own teammate. Perusing other teams' exchanges was extra work Lynn carried out because it helped her refine her own writing and research. Since a classmate on another team was insisting upon clarification of an issue similar to the one Lynn pointed out to her, Alana's intention to eradicate this inadequacy may have been stronger. Members of other team's handling of this issue peaked Lynn and Alana's interest. The forums permitted them to witness subtle details of their classmates' research.

5. CONCLUSION

Only five students divulged details of their lurking behavior and their opinions about lurking. The term paper scores of three interviewees who submitted the requisite number of critiques and also lurked were favorable. Papers written by an interviewee who lurked but did not submit the requisite number of critiques and an interviewee who submitted the requisite number of critiques but did not lurk were not worthy of high scores.

Alexis and Lynn's term papers were ranked at the highest level, their survey scores were also ranked at the top. Alana had one of the lowest baseline survey scores; her term paper ranking however was higher than her initial assessment score. Bea's teammates did not submit their written excerpts so she could not write the requisite number of critiques. Although lurking helped her overcome a number of writing challenges there was a precipitous drop from her high initial survey score ranking to her term paper score ranking. Nina was consistent in her condemnation of the online forums. She stated that lurking as well as contributing to the online forum did not help her write her term paper. Her term paper score ranking was significantly higher than her low baseline survey score ranking. Because Nina embedded plagiarized passages from a published article in her term paper her high term paper score could not be attributed to her forum involvement.

Placing students with high and low initial assessment scores and different ethnic backgrounds on the same team proved to be a fruitful idea. This enabled teammates to

contribute their divergent thoughts to negotiation of their team topic selection and thereby demonstrate their commitment to this group endeavor.

Students increased their opportunities to read relevant materials by perusing the work of classmates on other teams. Several interviewees did not establish very fulfilling connections with the members of their own team; hence, nine of the fourteen interviewees explained that they did a great deal of lurking. Feeling a greater affinity for students with whom they could only interact vicariously was a common theme among interviewees. If these students had been assigned teammates whose posts were easier for them to respond to, perhaps they would not have tried to examine the work submitted by other teams as extensively as they did. Consequently, the mixed ability and mixed ethnic background team assignments helped students broaden their perspectives on the social problems they were writing about and introduced them to a greater variety of writing conventions than they might have examined otherwise.

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Promoting cooperation in an MBA program: Experiential learning in the trees

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Abstract

MBA programs are inherently competitive. If a student excels they expect to be individually rewarded. At the same time, much of the work in an MBA program, as in organizations, is completed in groups or teams. Employees and MBA students work interdependently and therefore need to cooperate. This paper will look at an experiential outdoor activity for MBA students that highlighted the differences between competition and cooperation and encouraged students to consider these two different modes of interaction.

Keywords: experiential learning, cooperation, competition

Team work is common in organizations because without interdependency the organization does not operate as a system (Senge, 1990) but rather as unrelated functional areas. This organizational grouping is mimicked in MBA programs through group activities and projects. For MBA students, group work implies cooperation but such cooperative work has limits as MBA students compete for individual grades and seek to maximize benefit and minimize costs. According to Kohn (1992: 198), who argues we tend to confuse competitiveness with excellence, "…few values are more persistently promoted in American classrooms than the desirability of trying to beat other people." MBA programs often encourage a competitive program environment as it replicates the competitive market place that these students are being groomed for.

Competition and cooperation are common approaches to interacting with other individuals or organizations however managers do not always make wise decisions about when to compete versus cooperate. Even when they know in theory that competition is counterproductive individuals will still prefer to compete (Berg, 2010). Competitive structures work best when

individuals work independently and are rewarded individually while collaborative structures, such as teams, are most effective when individuals are interdependent (Johnson, Johnson and Bryant, 1973). Competition is viewed as positive for many reasons. Competition promotes fuller use of one's abilities, leads to a fairer allocations of benefits and burdens, discourages apathy and stagnation while leading to higher standards (Rich, 1988). Despite these benefits, competition encourages cheating and selfishness (Schwieren & Weichselbaumer, 2010; Cooper and Peterson, 1980). It creates stress and can lead to a sense of shame, despair and envy if one is defeated (Rich, 1988). Also, individuals in a competitive situation are more anxious, less self-assured and more self-oriented (Johnson, et al., 1973).

In complex problem solving situations cooperation has been found to produce better results than competition. It results in more integrative and less dominating behavior among participants (Johnson, et al., 1973). Each individual has their own set of skills and experience they bring to a work situation. As a result, the amount of individual contribution to a project or activity will vary depending on the nature of the task. However, teamwork is often beset with the notorious free-rider problem (Reuben & Tyran, 2008). "Collaboration could produce a better outcome for all, but it is not fully attainable because individuals are tempted to pursue their own goals while free riding on others' contributions" (Wu, Loch & Ahmand, 2011).

In organizations and MBA programs it is important for individuals to appreciate the benefits and costs of competitive versus cooperative behaviours. According to Kolb and Kolb (2005), who advocated for experiential learning in higher education, "(l)earning requires the resolution of conflicts between dialectically opposed modes of adaptation to the world." As such, learning about competition and cooperation, two different approaches to work and rewards, requires conflict between these alternative perspectives.

This paper outlines an experiential learning activity designed to enhance the awareness in MBA students of competition and cooperation. Experiential learning is learning through reflection on doing rather than through dialogue (Itin, 1999). "Experiential exercises that demand rigorous engagement and involvement on the part of students are found to be an invaluable pedagogical tool in underscoring and achieving learning objectives related to decision making in a dynamic 'real-life' environment" (Devasagayam, Johns-Masten & McCollum, 2012).

There are a number of reasons why this experiential leaning activity, examining cooperation and competition, is beneficial for MBA students. First, organizations generally expect cooperation among employees. For example, cooperation is common in organizations that empower their employees because experience and opportunity supplants authority during empowerment. Employees that are closest to a work issue and have the most relevant knowledge are expected to take responsibility. Organizations favour empowerment as it has been shown to be beneficial to individuals, teams and organizations (Maynard, Gilson & Mathieu, 2012). According to a study

by Lawler, Mohrman and Benson (2001) approximately 70 per cent of organizations have adopted some form of empowerment. If an employee is empowered, but does not hold the necessary formal authority, a cooperative organizational culture will be essential to make the empowerment effective. "Rather than rely on a coterie of subordinates to await their marching orders from detached bosses, organizations need to empower anyone who is capable and who has the willingness to assume leadership in the moment in his or her relationship with peers, team members, customers, suppliers, and other organizational partners" (Raelin, 2006:152).

Second, "MBA programs focus too much on analytical capabilities to the neglect of 'softer' skills" (Simpson 2006: 184), such as team work, cooperation and ethics (Crosbie, 2005), skills that are seen as "increasingly important in the workplace" (Simpson 2006: 184). Soft skills, critical in emotional intelligence, contribute more to an individual's ultimate success or failure than technical skills or overall intelligence (Goleman, 1995). However, despite the importance of soft skills MBA programs fail to significantly enhance student skills in this area. A study completed through the Association to Advance Collegiate Schools of Business ranked MBA students from two high level business schools on emotional intelligence before and after their MBA program and found only a two per cent improvement over the duration of the program (Boyatzis, 2009). There is clearly a need in MBA programs to develop and encourage softer skills. The experiential activity presented in this paper was aimed at reinforcing the softer skill of cooperation.

Third, a lack of attention to interpersonal relations and cooperation can lead to failure in leadership. For example, in his leadership at Enron, Jeff Skilling encouraged cut throat competitive behaviour (Swartz & Watkins, 2003). When Enron imploded, Skilling's contribution to the collapse pushed Harvard University, Skilling's Alma matter, to re-evaluate the Business Ethics education included in their MBA program. "MBA programs, by propagating…theories based on norms of competition, opportunism, and self-interest, help to produce managers with a limited sense of moral responsibility and so curb their ability to play a more positive role in society" (Ghoshal, 2005). This experiential activity links cooperation to individualized efforts at leadership by requiring participants to help each other and take on leadership roles and cooperation to succeed.

Finally, many organizations, such as financial institutions (Patterson, 2010), corporate groups, religious groups (Sekely, 2005) and the CIA (Earnest and Karinch, 2011) send employees to participate in activities outside the organization to enhance employees relations, provide a break from work and create learning opportunities. These activities, including paintball, high-powered gokarting, war gaming, rope climbing and simulations, have become common corporate training exercises. The aim is to help people internalize new knowledge on teams, leadership, relationships and interactions through actively participating in their learning (Nelson & Quick,

2011: Linder, 2000). It is a form of action learning. Action learning is "a method to generate learning from human interaction occurring as learners engage together in real-time work problems. Learning arises not just from representations of conceptual material but from questioning among fellow learners as they tackle unfamiliar problems" (2006: 152). Participating in a similar type of activity during one's MBA program can help prepare a student for the work environment. Outdoor education, once largely confined to orientation at business schools, is "making inroads at a growing number of MBA programs as schools look for more effective ways to teach students the dynamics of leadership and team-building" (Damast, 2012: 2).

This paper will start with a brief literature review on cooperation and competition. Next, an examination of the types of outdoor experiential activities available will be provided followed by a description of the experiential activity selected. Themes identified from the group presentations that followed the activity will be described. Finally a recommendation and discussion section will be provided.

Cooperation and Competition
"When people strive to achieve a goal, they may engage in cooperative, competitive, or individualistic efforts...As such one's actions may promote the success of others, obstruct the success of others, or not have any effect at all on the success or failure of others..…Nothing is more basic to humans than being 'for' or 'against' other people" (Johnson & Johnson, 1989). Of these three modes of interaction, competitive behaviour is the most popular. "Our collective creativity seems to be tied up in devising new ways to produce winners and losers" (Kohn, 1992)

For competition to exist two or more people or groups vie for a reward that is in short supply. In addition, the competitive activities are rule governed (Rich, 1988). It also requires social comparison in which participants are informed about their performance relative to their competitor (Levine, 1983). The reward can be monetary such as when a business wins a contract or an employee advances to a higher paying position over their peers or non-monetary such as an organization being recognized by a third party for top customer service or an employee being recognized as employee of the month. However, "the perfectly competitive market is neither the unique nor the most widespread type of competition among firms and individuals….(T)he oligopoly and winner-take-all market are two scenarios where actors' behaviour is influenced by the presence of several opponents. In both cases, they have to decide whether it is more suitable to try and cooperate rather than fight" (Ottone & Ponzano, 2010: 163). Even in competition there is cooperation.

Cooperation is more effective than competition when joint work can produce synergy and provide greater rewards for everyone. Cooperation is more productive than competition or individualistic efforts when there is positive interdependence and face-to-face interaction

between the participants and where there is frequent use of interpersonal and small group skills (Johnson & Johnson, 1989).

There are many successful organizations that engage in both the competitive and cooperative approach to business. General Electric, for example, had a long standing model of promotion that required senior executives to rank the employees and cut the bottom 10 per cent (Alsever, 2007). This required managers to evaluate employees relative to each other, share facts on the comparisons and ultimately determine who would be rewarded by keeping their job and who would be let go. It was a very public form of competition. Other corporations, such as Enron followed a similar employee evaluation process. A milder version of this employee competition plays out in many organizations in terms of bonuses. Who qualifies for bonuses, along with the amount paid in reward is a highly competitive process. Microsoft is another example of a highly competitive organization. Bill Gates built Microsoft on the premise that software was not to be shared openly but rather owned and managed (Uttal, 2011). Gates has also taken individuals and organizations to court to assert the rules of fair competition.

Alternatively, Toyota, Magna International, Harley Davidson, Southwest Airlines, Linux and Wikipedia are all examples of organizations that rely on cooperation. Linux represents a stark contrast to Microsoft by providing open-source software that nobody owns. Toyota and Harley Davison use extensive team work assuming the organization is a system not a set of functionally separate departments. The cooperation for some organizations goes beyond the boundaries of the organization. For example, Toyota and Magna International include suppliers in their network of cooperative relationships. Magna International also promotes a cooperative work environment by linking bonuses and pay to the performance of the organization and guaranteeing the organization makes donations to stakeholder groups based on the success of the organization (Keenan, 2011). Wikipedia provides a well-known example of cooperation in shared knowledge at the individual level. Participants join in the writing of Wikipedia pages without pay or reward other than adding to a well recognized body of knowledge (Benkler, 2011).

Competition and cooperation can be used simultaneously by creating situations where cooperation is promoted within teams but the teams compete. In this arrangement competition between teams increases cooperation within teams (Coen, 2006). Team members recognize that cooperation is essential to outdo the competition. In addition, "(i)ntergroup competition is often more constructive than interpersonal competition as teams tend to handle winning and losing more constructively than individuals do" (Johnson & Johnson, 1989: 34). Intergroup cooperation however has a limit when what is desirable for the individual is detrimental to the group (Coen, 2006). For example, if a student has a final exam to study for and a group paper to complete for one course, the student is faced with a dilemma. Studying for the exam is time that will benefit the individual but not the group. Such individualistic behaviour can be adopted by some group members as long as others are willing to carry the work load. However, if all the group members

elect to spend their time studying for the exam and not working on the group paper, the group will fail to complete their assignment. Individuals will also vary in their willingness to cooperate under similar circumstances. According to Kosfeld and von Siemens (2011) who looked at competition, cooperation and corporate culture, some individuals will cooperate if their coworkers cooperate while others only respond to monetary incentives. Their research found that individuals self select into firms that either promote competition through individual monetary remuneration or firms that promote cooperation.

Another model of cooperation is the all-can-win intergroup competition where the criteria for success is clarified and teams win if they meet the criteria. In the ideal condition all teams win. "The advantage of 'all-can-win' intergroup competition is that it reduces the potentially demoralizing effect of competition by mitigating the negative externality a winning team imposes on other teams" (Reuben & Tyran, 2010:26). However, such an approach limits the incentive to outperform others or to reach to a significantly higher level of performance than is expected in an effort to be the clear winner.

Given that individuals tend to self select the organizational environment they prefer – competitive or cooperative – and given that there are organizational examples of success that are competitive and cooperative it would seem the lesson for the MBA student is to be aware of the two modes and the ideal conditions under which these approaches works best. However, the criteria for evaluation of the individual's or organization's success should not be limited to financial measures. The effect of the means of interaction on the participants should also be considered. Working in a cooperative arrangement when successful can increase participants' psychological health through enhancing social competencies, achievement and productivity, and intrinsic and achievement motivation. In cases where there is failure cooperation can help constructively coping with failure and anxiety (Johnson & Johnson, 1989). Success in a competitive environment can lead to an enhanced sense of ability and self esteem. However, failing in a competitive venture can create feelings of shame, envy, despair, selfishness, and depression (Johnson et al, 1989; Rich, 1988).

According to Kohn (1992: 97), who critiqued society's preference for competition, "…we act competitively because we are taught to do so, because everyone around us does so, because it never occurs to us not to do so, and because success in our culture seems to demand we do so." For example, it would be hard to imagine an MBA program that did not encourage competition but rather focused solely on cooperation. To enhance understanding in students for the work environment both cooperation and competition need to be examined together and considered as contrasting perspectives.

Experiential Group Activities

Numerous studies have demonstrated positive benefits associated with cooperative based learning in various disciplines and among a variety of participants (Marr, 1997; Springer, Stanne, & Donovan 1997; Smith, Sheppard, Johnson & Johnson, 2005, Tomcho & Foels, 2012). Some of the benefits commonly associated with cooperative learning include increased motivation, greater self-esteem and more positive interpersonal relations (Bossert, 1988). While many of these studies are focused on in–class cooperative activities, experiential learning activities taking place outside of the classroom also positively impact students. In a meta-analysis of adventure education programs, Hattie, Marsh, Neill & Richards (1997) concluded that "there are few experiences in other educational programs that have as much potential to duplicate the quality and immediacy of experiences that occur during an adventure program" (Hattie et al. 1997). Adventure programs most commonly incorporate team-based cooperative learning into their programs while making use of social support within teams as a tool to help accomplish goals.

Numerous options exist for those seeking to use adventure style programs to promote cooperation and collaboration within groups. Some of the most popular of these options include laser tag, paintball, and outdoor adventure style experiences such as 'outward bound' and various types of obstacle courses. Laser tag and paintball offer similar experiences in that they allow individuals or groups to compete with others in a mock combat situation in a less threatening manner. Both are competitive and identify clear winners. Laser tag typically employs hand-held infrared devices which are used to target other individuals wearing infrared sensitive equipment. Whenever an individual is tagged by a user's hand held device, the event is recorded as a point for the individual/team that was able to successfully target their opponent. Paintball offers a similar experience, however as opposed to using infrared targeting devices, participants use a paintball gun which propels gelatine paint capsules at high speed to 'tag' the opponent.

While laser tag and paintball are two unique activities, outdoor adventure experiences are better viewed as a broad category containing a range of different possibilities. These programs can vary in duration from a few hours to several weeks depending on the goals of the program and the focus of the activities contained within it. These programs seek to promote cooperation through team-based activities aimed at improving social connections and fostering problem solving in unconventional, and often unfamiliar, situations. Often promoted as a fun and interesting way to interact with colleagues/co-workers in a unique environment, these activities also encourage bonding and closer interactions between group members through interdependence. There are a number of factors common across programs of this sort including a separation from the everyday routine, engagement with nature, incorporation of physical tasks, an increased reliance on team members to accomplish goals, and the use of small groups. Perhaps the most well-know forms of outdoor adventure programs are the activities which take place in remote locations over several weeks and use challenging physical tasks (rock climbing, forest trekking, hiking, rock climbing etc) to promote confidence and group skills. While adventure programs remain popular, safety has become a critical factor in the design and pricing

of such activities. The deaths of two participants of an Outward Bound trip in Lockhart Canyon, Utah, U.S.A. in 2006 (Ketcham, 2012) in combination with the intense physical nature of many of these activities, has resulted in a revaluation of the appropriateness and safety of adventure education programs in general. In an evaluation of why the Outward Bound trip ended in tragedy the failure of some of the students to cooperate in combination with ignoring trip protocol seems to have been at the core of the problem (Ketcham, 2012).

Selection of Activity

Each of the options listed above was considered for use. However, given that previous research has reported that students involved in these activities generally list enjoyment of nature as highly valuable to the experience (Brown & Haas, 1980; Rossman & Uleha, 1977) and that safety concerns needed to be met, it was decided that a less physically intense outdoor activity would provide the best fit. Also, given the time students spend in the classroom, it was important to create as different a learning environment as possible to encourage an openness to new ideas. "(T)he separation from everyday routine highlights the intensity of the immediate experiences and allows the participants full involvement in the activity" (Gunter, 1987). Additionally, given the intensive nature of an MBA program, and the severe time constraints under which such programs operate, an extended activity that lasted several days was not an option. While longer programs are often viewed as yielding greater benefits for those involved, the meta-analysis of adventure education programs by Hattie et al. (1997) found that "the effects for students were similar regardless of duration" .

After an evaluation of available options an outdoor aerial obstacle course activity was chosen. In addition to participating in the aerial obstacle course, students were required to prepare a presentation following the activity. This presentation allowed participants to reflect on the day's events and the impact these experiences had on them. Students were informed there would be follow up presentations but were not informed of the content of the presentations until after the aerial obstacle course had been completed.

Description of the Aerial Course

A total of 12 students were registered in the MBA program, and the entire cohort participated in the day's activities. The MBA program was structured with intensive sequential courses and the students were over halfway through the program when the aerial obstacle course took place. The aerial activity took place at the point that one course was finishing and another was about to begin. Three additional participants also took part in the aerial course, but were not required to prepare follow up presentations on their reflections of the experience. These additional participants included the program director, a writing/language instructor, and the program administrator; all of the MBA students were familiar with each of these additional participants prior to their involvement in the day's activities.

In order to create some sense of group identities and competition between groups, the 15 participants were divided into three groups with one member from the list of additional participants being added to each team. Each of these groups were also assigned a team colour to create a sense of group identity and required to arrive wearing clothing to match the group colour. In the days leading up to the aerial course, a strong sense of competition develop between each of the teams and competitive banter could often be heard whenever opposing team members were found in the same room. While competitive banter became common place, there was also a sense of nervousness among some of the participants concerning the difficulty of the aerial obstacle course and their ability to complete it. Since none of the MBA students had any previous experience with this kind of activity, there was a sense of discomfort among many of the students related to the unfamiliar activity that they would soon be attempting to complete. On the day of the aerial course, each group was provided with face paint of differing colours in order to further support group identities. Each group was free to determine how they would design the face paint. Some applied war paint designs while other adopted animal designs.

Aerial Obstacle Course and Presentations:
The outdoor aerial obstacle course chosen for this program consisted of numerous obstacles and zip lines divided into 5 separate zones spanning approximately 3 hours. All of the obstacles involved in the course took place above ground in the treetops of a forest outside the city where the university is located. Examples of obstacles involved included: zip-lines (participants hang from a pulley suspended on a cable attached to two points and are propelled along the cable by gravity), rope bridges, suspended walkways, monkey bridges, and rope swings.

In addition to a short preparatory training session, all participants were required to wear a harness throughout the obstacle course in order to ensure safety. The safety system consisted of two carabineers used to secure participants to safety cables throughout the course. After the successful completion of each obstacle, participants were required to detach themselves from the completed obstacle and reattach their carabineers to the safety cable for the following station. As an additional safety precaution, individuals were required to ensure that at least one carabineer was attached to a safety cable at all times. Employees on the ground observed participants throughout the course to ensure adherence to this rule. If any individual was caught with both carabineers detached from the safety cable three times they would be removed from the obstacle course and would not be allowed to continue participating. Additionally, if any individual felt uncomfortable during the obstacle course, due to a fear of heights for example, they could chose to be escorted back down to ground level and remove themselves from the day's activities.

While groups completed the obstacles in succession, due to the nature of the course, each obstacle could only be completed individually. Each obstacle was strung between trees. The program operators allowed two individuals on the platforms on each tree and one on each obstacle. In other words, although teams could support each other with verbal encouragements,

there was limited ability to physically aid others in the successful completion of each obstacle. Since groups completed the obstacle course back-to-back, interaction inter and intra group could occur throughout the course.

Following the completion of the aerial obstacle course the entire group was moved to a new open air location with tables, flip chart paper and markers. Each group was given approximately 1.5 hours to prepare a 15-20 minute presentation based on their experiences throughout the day and its perceived effects. The students were also given a list of questions to answer in their groups. Questions focused on strategy, values and feelings. See Appendix 1 for presentation assignment and questions.   Each group presentation was digitally recorded for later analysis. The presentations and the participation in the aerial were graded for participation grades in two courses – Strategic Management and Business Ethics.

Student Feedback: Themes and values
Presentations following the aerial obstacle course gave students a chance to reflect on the experience and what they learned from it. Preceding the day of the aerial activity, during the activity and the following presentations numerous themes emerged. The most common of these themes across the cohort of students are discussed below.

The Value of the Experiential Activity
Before the day of the aerial activity students were commenting on how much they looked forward to participating in a group activity held outside the classroom that everyone was involved in and that provided a change of venue and objective. While there was some apprehension concerning their ability to complete the obstacle course, students welcomed the break from their everyday routine and found the aerial course and the outdoor environment in which it took place to be an attractive event to look forward to. Considering the intense nature of the MBA program, many students viewed this as an opportunity to relax with their cohort and de-stress before the start of their next class. Students also reported feeling that they were being treated as "more than just students" and valued the chance to do something more removed from the standard MBA experience. The fresh air and ability to interact with nature in a new location with treetop views also added to the draw of this activity for the participants. Additionally, students commented that it was going to be enjoyable to include the program director, writing/language instructor, and program administrator in their adventure. The entire cohort brought along cameras to document the event and were excited to take pictures with those involved. Pictures taken by group members were also posted to a departmental website and helped to create a sense of cohort identify as students were proud of their involvement and completion of the obstacle course.

Competition and Cooperation

In the days leading up to the event, strong competition developed between students as they seemed to believe that the team divisions were an indication that the aerial obstacle course would be a competitive team based activity. As mentioned, this initial competitiveness may have also been partially due to the fact that the aerial course was an unfamiliar activity that students were somewhat apprehensive to take part in. Since students were unsure of how difficult the course would be, their ability to complete it was questioned. Students reported "waiting to be the last group to see how others do it" A_4, threatening sabotage of other participants to ensure they would not be the first to fail, and even interfering with other participants while they were trying to navigate the course. For example, one student reported shaking the safety cable of an obstacle another student was currently engaged in to create more difficulty for that student "I started to tap the rope by my feet… so she might fall" A_4. Despite these initial problems, once students began to get more comfortable with the aerial course, they quickly realized that competition was not the goal of the activity and that the groups were more of a support mechanism that the students could use. With this realization, competitiveness seemed to wane and support between and among groups increased (the student mentioned above expressed regret for his actions and apologized to the student he interfered with).

Two student groups also reported 'synergy' as an important value to their teams - a word that suggests the important role cooperation played in the day's activities, and believed this was a key to their success. In addition, 'teamwork', 'support' and 'friendship', were also reported as important values during group presentations and indicated the recognition of cooperation as a valuable element. By the time teams had reached the final zip-line, all group members cheered for each student as they completed the final task. The previous competitive atmosphere had been replaced by inter and intra group cooperation and support. This cooperative atmosphere was also evident in the socializing that took place between groups during and after the aerial course. "When we arrived we understood that it is completely different and we tried to support each other and other groups. Our strategy completely changed" A_2

Individuals Vs. Groups
Most students reported having a strong sense of accountability not only to their teams, but also to the entire group of participants. As one student stated, "each of us was responsible to other group members and other groups as well" B_2. Students were initially concerned that they might hold back the group and be the reason their team was unable to complete the course. Student presentations revealed that groups attempted to use strategies that would take advantage of each member's individual strengths to make the group stronger and more effective as a whole. According to one group, whenever the group failed, or did not perform up to the desired standard, individuals re-evaluated their roles within the group to see how individual actions could be changed to benefit the group. Additionally, the successful completion of the course was reported as both a group and individual victory by during their presentations. "All group

members were trying to think about other members, even other groups" B_3. We thought that maybe we should encourage other groups as well. A_4

Leadership
Although group work and cooperation were mentioned by all groups during their presentations, it was evident that in each group there were also clear leaders who took charge of guiding their teams to successful completion of the obstacle course. This leadership was clear both during the actual activity and in the post-activity presentations as well, and these leaders were observed directing group members on where to stand and even when to speak during presentations. Despite the clear identification of strong group leaders, each group member also had the chance to serve as a leader to other students during the obstacle course. An advantage of the fact that only one student could complete an activity at a time, students who had completed an obstacle could coach the following student on how to best navigate that same obstacle. In this way, even those students who rarely if ever got the chance to take the role of leader in their everyday lives were able to gain experience in this role and help others complete the course.

Confidence
Increased confidence was often reported during student presentations. The initial stress associated with facing a new and unfamiliar activity was quickly replaced by increasing confidence as students began to successfully complete the aerial course. Students reported that their confidence increased with each obstacle they were able to conquer, and this increased confidence led to better results. The reciprocal nature between confidence and results increased as the day progressed and additional obstacles were overcome. Encouragement and support from other students also helped to increase student's confidence as participants were often clapping and cheering for people both within and outside their groups. As one student reported, "our confidence just grows up, especially when our friends are helping and encouraging us" A_3. Another group reported that a fellow team member "tried to boost the spirit(s) for all group members, not just our group members, all group members… she tried to convince everyone that they can do anything" B_2.

The fact that the activity chosen for this study was relatively easy to complete may have also helped to increase both cooperation and confidence since participants were initially unsure of their ability to finish it, but were proud of themselves once they realized they could in fact complete the course. In addition, as previously mentioned, the opportunity for each participant to act as a leader and coach others on how to complete obstacles may also have acted to increase confidence among students. This may have been particularly beneficial to quieter students who rarely get the opportunity to act as a leader in their standard classroom interactions.

Discussion

The central contributions of this paper include (a) understanding when a cooperative approach is better than a competitive approach, (b) emotional connection enhancing receptivity to subject matter, (c) the importance of shared leadership, and (d) linking confidence and cooperation. According to Minztberg (2004), MBA students are taught how to analyze but not how to manage. Management, according to Mintzberg, is a blend of insight, experience and analysis. Having MBA students partake in an experiential outdoor activity is a way to provide insight and allow students to analyze their shared experience. This activity went beyond theory or cases analysis. It was personal and relevant to the cohort as a whole in how they interacted and viewed each other and their entire cohort.

When a Cooperative Approach is Better
During the aerial activity students adopted a helpful and cooperative means of interacting. However, of more interest is the initial assumption that the grouping of the students and the activity was naturally a competitive group interaction. Given that in the aerial activities there were many observers, the success or failure of a team or team member would be obvious, and this contributed to a sense of competitiveness. However, if the students had a fuller understanding of cooperation and competition they would have considered or asked about what reward would be given for completing the activity. As there was no tangible reward a more cooperative behaviour was appropriate among inter and intra group participants. Cooperation was also relevant given the safety and sometimes fear attached to the obstacle course. This assumption of competition over cooperation was likely the extension of the normal competitive intergroup relationship of the cohort in their MBA courses. This highlights the need to teach about cooperative behaviours, when such behaviours are appropriate and to reinforce the benefits of cooperative interactions. MBA students gain a wealth of experience working in groups but as this activity highlighted they are not as clear on when the competitive approach should be replaced with a cooperative approach. Students should be able to assess in advance when a cooperative rather than competitive approach will create a more effective outcome. This way the cooperative linkages can be established early and lead to innovative means for success.

Emotional Connection Enhancing Receptivity to Subject Matter
Creating the same level of understanding about the ideal approach to a task and when a cooperative approach is more appropriate, even if the competitive approach initially seems more fun, is more difficult and at times artificial since it focuses only on theory or theory and an in-class activity such as a case. The difference in this study is that the aerial activity impacted the participants on an emotional level not just an intellectual level. The emotions arose because some students experienced a level of fear given the height and perceived difficulty of the obstacles. Each participant in the aerial activity recognized that their success was not just a physical undertaking. It required encouragement and support by all for the groups to succeed. After the activity the MBA students easily spoke about the two modes of interaction and provided many examples of their initial assumption of a competitive approach and their transition to a cooperative approach. In providing these examples they talked about their emotional experiences

transitioning from a competitive to a cooperative approach. This learning supports prior research by Buskist and Saville (2012) that creating an emotional connection between student and subject matter increases the student's receptivity to the subject matter. Students could easily understand the differences between competitive and cooperative paradigms having experienced the different approaches on an emotional level.

Shared Leadership
Bennis and O'Toole (2005) argue that theory-based learning is far less effective in business than in the study of law and science. With high variance in human activity and judgment, theoretical models fail to accurately describe business environments and experiences. In addition, MBA programs are criticized for a lack of attention to leadership (Butler, Johnson & Forbes, 2008). The aerial program created an unexpected opportunity for leadership by individuals who usually adopt the role of follower. MBA class work is often completed in groups with the same students repeatedly taking the leadership roles in these groups. This is particularly true in MBA programs that require students to establish groups for the duration of the program. The sequential nature of the aerial activity created a need for a different type of leader, leaders that arose out of necessity, not selection. Also, given the nature of the task, groups ended up with more than one leader per group. At times all group members acted as leaders in a form of cooperative leadership. Such an experience in shared and cooperative leadership reflects human variation and provides more direct experience than theory from a text on leadership or cooperation.

Linking Confidence and Cooperation
Hollenbeck and Hall (2004) argue that managers need to pay more attention to self-confidence and its link to leadership success. In order to develop confidence one must place themselves in situations that stretch their capabilities and take risks "Self-confidence is based on perceptions, both of our capabilities and of what the task or challenge requires...Our self-confidence concerns what we believe we can do with what we think we have and what we think we have to do" (Hollenbeck and Hall, 2004: 257). In other words, self confidence is built on perceptions. For the MBA students in a competitive MBA program their sense of ability, that contributes to self confidence, is influenced by the other students in the MBA cohort and the abilities the students have writing papers and exams, making presentations and analyzing data. This is particularly true in a competitive environment where the rewards, such as grades, are limited. Changing the task requirements, by having the classroom in the trees and making the class work cooperative, allowed for a change in the source of confidence for students. This helps to challenge assumptions and generalizations about participant's abilities and therefore change their self confidence. In addition, the cooperative behaviour of the cohort cheering each other on contributed to an enhanced sense of confidence. Not only is the confidence built on an individual bases but also as a group.

Conclusion

MBA programs stress and reinforce competitive interactions among students and groups of students. Cooperative behaviour, while equally as relevant in a working environment, is often overlooked or under emphasized in the MBA setting. The purpose of this activity, completed with a cohort of MBA students, was to provide an activity that encouraged students to consider these two modes of interaction and when cooperation might be more effective than competition.

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Appendix 1

Group Presentations

Using only the resources provided (flip chart, pens and paper) and your experience and understanding of the subjects of Business Ethics and Strategy prepare a 20 minute presentation. Resist the urge to look up info on cell phones. The questions to answer for your presentations are included in the envelope. Remember to personalize your presentation with examples from your group experience. You can use the flip chart paper to itemize key points (story board as in DVD Presentation Zen) or for drawings and pictures. All group members must be part of the presentation. Focus on making key points and on making the presentation interesting and creative.

There will be three grading measures used for your presentations: Timing, presentation skills and content.

Questions for Presentation Content:

Q1: Which values (max 5 each) helped you individually and your group complete the aerial course successfully? See the list of values by Pavlina, Steve (2012). List of Values. Retrieved July 19 2012: http://www.stevepavlina.com/articles/list-of-values.htm. Explain through example. How are these values useful in the work environment? Explain.

Q2: During the aerial experience did you or your group experience the moral emotions (embarrassment, guilt and shame). How did you deal with this and how did individual and group empathy help deal with these emotions?

Q3: How did your group work together to complete the course? What advantages were there working in a group. How does the aerial experience help inform (provide insight) into group dynamics?

Q4: What planned strategy did you have individually and/or as a group to complete the aerial course? Remember a planned strategy may just be in your head it does not have to be written down. Did you or your group end up with an emergent strategy? If you had a planned strategy how was your emergent strategy different from the planned strategy? Explain.

Q5: What capabilities did your group members provide for the success of your group in completing the aerial course? Did your group develop capabilities as you progressed along the aerial course? Explain.

Q6:If your group was completing the aerial course again at another time what capabilities and resources would you develop in order to have a competitive advantage over the other groups?

ASSESSING STUDENT PERFORMANCE: THE CASE OF THE MANNING SCHOOL OF BUSINESS

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ABSTRACT

Business Schools have focused increasingly in recent years on assessing their effectiveness in providing students with the knowledge and skills they need to succeed in their future careers. From a assessment process point of view, this emphasis has led to concerns related to total quality management, process improvement, and other management tools that emphasize the importance of decision making based on quantifiable data. This paper describes an approach developed at one Business School in the northeast to establish these metrics that help to assess the extent to which the School is achieving its instructional objectives.

Assessment, Learning Objectives, Accreditation

BACKGROUND

There are many questions underlying efforts to more effectively measure student performance. These may be thought of as falling into at least two broad categories: 1) the extent to which students acquire knowledge and skills that maps what effective managers need to know, and 2) the degree of congruence between what students are learning in the classroom and the school's programmatic learning goals. These suggest such questions as: Are students learning subject matter content that has conceptual and practical value? Is there an appropriate balance between theory and application? To what extent are graduates able to effectively apply what they have learned in actual work situations? Do current teaching methods facilitate ease of application? How strong is the relationship between what is actually taught in our courses and the school's program-level goals, that is, are we in fact teaching our students what we believe they need to know? Are our methods of measuring student performance soundly-based in terms of their reliability and validity?

In an attempt to answer these and other questions, colleges and universities have adopted a wide array of approaches ranging from generic standardized assessment instruments applicable in any

school to in-house methods that are specific to an institution's unique circumstances and goals. Often a school's motivation for implementing an assessment process is partly extrinsic (i.e., compete more effectively with competitor schools; comply with formal accreditation requirements). Many of us are familiar with these requirements as articulated by the AACSB-International. This paper discusses the results of a program evaluation strategy instituted in one business school. We conclude with a serious of more general considerations relevant to the implementation of an effective outcomes assessment process.

PREVIOUS RESEARCH

Assessment of student performance, and how to deliver course material effectively, has long been of interest in academia. One direction has been to focus on how to integrate student learning across the curriculum. Some schools, for example, have spread disciplinary content across several courses (e.g., global issues). Athavale et al. [1] surveyed college Deans and found general support for this idea. What is relatively new is the tying of student outcomes at the course level to school-level learning objectives. Chen et al. [4] focused on assessing the impact of a tool known as Enterprise Resource Planning (ERP). They found that there to be a paucity of literature evaluating the effectiveness of ERP-based methodologies. Another approach reported in the literature is to assess the effectiveness of individual classes (Varner and Pemerenice) [9]. These authors describe many of the important characteristics of assessment tools including measures of their reliability and validity.

Several schools have designed tools that assess their overall curriculum. The results of one study are discussed by Callahan et al. [3]. In this case, one of the learning objectives was effective communication. This was considered to be an accreditation-related priority and an overall curriculum development and assessment need. Another common approach is for business schools to develop specific learning objectives. Dana et al. [5] addressed the effectiveness of a writing-across-the-curriculum approach to meeting the objective of effective communication. Their assumption was that this is a more effective strategy than, for example, requiring all students to take an English course. Fraser et al. [6] also looked at the learning objective of communication. These investigators used the assessment tools employed in the business writing course to evaluate the entire business program.

Yousif [11] looked at student outcomes in quantitative courses and found that performance depended on a large number of factors including a student's area of specialization, age, gender and high school background. This suggests that assessment methods might more appropriately be based at least in part on individual differences rather than on use of standardized instrumentation. Kelley et al. [7] reviewed the assessment activities of approximately 50 accredited institutions based on survey data provided by school Deans. They reported the

relative success of these programs on a number of specific attributes including cost and participation of faculty. Nicholson et al. [8], in reviewing the results of several marketing assessment programs, found that few programs applied a range of assessment tools. Rather, they tended to rely extensively on self-reports. Similar studies have been carried out by other (e.g., Walvoord and Anderson, 2010) [10].

THE ASSESSMENT PROCESS

The remainder of this paper describes the program-level assessment process used at a northeastern business school. In general the process has been fairly successful at measuring program-level learning outcomes. Since the school is scheduled for re-accreditation in FY2013-14, external feedback will soon be available regarding the adequacy of its approach, a key component of which is the development of measurement rubrics based on the following six-step model:

Figure 1
The Assessment Loop
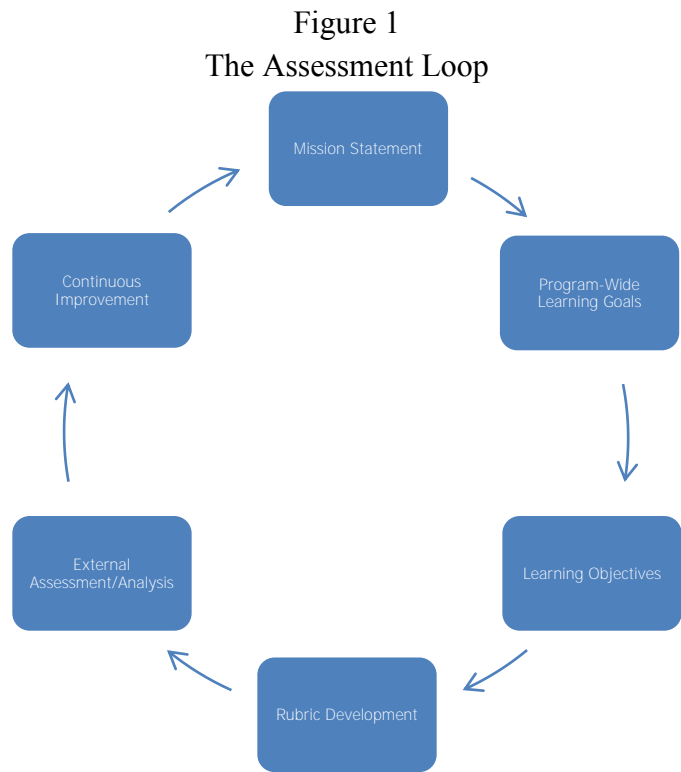
Step 1: <u>Creation of the school's mission statement</u>: This is a highly challenging task that can take months or longer to be fully and clearly articulated, and may sometimes emerge as a compromise statement. Issues that can arise include honest disagreements among stakeholders, resistance to change driven by individual or sub-group self-interest and organizational politics, a

paucity of ideas that conceptualize a desirable organizational future, difficulty identifying appropriate language that clearly and precisely captures key mission concepts, relationship issues among key participants, and failure to create a mission that will be perceived as inclusive to all organizational members.

Step 2: <u>Identification of program-wide learning goals</u>: Once the mission was established, specific learning goals had to be deduced. Learning goals articulate the pathways to mission achievement. For example, a learning goal may be: "Our students will be aware of global cultural differences affecting business practices." This goal is easy to state but, in part because of its level of abstraction, can be difficult to operationalize in terms of appropriate, quantifiable metrics.

Step 3: <u>Identification of learning objectives that will achieve programmatic learning goals</u>: This step requires "drilling down" to the individual course level. To do this, we applied a technique known as Primary Trait Analysis (PTA). PTA involves identifying in course assignments student performance factors, or "traits," that are both relevant to the course and to specific program-level learning outcomes.   For example, regarding the global cultural objective mentioned above, the following statements were developed:

Successful students will be able to:
  - Identify cultural differences and their implications when dealing with customers.
  - Identify cultural differences and their implications when dealing with co-workers.

Step 4: <u>Development of appropriate metrics to measure the performance indicators</u>: This step involved the creation of a scoring rubric that identified, in quantifiable terms, degrees of student learning with respect to each objective-relevant factor. These metrics were developed at the class level and were based on Bloom's taxonomy of educational objectives [2] (see Figure 2).

Figure 2: Bloom's taxonomy
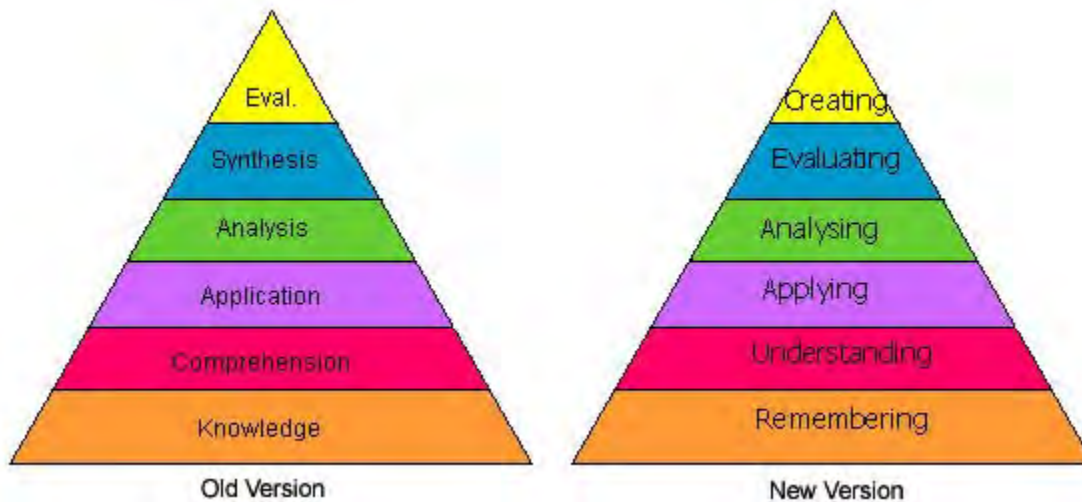
Bloom's model indicates that there are several hierarchical levels of learning that vary in terms of complexity and depth of comprehension. We applied Primary Trait Analysis to each of these levels:

Evaluation: define, argue, assess, judge
Synthesis: compose, create, design, propose
Analysis: compare, contrast, evaluate, analyze
Application: apply, choose, employ, practice
Understanding: describe, explain, classify, discuss
Knowledge: memorize, recite, name, identify

At this stage, we identified specific courses that contained content relevant to specific learning objectives, and which could therefore be used to determine if learning objectives were being met. Instructors then selected specific assignments (e.g., exams, cases, etc.) that could be tied to the specific performance indicators. Appropriate rubrics were then developed that contained quantitative level-of-learning measures (based on Bloom). These were used to evaluate the extent to which student learning relevant to each learning outcome had been achieved.

Step 5: <u>Determination of how well the school was doing in achieving learning goals (external review)</u>: At this stage, samples of student performance, along with appropriate measurement rubrics, were sent to professionally qualified outside reviewers who evaluated how well students performed relative to the levels of learning identified in Bloom's framework. The results were then sent back to the appropriate school committees (i.e., the internal stakeholders in the

assessment process) who reviewed the results and used them to develop recommendations for ongoing continuous improvement efforts.

Step 6: Continuous improvement: In this step, it is essential to follow through on committee recommendations. Questions the review committees should address include:

- What program elements are working well? Are any working poorly, and why?
- What prerequisites should be added or subtracted?
- Are our standards of achievement appropriate for our students?
- Are our assessment methods yielding information that we care about?
- Overall, are the school's courses adding value in relation to overall program goals?

At this stage, the data are summarized on analysis sheets designed for this purpose, and specific program improvements are suggested. These recommendations may include: adding courses, eliminating courses, changing course sequencing, adding online components, changing prerequisites, changing admission standards, or creating/modifying/eliminating entire programs. Clearly, these suggestions vary in the ease or difficulty of implementation. At this point, the assessment cycle returns to Step 1.

DISCUSSION

There are several other important data-related issues that need to be addresses when using this learning assessment strategy in an outcomes assessment program. These include:
- How much do you tell the students from whom performance data are being gathered about the school's overall assessment program?
- To what extent should students be informed more specifically by their instructors about why they are being included in this process?
- Should they be prepped in advance regarding the specific topics to be covered in the data gathering?
- Should students be told that they will receive some extrinsic reward for participating (e.g., additional credit toward their final course grade)? In this regard, should student participation be voluntary or required?
- Should their performance on the assessment be included as a formal component of their course grade and included on the course syllabus?
- Given the resource and time constraints that often affect the development of instrumentation and other aspects of the assessment process, how valid are the collected data in measuring what they are intended to measure? To the extent there are questions about data validity and reliability, care must be taken before deciding to act on assessment program results.

- Should there be consistency from one course to another will respect to several of these issues?

The school that conducted the learning assessment process described above has been at it for four years, and it has proven to be a challenging, though valuable, activity. As one might suspect, three of the biggest challenges are finding sufficient time to do it properly, eliciting sufficient faculty participation and faculty resistance to change. As with many new initiatives, there are a minority of faculty who will never "buy in." Another major challenge emerges when it is discovered that the school's learning goals do not reflect what is actually going on in the classroom. If this is the case, either the learning goals must be changed, or course content reviewed and modified. We do not yet have all of the answers to these and other questions. To date, however, we have completed one full assessment cycle, as outlined in Figure 1 and are slowly overcoming the challenges noted above.

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Sustainable Educational Practices: The Case of Liberia - Where Are We Now?

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ABSTRACT

This research concentrates on the on-going development of an academic program in Liberia. The focus of The Joshua Generation Program (JGP) is to develop and offer innovative academic programs for a generation of students who are in dire need of such opportunity. The academic programs are a first step in JGP's long term goal of helping to rebuild Liberia through education, economic development, civic and business leadership, and community service.

This study details the initiatives launched after an academic workshop conducted in December 2010 at the Justina L. Goods Memorial Foundation School (JLG) in Monrovia Liberia. The workshop resulted in the first online teacher training development program at JLG and a book drive conducted in 2011.

Originally we initiated the online teacher training program to help teachers enhance and develop lessons designed to teach students appropriate course level material in a manner that would be applicable to their communities. Our intention was to help the teachers establish professional relationships; obtain and develop educational materials; increase their personal knowledge; increase technology usage; and utilize educational services provided via the teacher training program.

Teachers Without Borders (TWB) provided online training courses but several were unable to be completed due to a lack of financial resources, sporadic access to the Internet, and teachers not understanding how to effectively use the online discussion boards. After collecting feedback and suggestions from the teachers, mentors and advisors, JGP decided that it was necessary to redirect a portion of our focus to obtaining some basic resources. This study reports the redirection efforts to deliver low cost education in Liberia.

Keywords: Liberia, education, teachers, leadership, innovation, sustainable, community

THE AWARENESS OF DIABETES AND ITS COMPLICATIONS IN A DEVELOPING COUNTRY

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ABSTRACT

Diabetes is a common disease affecting the general population in developing countries. According to Diabetes Association of Nigeria, about six million people are estimated to be living with diabetes in Nigeria. In this paper, the authors conducted a survey of educated and non-educated individuals, on the awareness of diabetes and of its complications. Our results show that while there is no significant difference in the awareness of the disease, the educated group showed more awareness of its complications. Based on our results we conclude an effective healthcare promotional strategy should aim for awareness of both the disease and its complications.

Diabetes, awareness, complications, risk, healthcare

INTRODUCTION

We have heard of a famous adage - "prevention is better than cure." Preventing a disease from occurring is far better than trying to cure the disease after it has occurred. In other words, being proactive is far better than being reactive. Non-communicable diseases (NCDs) such as diabetes, hypertension, and kidney damage can be prevented if adequate prevention and health promotion activities can be put in place.

Diabetes Mellitus, commonly known as diabetes, is a disease in which there are high levels of sugar in the blood, due to, either the body not producing sufficient insulin, or the cells not responding to the insulin that is produced. This, often times results in morbidity and mortality. Diabetes is the leading cause of health complications including blindness, heart disease, stroke, renal failure, neuropathies (amputations), and infant mortality resulting from deliveries involving diabetic pregnant mothers [11] (Norris et al., 2002).

The analytic framework for disease and case management interventions states that there are three entities involved in disease management - the healthcare delivery system, the healthcare provider, and the patient [11] (Norris et al., 2002). The healthcare delivery system provides the

structure, resources and processes that govern the healthcare delivery activities of the providers. The healthcare providers perform the functions of diagnosis, screening for complications, and prevention and treatment for patients. The patients, who are the recipients of the providers' actions, need to have sufficient knowledge about the disease so as to determine appropriate self-care behavior, which in turn will impact short-term and long-term health outcomes [11] (Norris et al., 2002). In this paper, we focus on the role of the patient in terms of the knowledge, in improving disease management.

Controlling the incidence of diabetes and treating the disease successfully depends on a combination of disease management and health care promotion strategies. The success of these strategies depends on the knowledge base of the patients regarding the disease and cooperation not only of the care givers but also the patients. The Disease Management Association of America defines the concept of disease management as "a system of coordinated health care interventions for populations with conditions in which patients self-care efforts are significant" [4] (DMAA, 2004). According to [10, p. m177] "the goal of [disease management] program is to offer a continuum of care that uses guidelines and case management protocols to prevent acute care episodes, achieve improved outcomes, and reduce healthcare costs". It is with this background that this study was conducted. In this paper, we empirically test the rate of awareness of type-2 diabetes in Nigeria.

LITERATURE REVIEW

Non-communicable diseases (NCDs) are on the rise worldwide. Studies conducted by the World Health Organization [17] showed that four main NCDs – cardiovascular disease (CVD), cancer, chronic lung diseases, and diabetes, kill three in five people worldwide, and cause great socioeconomic harm within all countries, particularly in developing nations. The prevalence of diabetes in Africa was estimated at 12.1 million people in 2012. By 2030, this figure is expected to rise to 23.9 million [16] (Sicree, Shaw, and Zimmet, 2009). A study shows that the incidence of diabetes as well as the burden of the disease is increasing [1] (Adeleye et.al, 2006). The WHO country profile on NCD for 2011 shows that these diseases account for 27 percent of all deaths in Nigeria. [9] list other complications of diabetes contributing to mortality such as neuropathy, foot ulcers, retinopathy, microalbuminuria, and coronary health disease. The prevalence of these chronic complications of diabetes in hospital inpatients and outpatient clinics are shown in other studies [2] [3] [12] [13] [14] [15]. This high level of mortality is due, in large part, to inadequate funding for the health sector of the country. Funding includes education campaign, purchase of testing kits, and affordable treatments such as oral glycemic drugs and insulin administrations.

Existing body of literature reveals that Nigeria continues to give anemic support to health care of its citizens. [7, p. 514] document that "Only 0.7 percent of the nation's gross domestic product is spent on health care and only 0.2 percent of the GDP is used for public health care services and facilities". This is a major discrepancy in funding compared to the United States' expenditures on medical care. The U.S. health care expenditures have been steadily increasing over the past several years – from $1.13 trillion (or 13.2% of GDP) in 2000, to about $1.9 trillion (or 15% of GDP) in 2005, to a projected $2.6 trillion by 2010 [6, p. 2-3]. In an advanced country like the

U.S., both the federal and state governments programs (largely medicare and medicaid), and the employer-based health benefits plans have contributed to these increasing expenditures.

In the case of Nigeria the extreme underfunding has led to inadequately equipped and inadequately managed health care system. The level of health care support falls way below the percentage of GDP recommended by the WHO for developing countries. [8, p. 4] posited "This critically small investment in health care makes it difficult to handle effectively the burden of preventive deaths and other challenges such as AIDS, tuberculosis, typhoid, malarial diseases, and 'Western-world-type' diseases such as high blood pressure, heart diseases, and diabetes". This situation exists despite the various attempts and efforts that seemed to be geared toward addressing the need for health services. The government's first policy attempt was documented in the *National Health Policy and Strategy to Achieve Health for All Nigerians* [8]. The aim of the policy was to provide the federal, state, and local government health institutions and their functionaries, other health related organizations including international agencies, and non-governmental organizations with a formal framework for an appropriate national direction in health development in Nigeria. This strategy has still not been fully realized.

RESEARCH METHODOLOGY

The surveys were conducted on two different groups in Lagos, Nigeria. The first group consisted of educated individuals who were college students with at least a bachelor's degree. The second group consisted of individuals with less than a high school education. 100 subjects were randomly selected from each group. The subjects were asked questions on their awareness of diabetes as a disease and of possible complications that could arise from the disease such as eye problems, amputations, stroke, and kidney damage. Statistical tests of significance between the two groups were conducted using an online calculator. The results of the survey are discussed in the following section.

DISCUSSION

The results of the survey reveal that 87% of educated individuals sampled in the first group are aware of the prevalence of diabetes, as compared to 84% of the non-educated individuals in the second group. A statistical test shows no significant difference in awareness of diabetes, between the educated and the non-educated groups (*p-value > 0.05*) (See Table 1). This signifies a high rate of awareness of diabetes as a disease in Nigeria, a country with case dense population of over six million. However, there is a significant difference in the awareness of complications arising from diabetes between the two groups. The statistical results are shown in Table 1 (*p-value < 0.05*). The individuals in the educated group have greater awareness of complications from diabetes than those in the non-educated group. This could explain the fact that, in Nigeria, when there is a report of an incident of death from diabetes, it could in reality, be a death arising

from the complications of the disease, rather than from the disease itself. If the occurrence of diabetes is controlled, the risk of developing complications from diabetes will be minimal.

Table 1: Results of Diabetes Awareness and Related Diseases in a Developing Country

	% of Educated Individuals n = 100	% of Non-Educated Individuals n = 100	Z – Test P-Value < 0.05
Awareness of Prevalence	87	84	0.5485
Diabetes complications of Eye Problems	69	14	0.00
Diabetes complications of Amputations	83	16	0.00
Diabetes complications of Stroke	74	18	0.00
Diabetes complications of Kidney Disease	70	20	0.00

Survey results were further analyzed by comparing the awareness by gender in the sample. The statistical results show a significant difference between the degree of awareness among males and females (*p-value < 0.05*), as shown in Table 2. When we look at all individuals in the sample, the female population has a greater rate of awareness than the male counterparts. Furthermore, gender analysis was done within each of the two groups. In the group with educated individuals, there is a significant difference between males and females in the rate of awareness of diabetes (*p-value < 0.05*). The rate of awareness is higher in females than in males, as shown in Table 2.

However, in the group with the non-educated individuals, there is no significant difference in awareness between males and females (*p-value > 0.05*) (Table 2). The rate of awareness in females is more than in males.

Table 2: Gender Awareness of all Individuals, Educated and Non-Educated Individuals

	Male (%)	Female (%)	Z-Test P-Value < 0.05
All Individuals	80	96	0.00362
Educated Individuals	81	97	0.0226
Non-Educated Individuals	79	94	0.06876

CONCLUSION

We can conclude from our analyses that, in Nigeria, there is a general awareness of the prevalence of diabetes as a disease. There is greater awareness of its complications among the educated individuals than among the non-educated individuals. While it remains a fact that diabetes cannot be cured, we can, however, mitigate the risk of developing the disease and control its existence through an effective awareness campaign. Currently, testing centers are localized to hospitals and specialized clinics. Most people only get tested for diabetes when they become sick and are taken to the hospitals. A proactive strategy of conducting effective health fairs with diabetes testing programs can facilitate early detection of diabetes and mitigation of its complications. Furthermore, people should be educated about the importance of physical exercise, diets, weight control, and annual physical examinations. With a change in lifestyle, the incidence of diabetes and other NCDs will effectively decrease in Nigeria and in other parts of Sub-Saharan Africa.

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NEDSI 2013

An exploratory study

Constructions and Deconstructions of Innovation in Education

Reflections on the presently paradoxical role
of technological innovations in education...

April 2013

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Constructions and Deconstructions of Technological Innovations in Education

Constructions and Deconstructions of Innovation in Education

*Reflections on the presently paradoxical role
of technological innovations in education...*

Abstract:

The present paper argues that technological innovation in information systems is the new dominance paradigm in education. This paradigm has led to a large scale adoption of a wide variety of 'innovative' information systems categorized as 'learning management systems', 'simulations' and 'adaptive learning platforms' amongst others. However, as a structural phenomenon, the dominance of technological innovation in information systems serves as a two edged sword: it serves to facilitate creative constructions, which produce a strong positive impact on educational objectives. The dominance of technological innovation in educational information systems also facilitates creative deconstructions, which would otherwise not be possible. These deconstructions are those which deviate from the purpose of innovation and the purpose of application of innovative technology in education. The present paper draws from various theories to provide a conceptual analysis of innovative 'features' and the permutations and combinations of these features, which constitute the nature of these artifacts. We do this with a focus on understanding the various dimensions of the technological innovation in education as well as the results envisaged by these efforts. Our explorative analysis of various technological innovations ends with a call for increased due diligence and student-teacher perspective based evaluation frameworks for the adoption of technological innovation in educational information systems.

Constructions and Deconstructions of Technological Innovations in Education

Introduction

" Artificial-Intelligence Computer System 'Watson' Goes to College" (Chronicle of Higher Education, 01.30.2013) reads the headline of a recent news update. The article goes on to provide additional details on IBM's artificial-intelligence computing system named "Watson" which is being provided to Rensselaer Polytechnic Institute, NY. The expectation here is that "...the Watson system will give professors and students an opportunity to find new uses for the technology, allowing students to gain experience with big data analytics and, in turn, deepen the system's abilities..." (Michael Henesey, VP for Business Development, IBM - 01.29.2013). Enterprise level decisions, on the adoption of technological innovations in educational information systems, are being taken by parties with mixed interests - this need not necessarily serve the best interests of teachers and students. An insightful study by David R. Johnson (2012) states that there is a significant "difference in views between the professoriate and administration about how technology should be implemented in academe thus constitutes a fault line for future conflict." In other developments, we see a host of companies rushing to grab a piece of the information systems driven "Adaptive Learning" pie. Known names like McGraw Hill and new companies like Knewton, KnowRe, Knowillage Systems, WizIQ and Area9, along with many others, have been rapidly raising money and investing into adaptive learning technologies. Arizona State University (ASU) is one of the first major institutes to actually deploy the use of adaptive learning systems on a significant scale (InsideHigherEd, 1.25.2013), thus converting "its classrooms into laboratories for technology-abetted "adaptive learning" -- a method that purports to give instructors real-time intelligence on how well each of their students is getting each concept...". While ASU leads the way in an experimental fashion, exploring how instructors can use adaptive systems to gather intelligence on student learning curves, other approaches

include the substitution of the traditional learning methods with adaptive learning, including the replacement of human instructors with adaptive learning systems. A plethora of additional technological innovations in educational information systems have already become commonplace - these include but are not limited to 'learning management systems' (LMS), knowledge management systems (KMS), automated testing and evaluation systems and a wide variety of educational simulations and 'games'. Thus the present and emerging scenarios appear to make the otherwise relatively stable and well-grounded academic domain a highly volatile and unpredictable ground for most of its stakeholders, including students and teachers. Schuster and Finkelstein (2006) call the role of innovative and "unpredictable" technology in education a "wild card". It is evident that we cannot continue to gamble and experiment with students and teachers by the unfettered adoption of technological innovations in educational information systems. The present study is one small step towards developing a shared understanding of the constitution of valuable 'constructions' of technology which help students and teachers achieve educational goals and separate it from value-scuttling 'deconstructions' of technology which distract and bear the capabilities to hinder educational goals.

Theoretical foundations and relevant literature

Structuration and innovation

The theory of structuration (Anthony Giddens, 1986), hyper-simplified posits that human behavior is subject to societal structure while simultaneously, over time, shaping the evolution of societal structure in which the behavior is expressed. The nature of learning management systems in education and other technological innovations in educational information systems have been shaped by the academic requirements and pedagogical frameworks. However,

simultaneously and over time, academic requirements and pedagogical frameworks themselves are being shaped and developed and formed based on the nature and behavior of learning management systems in education and other technological innovations in educational information systems. This creates an evolving and dynamic environment for participating institutions and artifacts to co-evolve in an interactive manner. This co-evolving and dynamic environment is also the operating framework for the future development of learning management systems in education and other technological innovations in educational information systems. This kind of 'appropriations' (DeSanctis and Poole, 1994) or behavioral adaptation lend itself to the structuration process with respect to innovation. This provides us a with a lens to view the interaction of technology and educational goals, and understanding the role of complexity.

Complexity and simplicity

"Complexity" and "simplicity" are two concepts that have received much attention from various academic and professional disciplines. Well known physicist Murray Gell-Mann (1995) points out that "...a variety of different measures would be required to capture all our intuitive ideas about what is meant by complexity and by its opposite, simplicity". He also studies the root of the word "complexity" to point out its foundation in Latin. The word "plexus" in Latin implies braiding and intertwining and thus the word complexity lends itself to the idea of something that is braided together or intertwined together. Thus we can view "complexity" levels to be measured or evaluated by the levels of intertwining - both from the number of elements or modules intertwined together and also from the degree of intertwining of these elements and modules. Such intertwining makes it proportionately difficult for the subjects facing complexity to comprehend the nature and impact of the elements involved, and of the complex system itself,

to the degree of complexity involved. While under certain conditions, complexity is desirable to foster creativity and innovation (Stacey, R, 1996), complexity usually increases uncertainty and volatility, thus increasing risk and leading to undesirable net effects. This is true even in cases where high levels of complexity are masked to create varying user perceptions.   This is an important point of application for evaluating innovative technologies in education because increased levels of complexity create an illusion of usefulness as they obscure objective evaluation of end results and bear the capacity to impress based on individual technological features and capabilities.

Dominance

Dominance has commonly been associated with the use of force, aggression and tactics with the intent of establishing superiority (Maslow, 1937). Social Dominance Theory (SDT – Sidanius & Pratto 1991) is a multilevel analysis of group conflict and this theory attempts to address issues surrounding the strength of group-based social hierarchies and this theory also provides a framework for studying individual dominance orientation (Pratto & Sidanius 1992) through the Social Dominance Orientation (SDO-6) scale. Burgoon and Dunbar provide interesting insights into dominance behavior by positing that dominance is best studied on an interpersonal dimension, within the context of the combination of person, situation, and relationship factors (Burgoon and Dunbar, 2000). Dominance is viewed as a stable personality trait, which behaves as a latent force seeking comparatively greater influence or control over communications, people, processes, resources, outcomes and benefits. Traditionally the idea of dominance was associated with physical characteristics, as is captured by the classic adage "standing head and shoulders above the rest", and with societal status traits. However, with the advent of technology

driven performance and information leveraged competitive advantage, new dimensions of dominance have emerged. We have arrived at a point in history where it is possible and beyond possibility, it is a present reality, that machines have dominance over human individuals and groups of human individuals. Robots have displayed tremendous strength, stamina and accuracy while information systems have demonstrated their computational superiority to the human mind. This has a strong relevance to our present study because of the ability of the characteristics of technological innovations to dominate the human mind and thus distort the decision making process and follow it up with a distortion of heuristic evaluation frameworks. Information systems characteristics and technological capabilities such as speed, data storage, data classification, data analysis, automation of processes and perceived ease of use can pose a dominance effect upon decision makers and users, whereby new combinations of features appear aesthetically impressive but do not necessarily provide sufficient clarity or objective insight into actual performance and net value creation.

Technology Acceptance Model (TAM):

In his seminal paper "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology"(Davis, Fred, 1989), Davis talks about the key drivers for users to accept technology. It starts of by outlining this idea conceptually and then proceeds to define "Perceived Usefulness" and "Perceived Ease of Use". Here the author defines "Perceived Usefulness" as "the degree to which a person believes that using a particular system would enhance his or her job performance" and "perceived ease of use" as "the degree to which a person believes that using a particular system would be free of effort." This is followed by a theoretical analysis of the stated concept and comparison to other related theories. The author

compares his hypothesis with the Expectancy Theory that speaks of the effect of the 'motivational force'. Davis also creates a contrast with the Self Efficacy Theory which espouses the idea that people with greater self efficacy have a belief in their own ability to manage technology. This model informs our study in the articulation of the key principles of constructions and deconstructions of technological innovations in educational information systems.

Innovation

> "*An invasion of armies can be resisted, but not an idea whose time has come.*"
>
> -- Victor Hugo, French poet and playwright

Innovation is defined as "the process of making changes to something established by introducing something new." Authors Kuboni and Lentell (2006) posit that technology is a significant driver behind change and sometimes affects the objectives of education and their delivery. Much has been said and written about innovation and it would be fair to acknowledge a common understanding on the basic tenets of innovation, variations of which have no bearing on our present study. However, we would like to draw attention to a series of works by Kim & Mauborgne, captured subsequently in their book "Blue Ocean Strategy: How to Create Uncontested Market Space and Make Competition Irrelevant" (2005) where they outline the concept of "value innovation". Though the emphasis of the book is on creating 'blue oceans' (new business dimensions) as opposed to military style 'red oceans' (defeat the competition through direct force approach), the authors posit the idea of 'value innovation' which states that real 'value' innovation must create positive value for both the buyer and the company. This breaks away from the traditional logic of value trade-off where increase in value for the buyer is

dependent and proportionate to the decrease of value for the company and vice-versa. The latter is a fixed-value game with a pie of a given size while the former "value innovation" approach plays a growing-value game with an expanding pie, and even a growing number of pies. Our research posits that technological innovation in educational information systems needs to follow the value-innovation approach. We argue further that only value-innovation must be categorized as 'innovation' and other forms of change which do not abide by the principles of value-innovation are simply changes which are often mis-categorized as innovations by virtue of the act of the introduction of something 'new' rather than the introduction of something purposeful. A careful distinction needs to be drawn here in the semantic usage of "innovation" between the artistic and related domains (such as music or fine arts) and functional domains (such as technology, medicine and education). In the former domains, virtually anything 'new' or that which has not been conceived before is considered as being a creative "innovation" and this may justifiably be so because the end objective is aesthetics which is often subjective in nature and at other times an acquired taste. This is quite in contrast to the latter domains which are, by definition, functional (distinct from the aesthetic and subjective goals) in nature and therefore need to serve the relatively more objective purposes of the functional domains such as education. This then forms the basis for our operational definitions of constructions and deconstructions of technological innovations.

Educational goals and technology

According to Robert Calkins (1946), "The task of business education is to develop the competence of students for lifetime careers in the management of business and economic affairs." What is highlighted is that it is not 'knowledge itself' that is the critical point but having

the necessary and sufficient skills to leverage that knowledge to build efficiencies. He insists "knowledge without the skill to use it is sterile" and becomes an "empty intellectual baggage" (1946). Objectives of education include functional literacy, critical thinking, ability to excel in the community and the work place, learning to learn, the use of technology to function successfully in today's world. Here is a compelling narrative on innovation, education and technology, which we felt was best reflected in the authors own words: "But, also, a third change had to occur. In the new climate of perspicacious choices regarding new technologies on campus, the rhetoric had to change: No longer could we live in la-la land believing the technology had magic. We had to become responsible. We had to recognize that watching an expert demo a technology did not in any way address the real strategic issues, the hard question of who will use the technology, how they will use it, for what purpose, with what support, guided by what assessment process, with what expected outcomes, and with what plan for sustainability. The real innovation, we painfully discovered, is not the technology, but the change in behavior of humans using the technology" (Trent Batson, 2010). This does not mean that technology does not have a positive impact on learning: studies which examined the effect of technological innovations on student performance and achievement show that "presenting information in a more vivid or more interactive learning environment will significantly increase satisfaction with the learning environment as well as interest in the topic. Furthermore, strong support was found for utilizing a more vivid or more interactive presentation to increase performance and reduce perceived mental effort when a task is more complex. Mixed support was found regarding the influence of vividness and learning style on performance and perceived mental effort for a more complex task." (Nicholson, Nicholson and Valacich, 2008). Dr. Martha Stone Wiske of the Harvard Graduate School of Education stated that "One of the most enduring difficulties about

technology and education is that people tend to think about technology first and the education later". According to the author, it is only by providing necessary focus on and "attention to the learner, the learning environment, professional competency, system capacity, and community connections, technology capacity and accountability, technology will be kept in service to learning."

Operational definitions

"Constructions of innovation", as used in our present study, refer to creative innovations which are purposeful and create net positive difference in value, distributed in some relatively increased proportion to the stakeholders involved.

"Deconstructions of innovation", as used in our present study, refer to fragmented creations, "new" arrangements and compositions, which have adopted change but do not necessarily create a net positive difference in value. Such 'deconstructions of innovation' may even benefit some of the stakeholders but at the expense of other stakeholders or participants. These 'deconstructions of innovation' may lead to deviations from the original domain purposes and create distractions, which could dissipate time and energy. 'Deconstructions of innovation' may be presented in the garb of "new technology" and tout speed and increased technological capabilities and features but are those innovations which fail the critical test of reasonable fulfillment of purpose and the creation of net positive difference of value for the stakeholders. "Deconstructions of innovation" do not refer to failed technologies or obviously incompetent technological artifacts.

Research methodology

Action research - We have chosen to conduct this study using action research principles as it allows to perform exploratory research using a qualitative methodology in a hitherto nascent domain of technological innovation in educational information systems. We treat this study as a work in progress and our attempt is to share what we research and learn by actually being involved in the related "doing"(O'Brien, R. 2001). A more formal definition states that "Action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to further the goals of social science simultaneously. Thus, there is a dual commitment in action research to study a system and concurrently to collaborate with members of the system in changing it in what is together regarded as a desirable direction. Accomplishing this twin goal requires the active collaboration of researcher and client, and thus it stresses the importance of co-learning as a primary aspect of the research process." (Gilmore, Krantz and Ramirez, 1986). We also use elements of the grounded theory (Glaser and Strauss, 1967) methodology to augment our action research strategy. The significant potential for ideation and theory development on technological innovation in educational information systems makes a quasi-grounded theory an ideal starting point. The prefix 'quasi' is mandated by the extensive amount of literature review that has already informed the formulation of thought on dominance. However, the 'blank slate starting point' approach used in grounded theory is being followed within the scope of technological innovation in educational information systems and the ideation is not being necessarily tied to potentially restrictive theories in IS or social sciences at this juncture. The research strategy involves observatory studies, exploratory analysis, ontological structuring, review of available artifacts and literature with an original perspective and most

importantly, the development of a set of logical arguments and models to help understand technological innovation in educational information systems.

		Objective Evaluation	Implementation Characteristics
	Technological Innovations in Education: A Conceptual Summary Diagram		
	Constructions	Educational goals achieved	Long term, student-centric
	Deconstructions	Technological capabilities provided but educational goals not achieved to desired extent	Short-term usage, not student /teacher centric
	Failed projects	Technological challenges, out of budget /scope	NA

Table 1: A Conceptual Summary Diagram of Types of Technological Innovations in Education

Observations

Observation 1: The effect of technological innovation in a synchronized virtual class-room through the introduction of a collaboration platform called "Dim-Dim": We observed a synchronized online MBA classroom (faculty and students never ever met physically) setting facilitated over an educational platform known as 'DimDim' in the Summer of 2010. It was observed that certain students were more tenacious than others in making their presence known and their contributions obvious. These students were proactive; they typed more words in the chat boxes and were quick to respond to the questions through voice chat. Other students were less involved and a few of the students were very quiet. As the course progressed a few issues became evident: Many students took a long time to 'figure out' the system and become familiar with the platform and its features. The objective of using the platform was to facilitate increased student interaction and collaborations - it was observed that interaction levels remain mixed and collaboration was relatively lower than the average collaboration levels prior to the adoption of the new systems.

Observation 2: We observed the implementation of a newer version of a leading learning management system (LMS1). The purpose of implementing the new system was to provide additional features to the users and to remove the bugs in the coding of the older systems. Here the platform was already being used by the stakeholders and the change was incremental and hence this was categorized as a borderline innovation. The new features were rarely used and many of the users were not even ware of the changes that were made apart from the obvious edits to the 'homepage' dashboard. Some users were happy with the fact that LMS1 had fewer bugs that its predecessor and others were largely not impacted. The overall perception was that of minimal benefit and the student stakeholders appeared to take a largely neutral and indifferent perspective.

Observation 3:

Figure 1: A TraderEx Screenshot

We participated in the delivery of course using an online trading simulation called "TraderEx". TraderEx is an "interactive computer simulation designed to provide participants with hands-on

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experience in making tactical trading decisions, and implementing them in different market environments. Continuous order driven and quote driven markets are simulated, along with call auctions and hybrid combinations." These simulations served as a very useful mechanism for students to strengthen their understanding of capital markets and it demonstrated how the structure of trading impacted actual trading patterns and behavior. Overall, this innovative simulation engaged the students and retained their interest. It achieved the professorial objective of communicating key concepts of the subject matter and provided students with a hands on "experience". The average time taken by students to familiarize themselves with the platform was about 20 minutes. The simulation focused on the core concepts and key market elements without adding complexity or "bells and whistles". This served as a case of a successful and useful technological innovation in educational information systems.

Development of an evaluation framework

Equipped with a fair understanding of educational goals, innovation, technological characteristics and theoretical underpinnings, we qualitatively extrapolated key conceptual items which could be used to build an evaluation framework. The second law of thermodynamics requires average entropy to increase, implying an increase in 'disorder' tending to homogeneity unless intelligence is employed at some level to create order, structure and relationships. Human will reverses the second law of thermodynamics but we are challenged when human will is pitched against human will and this could lead to us catalyzing the second law which in the educational domain has serious negative consequences for students and educators. This leads us to seek a framework which will help us understand and evaluate technological innovations in educational information systems better. We do this by categorizing technological innovations in

educational information systems as being either constructions of innovation or deconstructions of innovation. We then posit that there are key principles for identifying deconstructions. Deconstructions in technological innovations in educational information systems confuse students, drain their time and energy and often retard the original learning objectives and scuttle pedagogical intent. Such deconstructions in technological innovations in educational information systems can also create an uneven playing field. We can identify the deconstructions when the following dynamics occur or exist:

1. Adjustment period to effective usage period ratio is too high: Deconstructions exist when the ratio of time taken by users to adjust to the innovation or the platform (acquire, learn, experiment, familiarity, use) as compared to the actual effective usage time is high. Another way of looking at this is by inquiring about the duration for which the technology can be used for after the student develops familiarity with it?

2. Increased complexity levels: Complexity increases the probability of the occurrence of undesirable events and this represents an increased risk for the users and stakeholders. Technological innovations which demonstrate high levels of complexity are often counter productive and distract from the educational objectives. Complexity can be measured in a variety of ways as discussed in the theory section above and in essence it is represented by the depth and intensity of the intertwining elements of the technological innovation as well as the number of elements involved. Simplicity in in technological innovations in educational information systems will keep students focused on the educational objectives rather than on managing an educational support mechanism.

3. Facilitation of pseudo-learning: Technological innovations, which do such work for the students which the students were supposed to train their minds (or themselves) to do is counter-

productive. It creates an illusion of high performance and achievement but in reality it is merely encouraging undesirable and debilitating dependence on educational information systems. If a student who is expected to learn addition uses a technological artifact to perform the work then the student learns little, remains untrained and creates an illusion of being a high performer and strong achiever.

4. Bells, whistles and other avoidable baggage: Deconstructions of innovations in educational information systems may not necessarily be evidenced only by complexity or sophistication characteristics but deconstructions of innovations could be identified through it being voluminous enough to be distractive. Many systems provide features because they are easy to implement or because they are the 'latest' technology or the 'newest' artifact or some such other consideration without objectively evaluating the impact on educational goals. Such technological innovations and features tend to drain the users of time, energy and other resources that would be required to engage the additional features. Another way to examine an educational information system on this principle would be to study the number of features that could be removed without compromising educational goals. If this list is too large, it would imply the presence of ' bells, whistles and other avoidable baggage'.

5. Artifact conflict: Deconstructions of innovation in educational information systems can be identified by their tendency to be highly platform specific - the ground reality is that in most classrooms we are seeing a fair mix of OS users of different types (Apple, Windows and Android). Systems which are restrictive create an uneven playing field. Innovative programming is required to complete the educational information systems such it works seamlessly and allows for a level playing field.

6. Low ease-of-use and low utility user perception value: Low ease of use perceptions are common with many technological innovations geared towards aesthetic differentiation. This may be good for appearance and marketing purposes but does not lend itself to ease of use perception amongst users. Low utility user perception value happens in many situations where students do not believe that course specific learning management systems helps them to learn the subject matter better. This causes them to treat the said technological innovation artifact as a necessary evil rather than as a support mechanism. This dynamic is further accentuated by the fact that in most cases, students have to bear the cost of these systems in some form or the other.

7. Dominance effect: Deconstructions of innovation in educational information systems tend to have dominating effect on the subjects. Educational goals and pedagogical frameworks are overshadowed by the power and aesthetic of the technological might. Very often, these artifacts are designed to impress and to deliver high performance but the manner of design of these technological innovations lends itself to dominance characteristics. Undesirable technological dominance over human subjects can thwart educational objectives significantly.

Limitations of the present study:

Though the present study is conceptually interesting, it has not yet been developed into a mature and methodologically sound research paper. It remains a reflective paper with many unanswered questions. We recognize two immediate needs to improve this paper: 1. A need to expand upon the methodology and analysis section so as to provide a better representation of the authors analysis and thinking, and 2. Provide experimental and empirical frameworks for building an authoritative framework for evaluating deconstructions in technological innovations in educational information systems.

Scope for future research:

The present paper serves an important purpose in opening up a potentially new stream of research in education technology which draws attention away from the capabilities of the information system which has often captivated and at other times, misguided decision makers, to focusing on the impact and alignment of technological innovations in educational information systems with educational goals and objectives. Further case studies on the topic would add value to developing a firmer understanding of this topic and experimental studies which isolate key variables to examine the main drivers of performance with respect to achievement of educational goals and objectives would provide compelling insights.

Implications for practitioners and technology adoption decision makers in education:

The three types and seven dynamics presented in this paper for the evaluation of technological innovations in educational information systems provide reason for shifting the basis of evaluation of technological innovations in educational information systems from being technological capability dependent to being based on alignment with achievement of educational objectives. This then sets the stage for strategic decision making and provides an evaluation framework for decision makers, covering the entire spectrum of decision makers in academia, from the highest institutional administrative levels to individual course delivery levels. This research direction is also expected to inform developers and innovators of technology, publishers and other stakeholders of what would constitute a valuable 'construction' of technology and thus empower them to help build alignment in early design stages.

Conclusion

In conclusion, one of the critical questions very often is: Who is driving the innovation? Once we have the answer to this question, we can ask: Who should be driving the innovation?. We think that students and teachers, at large, should be driving the technological innovation in educational information systems. When this task is assigned to programmers managed directly or indirectly by investors whose objectives need not necessarily be aligned with the educational goals, then we have deconstructions of innovation in educational information systems - systems which are often based on the best of technology, but they fail to create net positive value. True technological innovations in educational information systems will result in satisfied teachers and students, along with satisfied administrators, as these systems will result in a positive value creation. The seven principles extrapolated from our action research can serve as a starting point for identifying and avoiding deconstructions in innovation and help us move towards constructions which will be sustainable and will support educational goals.

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The first part of this study reviews the utilization of a *critical thinking value rubric* developed by a team of faculty from different universities in the U.S. The second part of the study explains implantation of this rubric in evaluating research papers written by teams of students in a computer concept course. Explanation of topics under research, evidence of selection of appropriate information, team's perspective regarding the researched topics and identification of related outcomes were used as indicators of critical thinking, thorough comprehension and exploration of applicable issues. The rubric was used as a tool to determine the extent of development and enhancement of critical thinking among teams of students.

USING HYMNS, PSALMS, SPEECHES, AND MUSIC TO INSTILL VALUES

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ABSTRACT

There are many approaches used to teach values, morals, and ethics. This paper will describe how hymns, music, psalms, and famous speeches can be used to make students become more sensitive to moral and ethical issues. This is very important since there is evidence that traditional courses in business ethics have not been successful in making students ethical.

INTRODUCTION

There is a growing belief that education – K-12 as well as higher education – has to focus on instilling values, intellectual virtues, and character education [21] [2]. Tough [21] asserts that the belief that students can succeed in life by only developing their cognitive skills (intelligence that can be measured by IQ tests) is incorrect. He claims that the traits that really matter include ambition, conscientiousness, curiosity, grit, integrity, persistence, resilience, and self-confidence. Tough avers that individuals with these traits are able to bounce back more rapidly from adversity and changing circumstances. These cannot be measured by IQ tests or Graduate Management Admission Test ("GMAT") exams.

Berrett [2] feels that education has to stress habits of mind or intellectual virtues. The emphasis must be on traits such as "curiosity, open-mindedness, and intellectual courage, thoroughness and humility"; this would include a passion for lifelong learning.   This view is consistent with what Tough [21] has been saying, that true education is more than the memorization and application of facts.   Damon [5] is also a proponent of character education. He defines character education as "a broad range of efforts to promote positive values and virtues in students through explicit instruction." There was a time – between 1836 and 1922 – when texts taught values such as respect, honesty, kindness, etc. Teaching these type of character skills became unpopular during the 20th century due to an increasing emphasis on research-based approaches on how students learn and an increased focus on high stake tests. Recent years have seen resurgence in teaching positive character traits and incorporating values in the classroom instruction.

The Great Recession of 2008 has made many educators realize that business schools are not doing a good job teaching ethics and values. Many of the individuals responsible for the financial crisis had MBAs and took the required ethics courses.   It is not surprising that one

study found that 56% of MBA students cheated on a regular basis in college, this percentage is higher than students who cheat in other areas of study [11]   There is evidence that students who complete MBA programs are less ethical at the end of the educational program than when they started [7]. Regardless of the reasons why, this level of ethical misconduct on the part of students is unacceptable and must be either eliminated or at the least ameliorated. There is a growing body of evidence that suggests that we cannot teach students to be ethical using the current methods of instruction [4]. Despite this evidence, there is an emerging consensus that courses in business ethics can help students know themselves and their own moral values; improve their ethical sensitivity and awareness; and attain confidence and courage in making ethical decisions that can then provide them with the ability to question decisions that have ethical implications [4]

There are many approaches that can be used to instill values, morals, and ethics in business (as well as other disciplines). These include reading the Bible and other religious works, case studies, role playing, studying of theories of ethics, examining hypothetical scenarios, debates, using guest speakers, discussion of articles dealing with ethics, having students write papers on ethics, and viewing films that deal with ethical situations. This paper will describe how hymns, psalms, speeches, and music can be used to make students become more sensitive to moral and ethical issues.

USING MUSIC AND SCRIPTURE TO INSTILL VALUES

One way of delivering inspirational messages to students is through music. Music has the ability to transform and elevate the listener's emotional state. A poignant melody, driving beat or insightful lyrics can bring the listener to introspection or action. Most students listen to music so this can be another way to introduce and teach values. There are several examples of songs that helped change the world.

(1)The song "Strange Fruit" written by Abel Meeropol and recorded by Billie Holiday in 1939 is available at YouTube (http://www.youtube.com/watch?v=h4ZyuULy9zs). It made everyone aware of the viciousness of racism, particularly the lynching of black Americans in the South. The "strange fruit" hanging from trees was an eerie symbolism for young black men who were hanged from the limbs of trees. The song can be seen as a hymn and as a tautological device advocating the advancement of human rights and justice.

> Southern trees bear strange fruit
> Blood on the leaves and blood at the root
> Black bodies swinging in the southern breeze
> Strange fruit hanging from the popular trees
> Pastoral scene of the gallant south
> The bulging eyes and the twisted mouth
> Scent of magnolias, sweet and fresh
> Then the sudden smell of burning flesh
> Here is fruit for the crows to pluck
> For the rain to gather, for the wind to suck
> For the sun to rot, for the trees to drop
> Here is a strange and bitter cry

(2) The phrase "We shall overcome" was associated with the civil rights movement; the song associated with it is perhaps one of the most influential songs ever. It was originally a hymn composed in 1901 by the Reverend Charles Albert Tindley, a distinguished minister in the African Methodist Episcopal Church. His hymn was entitled "I'll Overcome Someday" [22]: "The world is one great battlefield; With forces all arrayed; If in my heart I do not yield; I'll overcome some day." It actually sounds like a hymn from Psalms. The song title was used by President Lyndon Baines Johnson in one of his landmark speeches. Joan Baez sang an unforgettable version of the song (http://www.youtube.com/watch?v=RkNsEH1GD7Q) The lyrics are an excellent example of human optimism and perseverance.

> We shall overcome,
> We shall overcome,
> We shall overcome, some day.
> …

(3) Frederick Douglass [6] used a verse from Psalm 137 to denounce slavery. The verse —"How shall we sing the Lord's song in a strange land?" --- refers to captivity, familial alienation and loss of freedom. Many picking up on this theme have recorded "By the Rivers of Babylon." One impressive version is at: http://www.youtube.com/watch?v=Nm1g8FFRArc ; it was recorded by Boney M. It has about 20 million downloads.
The lyrics for this powerful song comes from Psalms 137:

> By the rivers of Babylon, there we sat down
> ye-eah we wept, when we remembered Zion.
>
> By the rivers of Babylon, there we sat down
> ye-eah we wept, when we remembered Zion.
>
> When the wicked carried us away in captivity
> Required from us a song
> Now how shall we sing the Lord's song in a strange land
> …

These words were said by captives from ancient Israel who were sent into exile by the Babylonian King, Nebuchadnezzar. This message resonated with African slaves brought to strange lands who felt the same way as the ancient Hebrews.

(4) The "Let my people go!" proclamation from Exodus (5:1) became a famous African American spiritual and a mantra of the civil rights movement. It was also used as the battle cry of Soviet Jewish dissidents and refuseniks. Jews all over the world and many gentiles rallied to that passionate appeal for personal freedom and deliverance from the oppressor.
Louis Armstrong sang one impressive version of this song known as "Go Down, Moses." (http://www.youtube.com/watch?v=SP5EfwBWgg0):

> Go down, Moses, way down in Egypt land
> Tell old Pharaoh
> To let my people go.
> …

(5) The phrase "No justice, no peace" or "No peace without justice" is from Isaiah 32: 17. The complete quote is: "And the work of *tzedaka* (translated as either righteousness or justice) will be peace; and the effect of *tzedaka*, quietness and security forever. This phrase has been used to justify riots as well as peaceful demonstrations. Pope John Paul II spoke about this topic on the World Day of Peace [18]. It has been used by several rappers (e.g., hip-hop artist Young General at http://www.youtube.com/watch?v=pTpIEXFu_2E; also Intelligent Hoodlum at http://www.youtube.com/watch?v=NNBiA-GtRYc).

(6) Psalm 23, "The Lord is my Shepherd," below is arguably among the most powerful (and renowned) passages in Scripture dealing with faith in God. It has an important message for students. The Lord is being compared to a shepherd who has a rod (i.e., crook) and staff and takes care of His flock. These inspirational words help guide us through the stresses of life. It is comforting to believe that God is watching over us and cares what happens. Note that the Shepherd guides his flock on the path of righteousness and justice.

Snyder [20] sees the verse, "The Lord is my Shepherd, I shall not want," as a message of hope in these times of the Great Recession. Millions of people have lost their jobs including people in certain professions that were considered recession-proof (e.g., lawyers, doctors). The psalm cautions against want, i.e., accumulating unnecessary costly things that are not required for daily living. If we focus of fulfilling our needs we will not be tempted to live beyond our means. We will not be tempted to commit immoral or unlawful acts in order to amass wealth and material goods. If we follow the tenets of the Sheppard we shall be free of "want." If people can reduce their wants and needs and be satisfied with less, there will be plenty for everyone. It is greed that caused the recession and a desire for an ostentatious, flamboyant life filled with material goods that make us unhappy. Thus, making the Lord your Shepherd is also about rejecting the view that "a human being is fundamentally a being of desire" (similar to the *homo economicus* model taught in economics courses). Man is more than one who wishes to maximize his utility. We are spiritual beings who delight when everyone is satisfied. Snyder [20] concludes: "Part of what Psalm 23 is saying is that we do not need to be slaves to our wants. We can learn to come to want what the Lord, our shepherd, provides for us."

> A Psalm of David. The Lord is my Shepherd, I shall not want. He lays me down in green pastures. He leads me beside tranquil waters. My soul He restores. He leads me on the path of *tzedek* (usually translated as either righteousness or justice) for the sake of His Name. Even though I walk through the valley of the shadow of death, I will fear no evil, for you are with me; your rod and your staff, they comfort me. You prepare a table before me in the presence of my enemies: you anoint my head with oil; my cup runneth over. Surely goodness and lovingkindness shall follow me all the days of my life; And I shall dwell in the house of the Lord forever (Psalm 23: 1-6).

These sentiments have inspired many artist to put words to music. For example, Whitney Houston as well as many other well-known artists have recorded this psalm,

(http://www.youtube.com/watch?v=1iql92NWt30), (e.g., Jeff Majors --
http://www.youtube.com/watch?v=68766Zvof90&feature=related).

(7) Ecclesiastes also has a powerful message about life: people have little control over their
destiny. Ecclesiastes said (3: 1-8):

> To everything there is a season, and there is a time for everything
> under Heaven.
> A time to be born, and a time to die.
> A time to plant, and a time to uproot that which is planted.
> …

After examining various lifestyles, Ecclesiastes concludes (Ecclesiastes 12:13): "The end of the
matter, all having been considered: fear God, and keep His commandments; for this is every
person's duty." Thus, the most foolish endeavor is a life based solely on materialism and a
"greed is good" philosophy. The passage cited above was turned into a classic song by the Byrds
entitled "Turn! Turn! Turn! (To Everything There is a Season). It is available at:
http://www.youtube.com/watch?v=fHvf20Y6eoM

There are numerous websites dedicated to the music of the American labor movement. There
was a time when it was quite dangerous to go on strike and many workers were killed by militias
working for employers. A good website to find a nice selection of labor songs is:
http://folkmusic.about.com/od/toptens/tp/BestLaborSongs.htm In addition, there are hundreds of
anti-war songs. One website that features 155 of them is:
http://www.stopwar.org.uk/index.php/media/anti-war-songs   There is also a website for "Great
Protest Songs" (http://www.greatprotestsongs.com/. Nick Wall maintains a website describing
the 50 greatest protest songs (http://musictodiefor.wordpress.com/50-greatest-protest-songs/).
Lynskey [15] wrote a classic work describing the history of some of the great protest songs.
Songs such as these could be incorporated into a comprehensive ethics curriculum that would be
designed to impact students at their deepest and most profound decision making levels.

USING SPEECHES TO INSTILL VALUES

Speeches are somewhat similar to songs and can also influence people. Students can learn much
about values and morality (as well as some history) from studying the dialectic of speeches.
Fortunately, one can find the "Top 100 Speeches" of the 20th century compiled by Lucas and
Medhurst [14] at the American Rhetoric website.

According to Lucas and Medhurst [14], the best speech of all time is Martin Luther King, Jr.'s "I
Have a Dream Speech." Martin Luther King, Jr. stated the following in his 'I Have a Dream'
speech.

> Let us not wallow in the valley of despair, I say to you today, my
> friends.
> And so even though we face the difficulties of today and
> tomorrow, I still have a dream. It is a dream deeply rooted in the
> American dream.

I have a dream that one day this nation will rise up and live out the
true meaning of its creed: "We hold these truths to be self-evident,
that all men are created equal."
…
I have a dream that one day every valley shall be exalted, and
every hill and mountain shall be made low, the rough places will
be made plain, and the crooked places will be made straight; "and
the glory of the Lord shall be revealed and all flesh shall see it
together."

The last passage is from Isaiah (40:4-5). Reverend King often quoted from biblical sources in
order to impact his listeners on an emotional and psychological level. This was an ingenious way
to demonstrate to believers that his messages of equality and justice for all were based on core
Biblical values.

Martin Luther King, Jr. also proclaimed the following in his legendary 1963 'I Have a Dream'
speech:
We cannot be satisfied as long as a Negro in Mississippi cannot
vote and a Negro in New York believes he has nothing for which
to vote. No, no, we are not satisfied, and we will not be satisfied
until justice rolls down like waters and righteousness like a mighty
stream.

Here King was quoting a famous passage from Amos (5: 24): "But let justice roll down as
waters, and righteousness as a mighty stream." The use of this powerful scriptural metaphor
conveyed to the listener, the righteousness of the cause and the inevitability of the outcome.
Martin Luther King, Jr.'s "I've Been to the Mountaintop" speech is also one of the great
American speeches. It was delivered on April 3, 1968, a day before he was assassinated. It ends
as follows:
Like anybody, I would like to live a long life. Longevity has its
place. But I'm not concerned about that now. I just want to do
God's will. And He's allowed me to go up to the mountain. And
I've looked over. And I've seen the Promised Land. I may not get
there with you. But I want you to know tonight, that we, as a
people, will get to the Promised Land!

The "I've Been to the Mountaintop" speech does not quote directly from the Bible but alludes to
the story of Moses at the end of Deuteronomy where he is allowed to see the Promised Land but
will not be the one who leads the Israelites there.
And the Lord said to him: This is the land of which I swore to
Abraham, to Isaac, and to Jacob, saying 'I will give it to your
offspring.' I have let you see it with your own eyes, but you shall
not cross over there (Deuteronomy 34: 4).

There are many other interesting and valuable speeches at the above-mentioned website which if
properly presented could provide powerful ethical instruction.

USING PSALMS TO INSTILL VALUES

As previously indicated the Bible is one way to teach character and values. The ancient psalms were songs accompanied with musical instruments, and these songs had powerful messages. Many, in fact, did deal with the oppression of the poor and helpless. The *Book of Psalms* (*Sefer Tehillim* in Hebrew) consists of 150 inspiring and rousing hymns. The Hebrew word *Tehillim* means praises and it is a book of praises of God. But it is much more than thanksgiving and praise. Many human emotions, faith, joy, trust, lament, grief, confession, thanksgiving, awe, remorse, anger, and happiness – are revealed in *Psalms*. Birnbaum [3] avers:

> The keynote of the psalms is simplicity of heart, faith in God and
> good conduct. In them we find the human heart in all its moods
> and emotions—in penitence, in danger, in desolation, and in
> triumph. The psalms are as varied as human life; they are
> enlightened in their ethics as they are lofty on their religious spirit.

Three major religions – Judaism, Christianity, and Islam – consider its words holy. It has been a source of comfort for millions of people through the ages. The Bible, as an important work of literature, has influenced the lives of many, believer and nonbeliever.

The Talmud (Babylonian Talmud, Baba Bathra 14b-15a) states that David, king of ancient Israel, wrote the Book of Psalms but included the work of ten others: Adam, Melchizedek, Abraham, Moses, Heman, Jeduthun, Asaph, and the three sons of Korach. David, however, was the major author. After all, 73 of 150 of the psalms have the phrase *leDavid* (meaning to or for David). Modern scholars are not convinced of its Davidic authorship [13]. There are a number of psalms that refer to period hundreds of years after David's death.   For example, "By the Rivers of Babylon" refers to the Babylonian exile which took place hundreds of years after David's death. Either way, these psalms are quite ancient and the Book of Psalms "is the Bible's book of the soul" [13].

According to tradition, the Levites sang these Psalms in the Temple in Jerusalem. Many of the Psalms actually name the instrument on which they were to be played in the Temple; that is why several begin with the name of an instrument (e.g., *Shminit* [8-stringed harp], *Gitis*, *Neginos*, *Shushan Aidus*, *Machalas*, etc.).

The Psalmist provides a perfect description of the upright person who may "dwell on God's holy mountain." It is an individual who is concerned with helping others and being a moral and honest person. True religion is about helping others and having integrity. According to some commentaries, the "holy mountain" being referred to is the Temple Mount.

> A Psalm of David. Lord, who may abide in Your tent? Who may
> dwell on Your holy mountain? One who walks in total integrity,
> works righteously, and speaks truth in his heart. One who does not
> slander with his tongue and has done no evil to his fellow human,
> nor takes up a reproach against his neighbor. In whose eyes a vile
> person is despicable, but who honors those who fear God; one who
> keeps his oath even when it hurts. He lends not his money for

interest and neither takes a bribe against the innocent. Whoever
does these things will never falter (Psalm 15).

Birnbaum [3] states that Psalm 15 "has the most perfect description of a good man." This idea of
what it takes to be a good person is repeated in Psalm 24: 3-5.
Who may ascend the mountain of God, and who may stand in the
place of His holiness? He that has clean hands and a pure heart;
who has not lifted up his soul to vanity and who has not sworn
deceitfully. He shall receive God's blessing and righteousness
from the God of his salvation.

The next two Psalms makes it clear that we all have an obligation to take care of the unfortunates
of society.
Give justice for the poor and orphan; uphold the rights of the
afflicted and the destitute. Rescue the poor and needy; deliver
them from the hand of the wicked. They have neither knowledge
nor understanding, they walk in darkness; all the foundations of
the earth are shaken" (Psalm 82: 3-5).

He has dispersed, he has given to the poor; his righteousness
endures forever; his horn shall be exalted with honor (Psalm
112:9).

The world cannot exist without justice and equity for all. The idea of helping the weak is
repeated numerous times in scripture. The orphan, widow, and stranger are paradigms for those
who can easily be taken advantage of. In modern times, one might add the handicapped. In fact,
Psalm 146 demonstrates what God does for the oppressed, the poor, and the helpless.
He secures justice for the oppressed; He gives bread to the hungry.
The Lord releases the imprisoned. The Lord gives sight to the
blind; The Lord straightens those bowed down; the Lord loves the
righteous. The Lord protects the stranger; orphan and widow He
enables to stand firm; but the way of the wicked He thwarts (Psalm
146:7-9).

Since the Psalms were sung in the Temple by the Levites and combined poetry and prayer, it is
not surprising that many deal with faith in God. A key observation is that humans cannot
confide in mortals whose days "are as grass." One of the most important messages in Psalms is
never to give up and rely primarily on God. It is foolish for a person to confide in people who
are filled with deceit and whose days are numbered. However, those who place their trust in
God, will see that justice ultimately prevails.
Put not your trust in princes, nor in the son of man, in whom there
is no help (Psalm 146:3).

I will lift up my eyes to the mountains, from where comes my help.
My help comes from the Lord who made heaven and earth. He
will not let your foot slip; He who watches over you does not

slumber (Psalm 121: 1-3).

"My God, my God, why have you forsaken me?" a verse from Psalm 22, is well known to everyone since it is similar to Jesus' last words. Psalm 22 starts out as a message of torment and distress but ends with hope.

> My God, my God, why have you forsaken me? Why are you so far
> from helping me, and from the words of my roar? O my God! I
> call out by day, but You do not answer me; and at night but there is
> no relief for me (Psalm 22:2).

SPIRITUALITY

The tools of music, speeches, hymns and psalms also have another benefit. They can be used to enhance the spirituality of students. What is spirituality? First of all, it is not religion. Religion refers essentially to communally held beliefs and dogmas that are expressed publicly [16]. Religion tends to be associated with an organization or institution, spirituality, on the other hand, tends to be more individualistic and personal [23]. It is quite possible for an individual to be spiritual and yet not be part of any religious group. A key part of being spiritual is believing that life has a higher purpose and is meaningful [19] [17]. People who are spiritual sense that there is a "connectedness to something greater than the self" [16]. Spiritual people are concerned with making a difference, and desire to make the world a better place. The spiritual individual focuses on a meaningful life; those who are not spiritual will focus more on maximizing their own pleasure, i.e., all that matters is materialism, fame, and / or power.

Spirituality should not be taken lightly, approximately 90% of Americans describe themselves as spiritual; 75% believe that they are religious [12]. White [23] cites a study conducted by UCLA's Higher Education Research Institute that shows that spirituality is very important to college students today. In fact, 80% of students are interested in spirituality; 76% are searching for meaning and purpose in life. White believes that academe will have no choice but to be "visionary about the emerging issue of students' need for spiritual development and must empower them to articulate it in the academy…" Spirituality has become so important that Astin [1] argues that it deserves a central place in all liberal arts education. There is a commonly held view that college professors tend to be atheists and uninterested or even hostile to spirituality. Gross and Simmon's [10] survey of American professors indicated that this is not true: they found that 80% of college professors consider themselves spiritual. Indeed the disconnect from teaching ethical tenets, without addressing the students underlying spiritual reality, may be the very reason for the ever increasing levels of dishonesty exhibited in various MBA programs.

CONCLUSION

This paper demonstrates how music, songs, psalms, and speeches can be used as a tool for teaching students values and even spirituality. Moreover, a class can be made more interesting by using some of the examples provided. Music and speeches are simple, yet powerful ways of teaching students about truth, equity, and justice. Music can also be used to demonstrate connections between various disparate groups such as the ancient Hebrews enslaved in Babylon and Africans forcefully dragged from their homes to work as slaves in America.

After the Great Recession of 2008, which destroyed trillions of dollars in assets and millions of jobs, it is clear to most educators that we have to rethink what we are teaching in universities. In particular, theories that promote the idea that rational man maximizes his utility (*homo economicus*) and that the ideal form of capitalism involves unregulated, cut-throat competition and free markets must be re-evaluated. Adam Smith did not believe in predatory, ruinous capitalism that only enriches the few at the top [8] [9].

The shortest chapter in all of Scriptures may be the most meaningful psalm of them all. Psalm 117 is a hymn that asks *all* of humankind to pay homage to the Lord (for non-believers, substitute the spiritual values of making the world a better place for all):

> O praise the Lord, all nations; laud Him, all you peoples! For His lovingkindness has overwhelmed us; and the truth of the Lord endures forever. Hallelujah!

Has anyone ever described the ideal vision for humankind better than Isaiah?

> He shall judge between the nations, and shall decide disputes for many peoples; and they shall beat their swords into plowshares and their spears into pruning hooks; nation shall not lift up sword against nation, neither shall they learn war anymore (Isaiah 2:4). The wolf will live with the lamb, the leopard will lie down with the goat; the calf, the lion cub, and the fatling [will feed] together, and a small child will lead them. A cow and bear will graze together and their young will lie down together. The lion will eat straw like the cattle. An infant will play over a viper's hole, and a newly weaned child will stretch forth his hand over an adder's den. They will do no harm or damage anywhere in all of My holy mountain; for the earth will be filled with knowledge of God, as water covers the sea (Isaiah 11: 6-9).

REFERENCES

Available upon request.

THE VALUE OF POWERPOINT ANIMATIONS
IN TEACHING SPECIFIC OPERATIONS AND SUPPLY CHAIN MANAGEMENT
TECHNIQUES AND CONCEPTS

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ABSTRACT

This paper examines the value of complex animated PowerPoint presentations in teaching operations and supply chain management techniques and concepts. The potential benefits to faculty and students of using PowerPoint animations in operations and supply chain management classes are discussed. Subsequently, student perceptions of the value of specific PowerPoint animations are provided and analyzed. Readers are also provided with information about how to join an exchange for sharing PowerPoint animations.

Animation, Multimedia Instruction, PowerPoint, Presentation, Teaching

INTRODUCTION

This paper examines the value of using complex animated PowerPoint presentations in teaching operations and supply chain management techniques and concepts. The literature covering the use of PowerPoint animations in business education is briefly reviewed to provide context. The expected benefits to faculty and students from using PowerPoint animations, are discussed. This discussion is followed by evidence of the perceived value to students of using specific, complex PowerPoint animations. Individuals interested in participating in an exchange of complex operations and supply chain management PowerPoint animations are provided with the necessary information.

LITERATURE REVIEW

The Baby Boomer Generation has witnessed tremendous evolution and innovation in presentation technology. Appendix 1 [13] provides a chronological list of the various mainstream presentation technologies used over time. Not only have the capabilities and ease of use of presentation technologies increased dramatically over the last several decades, but the costs have decreased tremendously also. Unlike today's PC-driven presentation technologies, prior technologies were mainframe-based and required special printers and plotters. The cost of the technology required to produce high quality presentation materials at that time was

approximately $50,000 [2]. Many faculty have witnessed this entire spectrum of technologies and adapted their teaching to them over their careers.

The contribution of PowerPoint presentations to the learning environment has received increased attention in the literature over the past decade or so. James et al [5] examined student and faculty perceptions of the effectiveness of using PowerPoint presentations in business courses. They found that well prepared, targeted PowerPoints were perceived by both faculty and students to improve learning in a variety of ways. Interestingly the faculty's perceptions of the benefits were consistently greater than those of the students. Focusing specifically on PowerPoint animations, Ruffini's [12] results are similar to James et al [5] in that properly designed PowerPoint animations that are tied to learning objectives were found to be effective teaching tools. However, he warns that poorly conceived and constructed PowerPoint animations can be distracting. Li et al [6] found that use of animation to teach break-even analysis not only improved student learning, but did so with less perceived student effort. They identified ten "problem types" where animations would be beneficial. All ten "problem types" are typically taught in operations and supply chain management classes. Mayer and Moreno [10] suggest that animation can be used to effectively support text (or narration) only if the two are presented in close time and spatial proximity to each other.

Contrary to the results of the studies mentioned above, Mahar et al [8] found that students had better recall of the information when static slides were used instead of those that animated text and diagrams into the presentation. This was attributed to the longer exposure to all the material on a slide when static presentations are used versus only seeing a portion of it at a time when animation is used. Research has also suggested that animations can create a "split-attention effect" [9]. In this situation, learners have difficulty assimilating the text and animation portions of a presentation. This effect may be more pronounced in students without prior exposure to the material being presented [7].

Cournoyer [3] provides useful "best practices" to follow when constructing PowerPoint animations. Cournoyer's most important tip is to remember the KISS (Keep It Simple, Stupid) philosophy when developing presentations. Just because you have the capability to animate something, doesn't mean you should. He recommends sticking primarily to the following four animation techniques: appear, fade, wipe, and zoom. Gabrielle [4] also provides many useful tips on creating effective PowerPoint presentations. On the flip side, Gabrielle suggests that it is important to avoid negative aspects of PowerPoint presentations. Paradi [11] surveyed learners to determine the most annoying aspects of poor PowerPoint presentations and found the five most common complaints (with percentage of respondents citing) to be: presenters reading the slides (74%); full sentences instead of bullet points (52%); text too small to read (48%); hard to see due to poor color choices (34%); and overly complex diagrams or charts (26%). Numerous other articles and websites provide useful tips on how to do specific things with PowerPoint animation.

While the studies' methodologies and some of their specific results have varied, the general conclusions reached are similar. PowerPoint presentations and, in some studies, PowerPoint animations have been found to be *capable* of contributing positively to student learning. However, in order to actually make a positive contribution to student learning the PowerPoint presentations must be targeted, well prepared, and should not use animation excessively. These

studies found that poorly prepared PowerPoint presentations can be distracting and actually detract from learning. In fairness, it would seem the same could be said of presentations that don't employ PowerPoint technology.

The capabilities of the presentation technologies available to faculty have changed tremendously over the decades with PowerPoint software being the most obvious innovation. "Most faculty, however, don't use PowerPoint's features beyond creating basic slides with text, transitions, clip art or pictures, and hyperlinks." [12] Contributing to the minimal usage of animation is the limited extent to which faculty share their personally prepared teaching materials. Typically, faculty don't share teaching materials they have prepared themselves unless they are receiving compensation for sharing them (such as through publication of textbooks and supporting materials). Possible reasons for this include:

- their teaching materials are intellectual property and, similar to their research, faculty have been trained to protect their intellectual property;
- baby boomers tend to be competitive and, for faculty of this generation, sharing the fruits of their labor with others may be considered akin to "aiding and abetting" the competition;
- earlier media used for teaching were dominated by rigid/hardcopy formats and, as such, difficult to convey across the country/world; and
- faculty members have different teaching styles and what works well for one doesn't necessarily work well for others.

THE ANIMATIONS

The fifteen specific animations examined in this study address the following operations and supply chain management related concepts and quantitative techniques:

1. Group technology

2. Project network diagram creation

3. Computation of project time values (early start, early finish, late start, late finish, and total slack)

4. PERT estimation of the likelihood of completing a project by its due date

5. Quality cost theory graphs – Traditional vs. Modern

6. Six Sigma quality graph

7. Taguchi Loss Function graphs – "Goal Posts" vs. Taguchi

8. Type I Error probability computation

9. Transportation Method

10. Gantt Charts

11. Total inventory cost graph

12. Safety stock/Reorder point computations

13. EOQ with quantity discount graph

14. MRP computations

15. Kanban squares

These animations contain no audio and written descriptions were limited. They were created with the expectation that a knowledgeable instructor would be presenting them and explain the concept or technique as the animation progressed.

EXPECTED BENEFITS TO FACULTY AND STUDENTS

Use of PowerPoint animations should prove beneficial to faculty and their students in a number of ways. As indicated in the literature, this assumes the animations are well-conceived, well-constructed, and effectively delivered.

Faculty benefit from using animations because, once the faculty member has an animation tailored to his/her style, preparation for teaching that particular concept/technique is minimal. Additionally, some of these animations help to explain concepts that would be difficult to explain without the use of animation, while others error-proof the coverage of complicated quantitative technique examples, helping to minimize student confusion.

As more and more courses are being transitioned to on-line/distance learning, PowerPoint animations can be used "as is" or with voice-over instructions in an on-line/distance learning environment. This should help lower individual faculty members' cost of entry into this rapidly growing segment of higher education.

One of the authors reports that use of these animated presentations provided the unforeseen benefit of allowing the professor to focus on describing how a quantitative technique works without having to simultaneously concentrate on doing all the math correctly. This enables the professor to provide a better explanation of the technique and have every computation correct every time. This, of course, is also a benefit to students.

These animations also serve as 24/7 "tutors" for students. As they study, for example, how to determine the probability of completing a project by its due date, they can refer to a PowerPoint animation of the computations at any time of day or night, and every step in the process and all computations are always correct.

EVIDENCE OF BENEFITS TO FACULTY AND STUDENTS

Evidence of the value of using these animated presentations comes from two sources: the faculty teaching with them and the students learning from them.

Several dozen faculty attended PowerPoint-animation-sharing sessions recently offered at the Midwest Decision Sciences Institute (MWDSI) and national Decision Sciences Institute (DSI) meetings, indicating an interest in this approach to teaching. Two of these faculty members actually joined the "animation team" during the first year, indicating an elevated interest level on their part. One of these two faculty members recently used a number of animations created by a third member of the team in a graduate-level operations and supply chain management course and described them as "awesome". When asked to elaborate, he indicated that they did an excellent job of presenting the concepts and quantitative techniques and made it much simpler to teach them. While anecdotal in nature, there is every reason to believe that most faculty would have a similar reaction.

To evaluate the perceived benefits of these animations to students, a variety of complex PowerPoint animations were presented in three sections of an undergraduate, introductory operations management class during the Fall 2012 semester. The classes were broken into four modules, with an exam administered at the conclusion of each module. Within one week of the completion of each module, and after the students' graded exams were returned to them (for the last module, the survey had to be conducted prior to the final exam), the students were surveyed about their perceptions of the value of the PowerPoint animations used in the preceding module. Appendix 2 provides the instructions given to the students and an example of the questions asked. This approach was taken, instead of conducting a single survey at the end of the semester, so the students would still have relatively fresh memories of what the animations entailed and their exam performance on questions relevant to the material covered in those animations.

For each PowerPoint animation examined, the students were asked to rate its impact on:

1. Their ability to understand the concept/quantitative technique as it was presented in class;
2. Their studying of the concept/quantitative technique after it was presented in class.

A final question asked students to evaluate the frequency with which PowerPoint animations were used in the course.

(Data collection was completed in late 2012 and will be analyzed and presented in Brooklyn.)

CONCLUSIONS AND CALL FOR ADDITIONAL PARTICIPANTS

The results of research on the learning effects of PowerPoint animations in business school classes are mixed. However, it is evident from the research that well-conceived and well-constructed animations used in appropriate situations have the potential to be beneficial to student learning (both in increased understanding and decreased effort). This paper also provides further evidence that proper use of PowerPoint animations in operations and supply chain management classes can add value to the student learning experience. The value to the student is two-fold: (1) as an aid to initially understanding the concepts and techniques as they are presented in class and (2) as an aid to studying the concepts and techniques on their own.

Any operations and supply chain management faculty interested in participating in an exchange of complex PowerPoint animations should e-mail their PowerPoint file(s) to Mark Treleven (treleven@jcu.edu). The best animations submitted in a given year will be selected for presentation at the annual DSI meeting. Authors will be so notified and, if submitted in

sufficient time, will be listed in the official program for the meeting. Participants in the exchange will, of course, be provided with animations created by other participants.

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APPENDIX 1
Presentation Technologies by Decade Introduced

Decade	Content Medium	Display Technology	Software
1950's & Earlier	Teaching notes	Blackboard and chalk	None
	Teaching notes and prepared documents	Opaque Projector	None
1960's	Teaching notes	Blackboard and chalk	None
	Teaching notes and prepared documents	Opaque Projector	None
	Teaching notes and prepared and handwritten transparencies	Overhead projector & washable ink pens	None
1970's	Teaching notes	Blackboard and chalk	None
	Teaching notes and prepared and handwritten transparencies	Overhead projector & washable ink pens	Word processing
1980's	Teaching notes	Blackboard and chalk	None
	Teaching notes and prepared and handwritten transparencies	Overhead projector & washable ink pens	Word processing
	Electronic files	Overhead projector, LCD panel, and personal computer	Word processing, spreadsheet, linear programming, *HP Draw* [1]
	Photographic slides	35mm Slide projectors	Various
1990's	Teaching notes	Blackboard and chalk	None
	Teaching notes and prepared and handwritten transparencies	Overhead projector & washable ink pens	Various
	Electronic files	Overhead projector, LCD panel, and personal computer	Presentation software (*Presenter, Harvard Graphics, MegaType, PowerPoint,* and others)
	Various	Document camera	Presentation software (*PowerPoint* and others)
2000's	Teaching notes	Blackboard and chalk Interactive whiteboard	Various
	Hardcopy documents	Document camera	Presentation software (primarily *PowerPoint* and others)
	Electronic files	Multimedia projector and personal computer	Presentation software (primarily *PowerPoint* and others)
2010's	Teaching notes	Blackboard and chalk Interactive whiteboard	None
	Hardcopy documents	Document camera	Presentation software (*PowerPoint* and others)
	Electronic (computer) files	Multimedia projector and personal computer	Presentation software (*PowerPoint,* zooming presentation software, and others)

PowerPoint Animation Feedback – Module #1

Please provide your evaluation of the four major PowerPoint animations used in this module of the class.

There are two questions about each animation. The first question asks about that animation's impact on your ability to understand the concept at the time it was first presented in class. The second question asks about that animation's impact on your studying the concept subsequent to it being presented in class.

The five possible responses for each question are the same.

Your answers are anonymous and have no impact on your grade in this course. Please simply provide your single most accurate response to each question.

If you have any specific suggestions on how to improve any of these animations, please make a note of your suggestion(s) immediately following the questions on that/those animation(s).

GROUP TECHNOLOGY (animation of equipment being grouped together and fork lifts moving material around the facility)

How would you rate the impact of this PowerPoint animation on your ability to understand this concept **as it was being presented in class**?

☐ Significantly improved
☐ Slightly improved
☐ No effect
☐ Slightly counterproductive
☐ Significantly counterproductive

How would you rate the impact of this PowerPoint animation on your **studying** this concept **after it was presented in class**?

☐ Significantly improved
☐ Slightly improved
☐ No effect
☐ Slightly counterproductive
☐ Significantly counterproductive

Suggestions for improvement:

MAKING THE INTRODUCTORY STATISTICS COURSE MORE RELEVANT TO STUDENTS

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ABSTRACT

This paper describes an innovative way to make the introductory statistics course interesting and relevant to students. This method involves introducing attention-grabbing examples, cases, and stories involving the use of statistics; numerous examples are provided. Later on in the course, students have to find their own examples and then chat about them in a paper or on the Discussion Board in Blackboard.

Keywords: Teaching statistics; health research; happiness research; attractiveness research; college rankings.

INTRODUCTION

There are quite a few courses – most are in the area of mathematics – where students feel that they will never use the material and thus there is no point in learning it. In fact, some students might openly ask the instructor, "Will I ever use this information? Why do I have to know this?" (Surprisingly, few students ask this about, say, swimming, sex-education, basketball, or recess.)

Recently, one professor posited that algebra was a course that should not be required for graduation from high school [18]:

> The toll mathematics takes begins early. To our nation's shame, one in four ninth graders fail to finish high school. In South Carolina, 34 percent fell away in 2008-9, according to national data released last year; for Nevada, it was 45 percent. Most of the educators I've talked with cite algebra as the major academic reason.

Hacker also points out [18]: "Of all who embark on higher education, only 58 percent end up with bachelor's degrees. The main impediment to graduation: freshman math …" and considers that a course such as "citizen statistics" should be allowed as an acceptable alternative to algebra. The example Hacker provides of what should be covered in this citizen statistics course seems just as problematic (and boring) as algebra:

> It could, for example, teach students how the Consumer Price Index is computed, what is included and how each item in the index is weighted — and include discussion about which items should be included and what weights they should be given.

Like our colleagues teaching many other quantitative courses, it is up to those of us who teach the introductory statistics course to demonstrate the critical importance of this material to our students. In the words of students, we have to show them that this is an "awesome" course. The course should not focus on memorizing formulas but on how statistics has been applied in so many areas that affect us.

In a somewhat similar vein, several researchers have demonstrated the value of using humor in the introductory statistics course [11] [12]. Some have also advocated using real life data in the basic statistics course so that students can have a feel for what it is like to work with real data [7] [27] [31] [43] [49]. This paper will take a different approach and show how using attention-grabbing examples can make a statistics course interesting, thought-provoking, and relevant. Students do not actually have to work with the data to appreciate the importance of statistics. Once they hear how evidence-based research (using statistics) and statistics have transformed so many different disciplines, they will understand why it is important to learn and understand statistics.

The purpose of this project was to identify real-world examples, from a variety of fields of study, that emphasize the importance of employing a statistical, evidence-based view of reality. There are many examples of ridiculous assertions not based on true science. Let's not forget that doctors once told us that eggs were bad for our health and that margarine (made from hydrogenated oil) was healthier and better than butter. Even in the universities, we sometimes come up with nonsense. Many economics professors still believe that Marxism works or that man is rational (*homo economicus*). It is hard to believe, but Representative Todd Akin publicly stated that: "If it's a legitimate rape, the female body has ways to try to shut that whole thing down." Akin was trying to justify his position that abortion should not be allowed even for a woman who has been raped – after all, the victim will not get pregnant. Of course, Rep. Akin's implied message is that a rape victim who did become pregnant could not really have been raped. One assumes that Todd Akin went to college. How can someone be that stupid? Well, he is (at the time of this writing) running for Senate. Hopefully, he did not major in statistics. Or biology.

One method for engaging students is to require them to bring in their own examples of how statistics can be useful. One valuable resource is the Tuesday *New York Times'* Science section which describes current studies involving health. These studies often provide findings that demonstrate that much of the medical dogma surrounding health is often wrong. Even today,

doctors have been giving advice to patients that are not based on scientific evidence.   Students can use Google to find scientific studies that challenge the conventional wisdom. In fact, students who read a newspaper every day will find numerous examples.

Once students come up with their own examples, they can use the online Discussion Board in Blackboard (or other learning management system), written papers, and/or presentations to the class to discuss their findings. Students should also be asked to respond to at least the posts of two other students. The goal of all this is to (1) enable students see the relevance of the introductory statistics course , (2) make students realize that much of the information out there (including much of what is taught in college) is "junk," i.e., not evidence-based, and (3) help students understand the difference between junk science and authentic science. We want students to understand that society can only make real progress by using the scientific method. We may not rely on the stars and constellations any more, but many of our politicians are saying things that must have come from tarot cards or crystal balls.

Ideally, students will research and bring to the discussions examples from their own fields of study. First, to start them off, some very real examples are provided.

HEALTH

Health has improved greatly in most of the world thanks to the use of experiments. Even simple designs comparing an experimental group with a placebo group and using very simple statistical tools have done much to improve world health.

Semmelweis: One doctor who had a great deal of trouble convincing his colleagues to do the right thing was Ignaz Philipp Semmelweis (1818-1865). In those days – not very long ago – puerperal infection (an infection of the female reproductive organs after childbirth) was very common. Women who gave birth in maternity hospitals had mortality rates of 25% to 30%. Semmelweis noticed that women who gave birth in the first division of the clinic where medical students were taught had a much higher mortality rate than women who gave birth in the second division where midwives were trained. He surmised that the medical students who were coming from the dissecting room to the maternity ward were bringing infection with them; this was before we knew about bacteria. Semmelweis instructed students to wash their hands in a solution of chlorinated lime before treating the pregnant women and he observed that the mortality rates in the first division went from 18.27% to 1.27%. Today, we would say that this is a statistically significant difference. Later on, he worked at a hospital in Pest and, after an epidemic of puerperal fever broke out, successfully put an end to the epidemic by making doctors wash their hands. In 1861 Semmelweis published his major article, *Die Ätiologie, der Begriff und die Prophylaxis des Kindbettfiebers* ("Etiology, Understanding and Preventing of Childbed Fever"). Unfortunately, most doctors in other countries did not take his work seriously and refused to wash their hands before treating women ready to give birth. Indeed, his research was attacked by German physicians at a conference. In 1865, Semmelweis died in a mental institution; the stress had taken its toll [52].

Lister: In the first part of the nineteenth century, surgery was often done by barbers who often wore dirty clothing and reused their instruments; operating tables were dirty and surgeon's hands

were filthy. No one understood about bacteria. About 43% of amputees died from sepsis. Joseph Lister (1827-1912) read the research of Louis Pasteur and realized that microbes in the air (bacteria) were the cause of gangrene. He introduced acids as disinfectants into the operating room. He started with carbolic acid and used it to sterilize the equipment and the wound itself. He was able to reduce mortality rates to 15% and is considered the founder of antiseptic medicine [4]. Needless to say, modern surgery could not happen until physicians understood the importance of cleanliness. Lister acknowledged the important contribution of Semmelweis to the concept of antiseptic surgery.

The above stories are a good way to show why we need evidence-based medicine. Lest students think that evidence-based medicine is no longer needed, here are some examples from our own time.

The Annual Physical Exam: It is now becoming evident that such truisms as "make sure to get an annual physical examination" are incorrect. Annual physical exams often result in unnecessary procedures. In fact, we are one of the few countries in the world that still believe in them [42]. The American Board of Internal Medicine has come up with 10 unnecessary "routine" screening tests: annual physical, annual EKG, annual blood work, annual cholesterol test, annual Pap smear, prostate specific antigen test, pre-operation chest X-ray, bone scans to detect osteoporosis for women under 65, imaging for lower back pain of short duration, and imaging for common headaches [42].

Prostate Cancer: There are 50,000 radical prostatectomies performed in the United States every year of which more than 80% are not necessary [3]. Only one in seven men who are diagnosed with prostate cancer might actually develop the dangerous, aggressive form of the disease. The overwhelming majority of men diagnosed with prostate cancer will live just as long if they leave it alone and have it watched and treated as a chronic condition. In fact, only one man in 48 has his life extended by the surgery; the rest have to suffer needlessly from symptoms ranging from incontinence to impotence.

Statins: Statins, used to lower cholesterol, are among the most popular drugs in the world. In 2006, statin sales were $27.8 billion with 50% going to Pfizer's drug, Lipitor. Pfizer runs a campaign targeted to consumers that declares: "Lipitor reduces the risk of heart attack by 36%... in patients with multiple risk factors for heart disease." While the advertisement is literally true (in an experiment, 3% of subjects taking a placebo had heart attacks vs. 2% taking Lipitor) it is very misleading. The results of the experiment indicate that 100 people had to take Lipitor for three years in order that one person would benefit and not get a heart attack. Ninety-nine people taking Lipitor will not benefit at all from taking Lipitor; however, they will have to deal with side effects. The measure that focuses on how many people must take the drug for one person to benefit, is known as the NNT (number needed to treat); Lipitor has an NNT of 100. Medical experts say that one should not take a drug with an NNT of over 50. There is evidence that the NNT for low-risk patients using statins for five years is 250 [5]. These statistical measures, especially NNT, if made available to the public, can result in reduced medical costs and better health. Bach [1] notes that "with routine mammography, you'd have to screen more than 1,000 women in their 40's to prevent just one breast cancer death."

Chemo: Chemotherapy is extremely effective for some kinds of cancers (leukemia, lymphoma, testicular cancer, Hodgkin's disease) but ineffective for many other cancers (e.g., multiple myeloma, melanoma of the skin, cancer of the pancreas, uterus, prostate, bladder, and kidney). Despite this, a huge amount of money is spent on chemotherapy. In many cases, nothing is accomplished except possibly enriching oncologists and giving cancer patients false hope. With lung cancer, which kills more than 150,000 Americans each year, the chemotherapy treatment costs considerably more than $40,000 but life is only extended on average for about 2 months [28].

Salt: The conventional wisdom is that salt is extremely dangerous and we should all reduce our consumption of it. Surprisingly, there is very little scientific evidence to back up this claim. It is not clear that consuming too much salt causes hypertension, and then results in strokes and premature death. Meta-analyses examining the entire literature dealing with salt and health have resulted in findings that are "inconsistent and contradictory." There are new studies that suggest that reducing salt consumption can actually increase the risk of death. The reason given is that the less salt consumed, the more renin secreted by the kidneys. Renin seems to be linked to an increase in heart disease [47]. Not everyone agrees with Taubes; however, it is important for students to realize that the answer to many health questions will require statistical tests.

How to Prep for Surgery: Another piece of conventional wisdom that research has refuted is that patients should be shaved before surgery. One study actually demonstrated that shaved patients had a 5.6% infection rate vs. a rate of less than 1% whose hair was removed with clippers. The theory is that shaving results in microscopic nicks that make it easy for bacteria to breed and thereby cause a post-operative infection [39].

Scanning Our Kids: Medical research is finding that CT scans on children (computed topography, i.e., numerous X-rays taken from various angles in order to produce cross-sectional images) may result in a significant increase in brain cancer and leukemia. In fact, 500 of 600,000 children under the age of 15 who had CT scans would "ultimately die of cancer caused by the CT radiation." This does not mean that CT scans should never be used. Rather, it should not be the first choice and should only be used if absolutely necessary [16].

Survival Stats: Who is more likely to survive when there is serious famine and a lack of food, men or women? Grayson [17] studied this and compared the death rates for men and women in the Donner party. The people in the Donner party were on their way, using covered wagons, to California from Illinois and found themselves stranded for 6 months in the mountains. They had no food and eventually resorted to cannibalism and ate anyone who died. The death rate for men was 30/53 and for women it was 10/34. The women did significantly better than the men. Grayson's conclusion was that women have an extra layer of fat that men do not have. That is there for the baby in case food is a problem. That extra layer of fat protects women in times of food deprivation [17].

Diet: This is something most students probably know about; almost everyone has tried to lose weight at some time. Most diets do not work. Research demonstrates that people will lose weight on many different kinds of diets. Unfortunately, most of the weight loss occurs early on and a year later, most dieters gain everything back [46: 36-37]. Taubes [46] feels that diets that

are based on the principle of eating less, rarely work since people cannot starve themselves indefinitely. Moreover, they are training their bodies to make do with fewer calories which will make it more and more difficult to keep the extra pounds off. Taubes [46: 191-192] cites numerous studies that believe that the trick to losing weight is to shift away from carbohydrates and consume more fat and protein. There is quite a bit of research demonstrating that low-carbohydrate diets that are high in fat result in better health (lower blood pressure, lower level of triglycerides, greater weight loss, and higher levels of the good cholesterol) than several other diets that allow more carbohydrates. The conventional wisdom that all fat is bad for us has little scientific evidence to back it up. In fact, according to Taubes [46: 10-11], until the 1960s, the conventional wisdom was that people who wanted to lose weight should stay away from foods rich in carbohydrates (e.g., beer, bread, pasta, potatoes, sugary foods, and sweets). Carbs were the villain, not fat. Is Taubes right? The answer will eventually come from evidence-based research, not anecdotal evidence.

HAPPINESS

Everyone wants to be happy.   Students will be very interested in knowing what research using statistical techniques has to say about happiness.

Money: A major finding is that increases in income do not do much to help increase happiness once a person's basic needs are satisfied; what matters more than absolute wealth is relative wealth [19] [23] [34] [35] [38][50]. Layard [25: 48-49] describes the "hedonic treadmill" that families find themselves on. Their income increases so they buy a bigger and better house, a nicer car, go out more, and within a few months have adapted to the new lifestyle and are no happier than before the income increase. People compare their own income with those of neighbors and people similar to themselves. If a family's income doubles but the income of friends and neighbors triples, the family will actually become less happy [25: 43-46]. A simple trick for being happy is not moving to a wealthier neighborhood once your income increases. Stay in the old neighborhood where you are among the (relatively) wealthy ones. Another trick that researchers in the field mention is to keep a gratitude journal and be happy with what you have.   Dunn and Norton [9] cite research that asserts that "the beneficial effects of money tapered off entirely after the $75,000 mark."

Individuals are very poor judges as to what will make them happy [14]. They will therefore overestimate the joy that additional money will bring them and underestimate the joy they will receive from having more time to spend with family and friends. Long commutes to work are rough on happiness; yet people will change jobs to make more money and end up with reduced happiness. In most cases, a person with an easy commute and a job that is not demanding in terms of time will be much happier than the person who has no time to spend with family and friends because of work. Winning lotteries also does not do much in the long run to increase happiness [45].

Job satisfaction: Myers and Diener [38] cite numerous studies that show that there is a strong relationship between job satisfaction and life satisfaction. In fact, people want to be engaged in productive, meaningful work. Meaningful work, Myers and Diener [38] note, is more important than the size of the paycheck; people want challenging, fulfilling work that gives them a sense of

accomplishment. Thottam [48] cites numerous studies showing relationships between meaningful work and happiness.

Social Relationships: There is a strong correlation between happiness and social friendships; socializing and having many friends does a lot to increase happiness [8] [13] [26] [37] [50]. People have a need to belong to and be part of a group. This gives them identity and support. There is also a strong correlation between social connections and health [37]. The need to belong can be fulfilled by religion, work, family, or other support groups.

There is a correlation between marriage and happiness [37]. People in a happy marriage are among the happiest people. People who are separated are among the most unhappy. Myers [37] also found that those who are married are less likely to suffer from depression. What is especially interesting is that about 75% of Americans say that their spouse is their best friend; 80% say they would marry the same person again if they had the chance.

Blanchflower and Oswald [2] found a strong, positive correlation between sexual activity and happiness. Sexual activity appears to have very strong effects on happiness for those who are educated. This confirms the findings of Kahneman *et al*. [22] regarding the importance of sexual activity in happiness.   This was true for young and old, male and female. Those with one sexual partner exhibited more happiness than those with multiple partners. Individuals who had sex outside their marriage had lower happiness scores than those who did not.

OTHER AREAS

Examples from other areas studied include: safety, ratings and rankings, crime, teacher cheating, attractiveness, sports, and education. For the complete longer version of this paper (including references) is available on SSRN at:
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2129750.

CONCLUSION

The above examples from many different areas of research including health, education, sports, school ratings, crime, etc. should help statistics instructors make their courses more interesting. In addition, these examples and cases, we feel, will answer the question students often ask: "Why do I need to learn this?" Having looked at these examples, we can safely say that whatever path our students will follow through life, statistics will likely be critically important to understanding their professions and the world around them.

REFERENCES

References are available upon request.

STIMULATING REFLECTIVE LEARNING IN TEACHING A SERVICE OPERATIONS MANAGEMENT COURSE

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ABSTRACT

This paper looks at an innovative teaching method used to stimulate reflective learning in Service Operations Management in Fall 2011. The method integrates a structured questionnaire with students' self-assessment; effectiveness was observed in the course teaching. The paper discusses the benefits and the potential difficulties faced in applying this method. Finally, potential for future research is discussed.

Reflective Learning, Operations Management

1. INTRODUCTION

Over the last several decades, reflection has been widely accepted by educators as an effective way of facilitating students' critical thinking (e.g. Mezirow & Associates, 1990; Moon 1999). Reflective learning is "…the process of internally examining and exploring an issue of concern, triggered by an experience, which creates and clarifies meaning in terms of self, and which results in a changed conceptual perspective" (Boyd and Fales, 1983).

Reflection is an essential part in students' learning in higher education. Reflection is a way to build up connections. These kinds of connections do not only exist between theories and practice, but also exist among the past, the present and the future. The most traditional class environments separate students from the real practice physically. The gap between practice and theory leads to the loss of students' interests. Students are less motivated to work hard and end up with low performance. Although this situation could be alleviated by actively bringing examples into the classroom from the real world by instructors, students totally play a reactive role in the process and only passively adopt those ideas. Reflection actively leads to students' proactive thinking and builds up connection with the real world through active involvement. Meanwhile, even for those students who have great performance in academic study, they may still lack the capability of applying theories to the practice if the learning process does not include this element of reflection training since all the knowledge that students obtain is isolated from the real practice. When the real problem rises, students cannot connect it with what they have learned and they therefore cannot come up with a solution. The active thinking is essential in the process of learning.

Reflection could enrich students' learning experience and encourage students' deep thinking. Reflective learning changes the traditional learning pattern, where the professors pass the information and knowledge to students. In reflective learning, students can also effectively provide feedback immediately to the professors. Meanwhile, students' thoughts are sometimes so interesting that they could be further integrated into the teaching process.

Reflective learning helps students "…raise their own awareness of their learning process" (Murugaiah and Thang 2010). Through reflection, students have better control over their learning process. Not only can students have a better idea of what they have learned, but they can also have better control on the continuing learning process.

As a result, reflective learning should be embedded into the course design. Self-assessments have greater potential to feed into future learning. Our study is motivated by this phenomenal situation. In the next sections, we provide a brief literature review, followed by a further discussion on how to apply reflective learning in teaching an Operations Management course in a business school. Students' response and feedback are analyzed and some interesting results are presented.

2. LITERATURE REVIEW

Reflective learning has been emphasized in teaching humanity courses, including social work, communication, education and arts (Birenbaum and Amdur, 1999; Thorpe, 2000; Halton et. al., 2007; Hay, 2008; Ji and Kastains, 2009; Bubnys and Žydžiūnaitė, 2010; Davys& Beddoe, 2009; Wolf, 2010) since the pedagogy naturally belongs to the social science . For the same reason, it is not difficult to understand why reflective learning has recently been intensively used in medical education (Thorpe 2004; Rose and Devonshire, 2004; Grant et. al., 2006; Morgan et al., 2006; Sandars et. al., 2008; Lee et. al., 2009; Leung et. al., 2010; Braidman et al., 2008; Leung et. al., 2010; Black& Plowright, 2010); medical education is centered on real practice. It is understandable that limited number of research has discussed the application of reflective learning in teaching sciences (Thompson et. al., 2005; Stefani et. al., 2000; Valkanova and Watts, 2007) while it starts to get more attention from educators who teach Business courses (Stefani et al., 2000; Bourner et. al., 2000; Carroll , 2006; Abrahams and Singh, 2010). It therefore becomes important to explore the potential effects of using reflective learning in teaching Operations Management.

The formats which have been implemented to represent reflective learning include journaling, story-telling, self-assessment, and reflection on written feedback. As a first attempt, Birenbaum and Amdur (1999) utilized multiple activities such as discussion, hands-on activities and projects

with modeling to promote reflective learning in teaching a single course. Since then, journaling has become the most popular method in promoting reflective learning (Birenbaum and Amdur, 1999; Rose and Devonshire, 2004; Thorpe , 2004; Grant et. al., 2006 ; Morgan et. al., 2006; Halton et. al., 2007; Sandars and Homer, 2008; Braidman et. al., 2008; Hay, 2008; Ji and Kastanis, 2009; Black and Plowright, 2010; Wolf, 2010). Through journaling, students can reflect on what they have learned or practiced in a formal writing format. With the promotion of a student-centered learning environment, storytelling is an innovative way to conduct reflective learning, whether it is traditional storytelling (McDrury and Alterio, 2001), digital story telling (Valkanova and Watts, 2007; Sandars et. al., 2008), actively participating in role play in the classroom (Carroll, 2006) or the creation of advanced digital movies (Généreux and Thompson, 2008); technological advances have paved the way for new formats in reflective learning. However, since story-telling often has a loose structure, instructors have very limited control on what perspective/subject students reflect on; thus, the quality of reflection and the effectiveness to promote learning cannot always be assured.

As a result, it is timely to reflect on how to implement a more structured teaching method to stimulate students' reflective learning and help them develop a long-run strategy to learn. The method should focus on students' awareness of their learning process and the skills of critical thinking. This motivates our study in exploring the new method.

3. THE INNOVATIVE TEACHING METHOD

The teaching method is conducted through a blank sheet constructed to overview the knowledge covered in class systematically, which is handed out to every student before every class. This sheet has two parts. In the first part, there is a table designed for students to answer some questions about the key information to be covered in the class. These questions are generalized questions including the definition of some specific core concepts, the format of certain models, the utilization of those techniques etc. Students are directed to fill in the two columns in this table; left is for knowledge "before class," while the right is for knowledge "after class." Using this table, students can directly compare their own knowledge about the key concepts before class and after class.

In order to better guide students, a written format is required from students. The benefit of doing this is obvious. On one side, students are encouraged to express their ideas in a more formal format. In this process, students could comb and organize their thoughts and clarify their thinking ultimately. On the other side, students also benefit from these writing trainings in the long run.

At the bottom of the sheet, we designed an evaluation form, which requires students' self-assessment. With a 5-scale point, students indicate their level of the knowledge of the concepts or applications. 1 stands for "know nothing", 2 stands for "know little", 3 stands for "know well", 4 stands for "very familiar" and 5 stands for "can apply it freely". Students need to fill in their self-evaluations into the table. Based on the answers to the first part, students may be better able to provide a more solid evaluation.

The sheets are distributed to all the students right before each class starts. Students are left with 5-10 minutes to review the questions and complete the left part of the sheet. At the end of the class, another 5-10 minutes are designed for students to complete the right part of the sheet (the "after the class" part). Students need to turn the sheet in before they leave the classroom. Although student names could facilitate individualized attention and identification of deficits, they are not needed since the sheet will not be graded and this would not directly influence students' final evaluations or scores.

4. THE IMPLEMENTATION IN A SERVICE OPERATIONS MANAGEMENT COURSE

The course MGMT426 Service Operations Management is a fundamental course introducing operations management in the service sector, the interaction with the other business functions, and the impact of service operations management on the business as a whole. It covers topics including demand forecasting, service design, human resource management, location selection, quality management, and scheduling. In Bridgewater State University, we offer this course multiple sections in each semester. The current experiment was conducted in 2 sections in Fall 2011.

MGMT 426-002 is a day-time class and students meet every Monday and Wednesday while MGMT426-004 is an evening class, which only meets once a week. Each of these two classes has 37 students. Since Service Operations Management is one of the concentration core courses for several concentrations such as General Management, Operations Management and Finance & Accounting, the majority of students are from the management department and finance and accounting department. In MGMT426-002, 38% of the students are male and 44% are female. In MGMT426-004, 57% of the students are male and 33% are female.(Due to the self-identification process of students, this does not add up to 100%) Most of students are either junior or senior students (89% and 78% in MGMT426-002 and MGMT426-004 respectively). Meanwhile, most students have part-time jobs (79% and 45% in MGMT426-002 and MGMT426-004 respectively) or full-time jobs (14% and 30% in MGMT426-002 and MGMT426-004 respectively). Therefore, students are expected to build connections between the academic study and their work experiences. The reflective learning is embedded in the curriculum of both sections. At the time

of our study, the majority of the students had little to no knowledge about the reflective learning methods (only 24% and 9% in these 2 sections mentioned that they had known of these methods), but by the end of the course term, most students believed that the method is very effective (91% and 82% in these 2 sections).

5. THE RESULTS

In the first part of the questionnaire, students were required to fill in the answers to some critical questions which guided their further thinking. To answer those questions, students were guided to reflect on those concepts and try to find the connection between their previous practices with the theory to be learned.

For example, in order to answer "What are the three major functions of an organization?", one student answered, "…to perform a service/good… make money for share/stake holder… and [to ensure the] well-being for the public".

Although this is not the exact answer mentioned in the textbook, this student shows his introspection, his inner conversation. We believe these questions prompted before class helped students focus on exploring the answers to these questions during class. The thoughts they put on the sheet helped them reflect on how those ideas are connected and why these are important to those operations managers in practice. They were even able to think critically and evaluate the correctness of those theories.

Students' self-assessments on the effectiveness of the before and after class shows an obvious change:
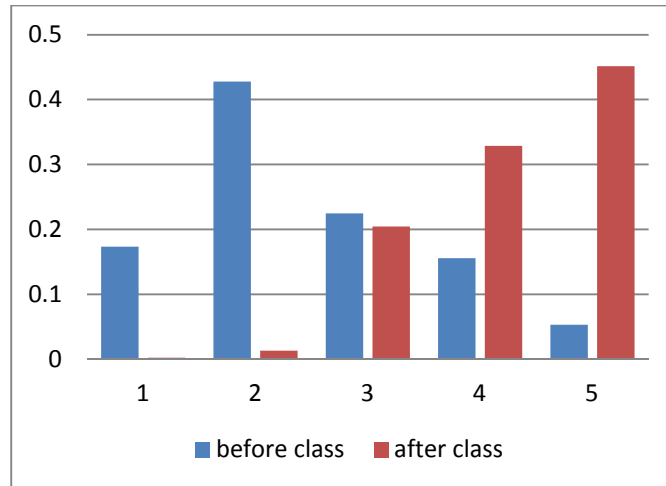
Figure 1 Students' self-assessments comparison chart

The distribution from densely distributed "know little" before class moves to the right which stands for "very familiar" and "can apply it freely", which shows the effectiveness of this method.

6. CONCLUSIONS AND FUTURE DIRECTIONS

From this study, it is easy to see the effectiveness of using this method to promote reflective learning. However, some potential problems related to the method could be identified.

The self-assessment method applied here itself needs to be improved. Although the questions in the first part of the questionnaire provided students with some idea of conducting more subjective evaluation, the evaluation was still very subjective. Meanwhile, the scale may have confused students. We can observe that some students had a hard time in choosing between "3 know well" and "4 very familiar" this can be improved in the future design of self-assessments.

Therefore, we expect more methods targeting reflective learning be designed. The new format of reflective learning methods should be a good balance of free thoughts and structured guideline. Then the effectiveness could be ensured and the skills of students' learning can be improved.

Note: The study has been approved by the Institutional Review Board. The case number is #2012053.

References available upon request from Xiangrong Liu

USING EXPLORATORY FACTOR ANALYSIS TO UNDERSTAND BEST E-LEARNING PRACTICES AND THEIR IMPACT ON STUDENT SATISFACTION

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ABSTRACT

Keywords: E-Learning, Best, Practices, Satisfaction

The aim of this research is to provide a broader understanding of the best practices for online education and to examine their impact on students' satisfaction. Using principal component factor analysis, we analyze 59 initial indicators of best e-learning practices to determine whether these items can be explained by a smaller number of hypothetical factors. A convenient sample of online MBA students is used and a web survey instrument administered to gauge their perceptions of the best practices using a 7-point Likert scale. Ultimately, 169 survey responses from online students are used to conduct exploratory factor analysis using the "Varimax" rotation method. Eight factors that account for approximately 50% of the total variation in the observed variables are extracted, which are interpreted, respectively, as *Course Content*, *Professor / Student Engagement*, *Quality of Technology*, *Challenging Coursework*, *Contributions of Fellow Students*, *Flexibility of Professors*, *Use of Non-Textbook Learning Resources*, and *Fairness of Exams*.

The reliability (i.e. internal consistency) of these eight factors is checked using Chronbach's Alpha. Factors 1-6 have Chronbach's Alpha coefficients higher than 0.7, indicating adequate reliability, while the remaining two factors have Alpha coefficients below 0.5. However, these factors are retained based on their mean Inter-Item correlation that indicates adequate reliability. The eight extracted factors are next used in developing a multiple regression model to determine which of these underlying factors are most helpful in explaining satisfaction (the dependent variable) among online student. Using the stepwise regression method, three significant variables (*Course Content, Contributions of Fellow Students,* and *Professor / Student Engagement*) are retained explaining 76.4% of the total variation in the model. Based on the standardized beta coefficients, *Course Content* has the highest importance to satisfaction, followed by *Contributions of Fellow Students*, and finally *Professor/Student Engagement*.

HOW ACCOUNTING PROFESSORS CAN HELP TOWARDS SOLVING THE CRISIS IN HIGHER EDUCATION

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ABSTRACT

This essay proposes an incremental improvement that professors can introduce to improve the efficiency and effectiveness of accounting courses with little to no investment in additional time and money. The improvement consists of leveraging video resources of the internet to assign ethics assignments to supplement the course material of regular accounting courses, such as principles, intermediate, and advanced accounting. The professor can also make use of learning portals such as BlackBoard or Moodle, by having students post their discussions of the ethics videos on the portals.

KEYWORDS: MOOC, student debt, hybrid classes, ethics

INTRODUCTION

In the aftermath of the "Great Recession", the quality and affordability crisis in higher education has engaged the attention of the general public as never before. One the quality side, critics such as Arum and Roska (2011) have found that students fail to learn the requisite technical skills and professional, humanistic, critical-thinking and ethical knowledge needed to function in well-paying, challenging positions. As for affordability, the $1 trillion in student debt now exceeds credit card debt. The related issues of college affordability and the dearth of suitable jobs for graduates have even entered into the discussion in the presidential debates (Federal News Service 2012). In October 2012 *Time* devoted a cover story to the topic of higher education and reported the results of a survey which found that 80 percent of Americans think that college is not worth the money (Ripley 2012).

This essay proposes an incremental improvement that professors can introduce to improve the efficiency and effectiveness of accounting courses with little to no investment in additional time and money. The improvement consists of leveraging the video resources of the internet to assign ethics assignments to supplement the course material of regular accounting courses, such as principles, intermediate, and advanced accounting. The professor can also make use of learning portals such as BlackBoard or Moodle, by having students post their discussions of the ethics videos on the portals.

According to Ripley's cover story in *Time*, the silver lining of the higher-education crisis is the advent of on-line courses, specifically massive-open-online-courses (MOOCs). The purpose of this essay is to propose small steps that accounting professors in traditional classrooms can take to leverage the power of on-line resources. We specifically focus on videos that bring to light ethical issues and concerns for which the instructor does not have the time to devote in the classroom.

These technology-based additions to traditional classes should improve both the effectiveness and efficiency of accounting education. Furthermore, we propose to leverage technology tools to improve students' writing skills and knowledge of the economic, social, legal, and ethical context in which accountants operate. We demonstrate how these objectives can be met without sacrificing the time devoted to technical accounting issues. Our solution involves the use of on-line teaching platforms such as BlackBoard, Angel or Moodle to deliver hybrid or blended courses that involve both in-class and on-line components.

Rather than devoting additional courses and instructional resources to developing students' writing and ethics skills, we propose that accounting instructors, at all levels, assign appropriate videos from youtube.com or TED for students to watch on their own time. Students will then write short papers to summarize the critical issues and lessons from these videos. On-line teaching platforms such as BlackBoard allow students to post their comments on line and even have features to allow students to access and comment on their colleagues' comments. Such an iterative comment process allows for a thoughtful conversation about extra-curricular issues such as ethics without sacrificing valuable classroom time needed to cover more conventional accounting topics.

Our proposal to blend on-line coverage of "soft" areas into traditional, technical accounting courses offers the following benefits:

- *More effective delivery*: research has found that blended courses are more effective than either traditional courses or purely on-line courses (Means et al. 2009).
- *Efficient use of time:* Through the use of technology, students gain the benefit of engagement with and writing on ethical issues without taking away valuable classroom instruction time needed for more technical aspects of accounting education.
- *Ease of assessment:* The additional time demands on the instructor are minimal due to the BlackBoard or other portal technology that allows for easily accessible on-line storage of student work. Furthermore, by allowing students to view each other's work, instructors can point out good examples of student analysis and writing for the benefit of all students.
- *Improving the substance and image of the Accounting curriculum:* University-level accounting courses should be more than just about CPA exam preparation. By offering a more global, societal perspective on technical accounting issues, accounting educators add value to a university course over and above a CPA review course. By broadening the scope of the instruction, the profession also successfully addresses academic critics who view the accounting curriculum as "vocational" and somewhat less edifying than a course of study in social sciences.

SAMPLE VIDEO RESOURCES

While the internet undoubtedly features hundreds, if not thousands, of effective videos on ethics, we highlight a number of such videos to provide professors with a convenient way to start experimenting with the approach outlined in this essay. We selected the following videos as effective stimulators for students to think and reflect about economic, legal, and ethical aspects related to accounting:

Video 1: TED video by Bill Gates on the crisis on State & Local Government Pensions			
Title	How state budgets are breaking US schools		
Who	Bill Gates		
Description	"America's school systems are funded by the 50 states. In this fiery talk, Bill Gates says that state budgets are riddled with accounting tricks that disguise the true cost of health care and pensions and weighted with worsening deficits -- with the financing of education at the losing end" (quoted from TED).		
Short link	http://on.ted.com/kKd2	*Length*	10 minutes
When	March 2011	*Views*	500,000+

Video 2: Yale Panel on the Financial Crisis			
Title	Understanding the Financial Crisis		
Who	Moderated by Yale's president; panelists of prominent law scholars and economists, including Robert Schiller		
Description	A Panel discussion on "Understanding the financial crisis: The stimulus, bailouts, and other solutions"		
Short link	http://tiny.cc/y7deqw	*Length*	82 minutes
When	February 2009	*Views*	27,000+
Note	While a little dated, this video is also instructive how experts during the depth of the financial crisis had widely differing assessments of the future. Some were expecting a much worse recession than we have experienced, while others like Schiller was relatively optimistic.		

Video 3: "60 Minutes" on derivatives			
Title	Financial WMDs		
Who	Former SEC Commissioner and General Counsel Harvey Goldschmid is interviewed by Steve Croft		
Description	Excellent introduction to derivatives and their potential risks to the financial system with a special focus on credit default swaps		
Short link	http://tinyurl.com/lxs8hh	*Length*	12 minutes
When	October 2008	*Views*	Unknown

Video 4: Harvard's Michael Sandel on "Markets and Morals"			
Title	Markets and Morals		
Who	Harvard political philosopher Michael Sandel		
Description	"This Chautauqua speech tackles some of economics' toughest ethical questions, such as the business of commercial surrogacy and the price of citizenship. Sandel argues that free market economics have affected American perceptions of ethics, morality, and value. By emphasizing the monetary value of human goods, says Sandel, Americans may be moving away from notions of emotional and social worth" (from YouTube description).		
Short link	http://tinyurl.com/a6uhase	**Length**	66 minutes
When	Summer 2009	**Views**	40,000+ as of January 2013

Video 5: Daniel Kahneman on the financial crisis			
Title	Why Greenspan's Framework Went Awry		
Who	Nobel Laureate Daniel Kahneman		
Description	Kahneman discusses the theoretical weaknesses of classical economic theory and why banks failed		
Short link	http://tinyurl.com/a4c2bqz	**Length**	3 minutes
When	January 2009	**Views**	93,000+ (including FORA site)

Video 6: Phil Donahue interview with Milton Friedman			
Title	Greed and Virtue		
Who	Milton Friedman		
Description	As a stimulating counterpoint to the other videos, Milton Friedman defends greed as a flawed motivator in a flawed world: "What is greed? Of course none of us are greedy; it's only the other fellow who's greedy." The U.S. capitalist system is still the best in the world.		
Short link	http://tinyurl.com/63uglhd	**Length**	2 ½ minutes
When	1979	**Views**	Nearly 2 million, January 2013

While some of the listed videos directly relate to accounting and accounting ethics, others relate more broadly to the economic and societal context in which accounting operations. In the past, accounting professors may have felt that these topics are outside of our turf of technical expertise. This can no longer be the case. While accounting has always been the language of business, accountants are now entrusted with greater responsibilities in assessing the ethical and economic environment in which the business operates. Internal control is an example. In the advent of the Sarbanes-Oxley Act of 2002, internal control has become as important as the fair presentation of the financial statements. At the same time, the Committee of Sponsoring Organizations (COSO) has issued a draft of "Internal Control – Integrated Framework that stresses the importance of an ethical "tone at the top and throughout the organization". COSO similarly requires that the organization continually assess risk by monitoring changes in the economic and business environment.

In today's business environment, therefore, accounting professors must broaden the scope of their courses to areas outside technical accounting rules. Our reluctance to do so may have had some justification in the pre-YouTube era, when scope of course-coverage was a zero sum game; that is, any time devoted to larger, contextual issues came at the expense of coverage of technical accounting issues. With the onset of on-line videos and teaching technologies, however, students can explore the non-technical issues on their own. Instructors can effectively guide and monitor those activities without onerous time commitments.

A recent study has found that students actually devote less time to home-work today than a decade or two ago. Business students, moreover, are amongst the biggest slackers, although accounting students are more diligent than other business students (de Vise 2012). Professors can therefore in good conscience assign this additional work-load without the fear placing an undue burden on students' time.

Another benefit of assigning the additional ethics work is that increased engagement of students in non-technical areas of accounting will solidify their commitment to the accounting curriculum. Consequently, the addition of supposedly "soft" areas to technical accounting courses can actually improve student attention and performance in the technical areas.

Writing and communication skills have been a weak area for business majors in general and accounting majors in particular. Needless to say, these are skills that are necessary in any knowledge-based position. Even students who have mastered the technical skills for the CPA exam often lack problem-solving abilities in less structured situations. This essay proposed steps to address some of student weaknesses in awareness of the ethical, social, and economic context of accounting. It provided a framework to assign thought-provoking videos for students to watch, followed by a challenge to form an opinion on the video, to integrate that opinion with other knowledge, and to effectively communicate their opinions to colleagues and professors.

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CREATING A CULTURE OF HYBRID AND ONLINE TEACHING: A HOT CASE STUDY

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ABSTRACT

This paper examines hybrid and hybrid (HOT) learning in higher education, in the context of a large urban university that recently saw a very large increase in its HOT offerings and enrollments over a two-year period. Some of the activities undertaken in order to make this happen include: faculty seminars and workshops, instructional technology support, web support, faculty incentives, and a teaching award.

INTRODUCTION

Friedman [5] observes that one of the crucial challenges facing government today is: "How to generate growth and upgrade the skills of every American in an age when the merger of globalization and the information technology revolution means every good job requires more education." To make matters even more challenging for government, the spigot — i.e., the stimulus money which began in 2009 and saved about 400,000 education jobs — has been turned off. About 100,000 individuals in the field of education (the White House claims that the number is more like 250,000) have lost their jobs in the last few years. This is one of the problems facing public (and private) education: a shortage of money. There is less money but the skills people need in order to be successful in the workplace are increasing.

Another problem facing education is the belief that we are not getting much bang for the education buck. In fact, Arum and Roksa [3] claim that a significant number of college students barely improved their skills in the vital areas of critical thinking, writing, and problem solving/critical reasoning. In fact, after four years, 36% had made no significant gains in those three areas. The average amount of time spent studying by college students is now less than half of what it was in the 1960s. Clearly, we have to transform education and come up with new methods of teaching. There are those who believe that online teaching will have to be part of any solution [6]. After all, online education provides numerous opportunities for educators to introduce writing, critical thinking, and problem solving into courses. Online homework managers enable instructors to provide students with problems that can be corrected by computer. MOOCs (massive open online courses) also allow thousands students to learn from experts in their fields.

There is no question that colleges and universities across the country have increased their offerings of online and hybrid classes and programs. It should be noted that until last year, the Sloan Consortium was responsible for the research involving online learning [1]; this research is currently being conducted by the Babson Survey Research Group. According to the most recent

Babson study conducted in 2011, about 31% of college students were taking at least one online course [2]. The number of students taking online classes has increased for nine straight years, although it started slowing down a bit. Despite all this, Lytle [9] reports that "many faculty members are frightened by its growth and prevalence." Even today, less than one third of chief academic officers reported that their faculty accepted the "value and legitimacy of online education" [2].

This paper will show how one college convinced faculty to see the value of online teaching and, in effect, changed the culture.

THE SETTING

The college in question is located in New York City and has more than 17,000 students. It is a college with one of the most ethnically diverse student bodies in the United States. It also houses one of the largest business schools in the country.

In fall 2009, students were offered only four small classes in hybrid or online teaching (HOT) mode, of these three were online and one partially online. In fact, during all of academic year 2009-2010, only 197 students were enrolled in HOT classes, all of these in the business school. Barely two years later, by fall 2011, a total of 2,246 students were enrolled in HOT classes, 1,964 in business school classes. These strong numbers, which continued in future offerings, may be related to a flurry of HOT activities that changed the way faculty and students saw curriculum delivery. In any event, there was a definite transformation at the college. What happened?

First, let us look at some relevant terminology at the institution in question. At that time, a hybrid class was considered to be one in which one-third to two-thirds of instruction occurs online. This could be scheduled in a variety of ways, e.g., in one- or two-week modules, for some time each week throughout the semester, or in some other arrangement. A class is considered online when at most one-third of the class is delivered in face-to-face (FTF) mode. Hence, students in a "fully" online class can still be required to come into school for exams, labs, problem sessions, review sessions, etc.

ONLINE LEARNING

Surprisingly, there are quite a few faculty members that believe that online teaching is a "scam" and that the only way to teach is in a traditional face-to-face classroom. This is why it is important for any proponent of online teaching to know that the evidence does not support the view that the best way to learn is in a classroom.

Means *et al*. [10] did a meta-analysis of more than 1,000 studies published from 1996 to 2008 comparing online with traditional classroom teaching. What they found was that online learning does offer many advantages over traditional classroom learning. In fact, students who take courses that are either completely or partially online will perform better than students taking traditional, face-to-face courses. Interestingly, hybrid courses that combine classroom learning with online learning seem to be the best of all delivery methods.   Means *et al*. conclude:

1

Despite what appears to be strong support for online learning applications, the studies in this meta-analysis do not demonstrate that online learning is superior as a *medium.* In many of the studies showing an advantage for online learning, *the online and classroom conditions differed in terms of time spent, curriculum and pedagogy.* It was the *combination* of elements in the treatment conditions (which was likely to have included additional learning time and materials as well as additional opportunities for collaboration) that produced the observed learning advantages. At the same time, one should note that online learning is much more conducive to the expansion of learning time than is face-to-face instruction.

Diana G. Oblinger, president of Educause, made the following statement in response to the above study: "Online education provides additional opportunities. It gives people greater opportunity for flexibility, for experiential learning, for illustrating things in multiple ways such as visualization." She emphasized that the study makes it quite obvious that colleges have to make sure to use online education and not insist on only offering courses using traditional, face-to-face instruction [7].

The Open Learning Initiative at Carnegie Mellon University has been using hybrid courses that combine online and traditional classroom courses to accelerate learning. In one study involving different approaches to teach statistics, a comparison was made of a traditional class with a hybrid class. The traditional class met for 15 weeks, 4 times a week. The hybrid class met twice a week for 7 1/2 weeks. Students in the hybrid class had test scores and retention scores that were equal or better than those for the students in the traditional classroom[8]. It appears that a hybrid approach can enhance productivity even with a course as complicated as statistics.

The belief that the best way for students to learn is via traditional, face-to-face classes is rapidly becoming obsolete. The best one can claim is that the traditional class offers advantages for some students; after all, not all students have the same learning styles [4]. Younger students, in particular, who are comfortable with social networks, may benefit greatly from online learning communities and social media learning tools.

It is important for any advocate of online teaching to recognize that online teaching, especially hybrid or blended courses that combine both online and face-to-face teaching, may very well be the ideal way of teaching most classes. This is the modern way to teach a course. Faculty who refuse to use online tools are as myopic as those who might refuse to use email in communicating with students.

HOT ACTIVITIES

A flurry of HOT-related activities over a two-year period helped increase the number of HOT offerings and enrollments dramatically.

Summer Seminars and HOT Workshops

The first thing that had to be done was spread the word about online teaching. This was accomplished by using summer seminars and workshops. It all started during the summer of 2010, when faculty representing the various disciplines of the business school met regularly in

2

several full-day sessions for the purpose of learning more about the teaching of hybrid and online classes and exploring issues related to this modality. It was important to get the faculty to use word of mouth and word of mouse to tell others about the value of using online teaching tools. One-day faculty development workshops were held twice a year. Each workshop had a different theme, for example, one focused on best practices, one on social media and, in one, the college's own HOT faculty reported on their experiences in the virtual classroom.

A two-week Blackboard-based online course for faculty who wanted to teach HOT courses was offered several times a year. This course used a fully online and asynchronous method of delivery and the goal of the course was to help faculty walk the bridge from FTF to HOT course delivery. The course provided them with their own first-hand experience of how the daily activities in an online course unfold. At the end of the course, participants had a first draft of their online course syllabus and course website as well as a clearer idea of how online course activities worked.

Faculty Support
It is important to have instructors who can help faculty who are having difficulty with online. There has to be a go-to person where to send faculty if they want to learn about online teaching one-on-one. The college hired two instructional technology fellows, doctoral students with specialties in this area who helped faculty with online course materials and ideas. These IT fellows were charged with training faculty and supporting them in their efforts to develop course materials for online and partially online course delivery. Recognizing that it is important to have a specialized website dedicated to helping faculty develop their online course materials, the IT fellows produced and maintain a Website with information about many HOT faculty resources available at the college and beyond.

Incentives
Incentives are a good marketing tool. Fifteen fulltime members of the faculty were able to receive fully loaded laptops to support them in their online coursework, as an incentive to teach a course in hybrid delivery mode. Participation in the Hybrid Course Laptop Incentive Program required applicants to specify the course and semester in which this class would be offered and to complete a survey at the end of the course to share their experiences with other instructors interested in hybrid instruction.

HOT Teacher Award
The Hybrid & Online Teaching (HOT) Award was designed to recognize instructors in the business school who adapted instructional technologies in innovative ways in support of student learning and the university's mission to broaden the use of technology in the academic environment. Nominees submitted a personal statement and supporting materials like student evaluations, sample course materials, etc. Selection criteria were based on breadth of technology adoption for student learning and engagement; original and creative use of technology for the given curriculum; use of diverse technologies in the (real or virtual) classroom; and enthusiasm, i.e., a clear interest in and passion for teaching with technology, particularly in the service of hybrid or online courses. The first award was a prize of a Kindle e-reader. The advantage of these awards was that it helped generate additional publicity for HOT courses.

Assessment

Since fall 2010, the school has been piloting and testing online student evaluations for online courses. It is important to be able to demonstrate to faculty that students are satisfied with HOT courses. It is also important to fix problems before they undermine the entire HOT program. Since the college's regular course and teaching evaluations were still conducted using paper and pencil, the online courses needed to be assessed separately.

CONCLUSION

Needless to say, the school and the college were quite pleased to see the increase in online offerings. Like many other urban institutions of higher education, this college has been operating at nearly 100% room capacity. The number of students keeps growing but there is no money for new buildings. The business model used for HOT classes is quite familiar to those in the retailing and banking industries – namely, click and mortar. Many successful retailers have stores but also sell online. Colleges are also doing the same: offering both traditional and online courses. As the number of faculty who have expertise in online teaching increase, it will enable our colleges to grow, and to serve the needs of an increasing student population, without having to find the space or the funding for additional physical buildings.

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ONLINE LEARNING: THE GOOD THE BAD AND THE UGLY (PANEL)

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PANEL FORMAT

Models of distance education have evolved over decades, just in time to collide with modern pedagogies in which communication, interaction, student engagement, and active learning are of critical importance. The best of online learning, much like the best of face-to-face learning, requires active engagement on the part of the student. Rather than being passive recipients of transmitted knowledge, students are active participants in the learning process; they are engaged. Students help to create the learning environment. Ideally, while we manage the learning activities and facilitate learning, we would like students to learn as much from each other as they do from us. This panel of educators experienced with online learning modalities will draw on their experiences to discuss the pros and cons of this paradigm.

INTERNATIONALIZING THE BUSINESS CURRICULUM: FACILITATING FACULTY DEVELOPMENT VIA A SHADOW PROGRAM

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ABSTRACT

Business graduates increasingly find themselves subject to the demands of a dynamic, globally interconnected work environment. Business academics and business executives mutually acknowledge the responsibility of academic institutions to prepare college students for the challenging road in front of them. Yet, evidence suggests that some colleges/schools of business continue to struggle to internationalize their programs. One promising approach, the shadow program, immerses faculty members in an international field experience that provides fertile

ground for the development of international content and programming. This paper explores the shadow program concept and provides a case example of successful use of a shadow program.

INTRODUCTION

There is little doubt that business graduates need to know how to function successfully in a dynamic global environment. Business schools, both large and small, have the duty to develop their students for careers as knowledgeable global managers. Business executives assert that it is indeed the responsibility of academicians to prepare college students for this exciting but daunting task (Necht, 1987; Ball & McCullohgh, 1993; Webb, Mayer, Pioche & Allen, 1999; Harrison 2000).

Some colleges and schools of business still have not successfully met this challenge (Han 2004; Shetty & Rudell, 2002; Praetzel, 1999; Kwok, Arpan & Folks, 1994). Despite many schools' efforts to educate their students, many students still seem ill-prepared to operate successfully in the international business environment. Students are primarily monolingual and many do not have adequate knowledge related to the cultural differences and complexities they will inevitably encounter (Adler 2002). This is not just a problem found at smaller colleges that are oftentimes constrained by limited resources. In fact, it has been found that even students graduating from large universities have deficient levels of knowledge and understanding about foreign countries and cultures (Hise et al., 2000).

The extant literature related to the internationalization of the business school curriculum tends to focus primarily on the best ways in which to give students an international focus through their education. But according to Arpan and Kwok (2000), only a minority of the business schools studied were pleased with the level of internationalization that the faculty had attained.

This dissatisfaction/tension may be due to the fact that "globalization in the world is increasing faster than the internationalization of the curriculum and faculty, thereby creating a gap between academic and world developments and realities" (Arpan & Kwok, 2000, p. 18).

An often overlooked challenge relates to the lack of expertise among faculty members related to international issues. Students may struggle to gain critical international business preparation if faculty first are not internationalized (Keating & Byles 1991; Webb et al 1999; Kedia & Cornwell, 1994; Aggarwal, 1989). What if the faculty has minimal or no international business education, experience, and/or training?

PURPOSE OF THE STUDY

There is a wealth of academic research and literature related to preparing university students to compete in a global business environment. In contrast, there seems to be a paucity of information related to the preparation of the professoriate for the role they will play in internationalizing the business curriculum. Given that some business Ph.D. candidates may graduate with little emphasis in international business issues, it should not be assumed that the neophyte or seasoned professor possesses the international expertise needed to prepare students for the pressures of operating in a global environment.

Therefore, it is important to address how academicians can be prepared for this important task. The purpose of this paper is:

1. to review the literature related specifically to faculty development techniques utilized to "internationalize" academicians;

2. to discuss one such faculty development technique successfully employed by a small university (i.e. ,the "international shadow program") which not only trained faculty members but created/facilitated a much needed interface between the university and the business community;

3. to present an actual international shadow program case study and its contribution to the infusion of international content into the business curriculum.

RELATED LITERATURE: FACULTY DEVELOPMENT TOOLS

"*The education of the global citizen, one who will be comfortable visiting,*

working and living in diverse countries, is the responsibility of academia."

(Lundstrom & Schuster 1988, p. 15)

If the faculty is not adequately trained and /or continuously retrained, the internationalization of the business curriculum will be undermined. Faculty members cannot impart that which they do not possess (Shetty & Rudell, 2002).

The majority of literature related to curriculum internationalization tends to focus on specific strategies utilized to achieve the needed improvement in the business curriculum. Infusion of global content into existing courses is one such technique (Wardorpe & Minifie 2005; Mestenhauser, 1998; Satterlee 1997; Kwok & Arpen, 1994; Kendrick 1993: Loch & Deans, 1997). There is also a plethora of research related to the development of new international courses (Wardorpe & Minifie 2005; Raby 1996; Kwok & Arpen, 1994) and partnerships with foreign universities and institutions (Raby 1996; Satterlee, 1997). In many of these studies, faculty training is mentioned but never really fully addressed.

Raby (1996) suggests the recruitment of new faculty as a means for acquiring international faculty expertise. Cort, Das and Synn (2003.) state the current faculty may need to be retrained in order for successful curriculum infusion to be achieved. But what are the best ways to go about this?

Because the majority of business schools, both large and small, are currently operating with very limited resources, it is imperative that a group of highly motivated faculty members be

identified to lead the charge of internationalization (Shetty & Rudell 2002). It can be problematic if only one or two champions are involved, given that the endeavor might be abandoned should even one engaged faculty leave or retire (Raby 1996). It is advantageous to appoint an internationalization curriculum committee to oversee, coordinate, and evaluate faculty efforts. An initial step for the committee to take is the examination and assessment of existing international course content in current syllabi of the faculty (Cort, Das, & Synn, 2003).

After the assessment of syllabi, the committee can then critically examine the international skills/background that the faculty possesses. An international inventory assessment needs to be undertaken to evaluate the faculty's knowledge, skills and training (Harris, 1993).

An impediment to successful curriculum change may indeed be the lack of expertise possessed by the faculty asked to subsequently prepare students (Raby 1996). It should not be assumed that all professors will be entirely comfortable with the associated demands.

So then the next question becomes, "What faculty development strategies/modalities should be employed to best prepare professors to integrate and disseminate international course content?" One faculty development tool is the on-campus seminar. The training can address such issues as: levels of internationalization, infusion of international issues into existing course content, seeking external resources, integrating non-business international courses into the curriculum, and developing study abroad programs. It is imperative that faculty also be encouraged and supported to attend off-campus seminars, workshops, and courses. (Wardrope & Minife 2005; Cort, Das, Synn, 2003).

However, there is no substitute for first-hand international experience. Bisoux (2007) suggests that faculty be sent abroad on international "immersion experiences." This immersion could take the form of a faculty exchange program. One drawback to this developmental tool is

the absence of the faculty member back home; however, the exchange need not be for long periods of time. Many European business schools welcome professors from the United States to teach one or more courses of limited duration (Helsinki 2004; Uppsala 2004). For a U.S. university with limited human and monetary resources, this is beneficial because the professor does not have to be gone for a lengthy period of time. Upon return from this intellectual and cultural experience, the faculty member often serves as a "champion" for internationalization and will work more enthusiastically toward this goal (Warzyn 1997). It has been argued that faculty complacency and apathy are the primary reasons why internationalization initiatives fail (Raby 1996). Thus, the faculty exchange program can be used to combat faculty inertia.

Fugate and Jefferson (2001) note that forging relationships with U.S. based businesses engaged in international commerce can also help to internationalize the faculty. The authors state:

> Realistically, most current faculty members do not have the experiences/background to recognize and address the job related demands of the international manager at each of the three levels: (1) manager of a domestically based global enterprise, (2) manager of the international trade function (3) or the expatriate manger.

This successful interface/relationship between business and the educational institution could take many forms. A global manager could teach courses as an adjunct professor or could be tapped to lead seminars for faculty members. Another possible interface is to offer internships to the faculty (Fugate & Jefferson 2001). Internships need not be for students only!

ONLY THE SHADOW KNOWS

Another example of successful interface between business and faculty not mentioned in the literature as a faculty development tool is the "shadow program." When one thinks of shadow programs, they are usually associated with high school and college students "shadowing" business executives as they go about their daily work duties. However, this

international "immersion" technique was used very successfully by a small university with very limited resources and faculty expertise. The international shadow program was one tool successfully used to internationalize several of the business faculty from all departments within the College of Business. Included in this discussion is how to successfully develop an international shadow program for faculty. This advice and experience is based on the diligent and tireless efforts of one such "champion" who was instrumental in internationalizing the business curriculum.

SHADOW PROGRAM IMPLEMENTATION

The idea for the Shadow Program was developed in 2005 as part of a proposal for a U.S. Department of Education Title VI-B, Business and International Education (BIE) grant. The eligible activities provided in grant guidelines specifically mention projects which create opportunities for business and professional faculty to strengthen their international skills. The BIE is defined as a program which

> provides funds to institutions of higher education that enter into agreements with trade associations and businesses to improve the academic teaching of the business curriculum and to conduct outreach activities that expand the capacity of the business community to engage in economic activities.(need cite)

The Shadow Program concept came about in a discussion between the grant author and a plant manager of one of the multinational companies and also one of the individuals who pledged to support the grant activities if said grant was awarded. The initial arrangement was that an identified faculty member would travel with the managers of the company for a two- to three-week period when those managers made trips to their foreign facilities or met with foreign vendors or clients. The expenses for the faculty member were to be split evenly between the BIE grant and the company.

Prior to leaving on the trip, the faculty member was asked to identify how he or she would integrate their new-found knowledge and experiences into the classroom. Not only would the professor be learning more about international business, but it was expected as part of the grant, that their students would also benefit from the professor's learning experience. The professor was also expected to keep a diary of their experiences and was asked to keep the faculty "back home" up-dated about their adventures via e-mail. Upon returning from their trip, the faculty member gave a presentation to the faculty describing their trip and what they had learned.

When the $195,000 BIE proposal was awarded for the 2006-2008 period, three plant managers, the area SBDC director, the Chamber of Commerce executive director, the college dean, and the BIE project director began working together as the BIE Advisory Committee. Each of the three plant managers pledged their support of the Shadow Program and agreed to offer opportunities for the faculty to participate in shadow projects with their companies.

The first opportunity came from a manager who had been instrumental in developing the grant proposal with the grant author. The executive worked at "DBS" Technologies, an oil field equipment company headquartered in Chicago, but whose revenue producing plant is located in a small town in Texas. The two-week trip was to various locations in India. Thus, the first professor selected to participate in the shadow program was one whose home country of origin was India. It was felt that his first-hand knowledge of the country and its culture, as well as his language proficiency made him a perfect fit for the job.

The outcomes of the "DBS" trip shaped the format for the remaining shadow trips. First, it became clear that the two-week format was too long a period for the professor to be away from the classroom during the semester, and that the pace of the business managers was difficult to

match. The managers met with clients or vendors all day, then went back to the hotel to prepare reports for the home office via conference calls that were held in India's middle of the night. Secondly, the original agreement to split the faculty member's expenses equally was difficult to calculate after the return home, so it was agreed that the company would pay all transportation costs, international and within the foreign country, and the BIE would cover the faculty member's hotel and per diem expenses. The company's contributions were recognized as a contribution to the university and counted toward the required matching funds for the grant.

The greatest outcome of the "DBS" trip was the realization of the added value the finance professor provided toward the company's trip goals. The professor served as an extra set of eyes and ears during the vendor and client visits, and in his case, one with exceptional language abilities. Knowing several Indian languages and dialects, he was able to carry on discussions with vendors, clients, and workers which revealed information that would have not been understood had he not been on the trip. Also, his financial expertise was utilized as part of the company's negotiations. All members of the trip came back feeling it had been a win-win, exhausting experience.

Future shadow projects were planned based upon the "DBS" results. Faculty members with specific expertise as requested by the company were selected as often as possible. Companies were given a list of faculty members interested in a shadow project, and the company selected the professor from the list. In all cases, the availability of a passport and the willingness to make plans on short notice were basic requirements.

During the grant period, two other faculty members made trips with "DBS" to China, one with "Fiberbolt" Composites, Inc. to Mexico, and one with French-owned "FrenchCo"

Abrasives, Inc. to China. The following is a brief case summary of one professor's trip to Suzhou, China, with "FrenchCo".

THE INFAMOUS CHINESE STICK CAPER
(OR HOW COSTLY INCONSISTENCY REALLY IS!)

As one specific case example of a business faculty member internationalizing their courses via the Shadow Program, consider an operations management professor's experience in China. The shadow project team consisted of the operations professor, the "FrenchCo" project engineer/team leader, three subcontractor German mechanical engineers, and three "FrenchCo" mechanical engineers from India. The destination was the Suzhou Indisutrial Park (SIP), located just outside of Suzhou, China which is roughly thirty miles west of Shanghai. The "FrenchCo" plant visited was located in the SIP, the most vibrant industrial zone in all of China. Coated abrasives are produced in the plant which is roughly 200,000 square feet and is physically divided into "make" (where the coated abrasives are actually produced), "conversions" (where the cutting of various finished products such as belts, discs, and sheets is done), and work-in-process and finished goods storage areas.

"FrenchCo" is a late entrant to the Chinese market and this plant is a bold attempt to capture share in what is a booming marketplace. Given the criticality of time, the project schedule for this factory was very aggressive. The shortened project cycle meant that the extensive definition and planning activities that initiate any project had to be shortened by necessity. This resulted in a large number of engineering decisions/modifications/change orders to be made as various problems and issues arose during the final stages of the installation and testing of the line. As systems were brought on-line and tested, "gremlins" stuck their heads up and made their presence known.

One such "mischievous gremlin" involved the coated abrasive flow line. In particular, the conveyor system had been giving the engineers fits and much of the problem was traced back to the aluminum sticks or slats that comprise the critical working bits of the system. Unfortunately, the Chinese contractor that fabricated the aluminum sticks was less than capable.

Apparently, responsibility for quality, and in particular quality problems, is a thorny issue in China. Chinese culture values the concept of "face" or personal honor. That is, to acknowledge problems is perceived to result in a loss of face to the individual worker as well as to the team and ultimately to leadership. Thus when quality problems arise, there is a conspiracy of sorts to ignore issues, as acknowledging them might result in a damaging loss of face. This, of course, is anathema to modern quality philosophy that emphasizes proactive problem cause identification and problem solving. How can you solve problems that you are not willing to acknowledge?

In the real world, there must be a way of measuring how a process (service or manufacturing) is performing against standards. Process capability (real process performance against standards) has a huge impact on operating costs and profits, and on responsiveness and customer satisfaction. As long as process output meets specifications, it is considered conforming or good.

The ugly reality of the process capability in this case was that the aluminum sticks that made contact with the conveyor drive system were "nonconforming." The sticks were tapered at both ends and the dimensions of the ends were critical, as this was the part of the stick that made positive contact with the conveyor drive system. Specifications for the dimensions of the aluminum sticks were given to the Chinese contractor as part of the supporting contact documentation. However, the Chinese contractor's fabrication process was not too capable. The

result was that many of the sticks had dimensional measurements outside of specification or were "nonconforming." Thus, the Chinese contractor had to, at their expense, pick up the nonconforming sticks, scrap/rework them, and then pay to re-deliver them.

However, upon delivery of the now conforming sticks, extensive "racking" of the sticks occurred causing jams in the conveyor system. If the tapered ends of the sticks now met the dimensional specifications (were conforming), why didn't they function properly? Could this be all about consistency, or the lack thereof?

It was realized that this dilemma would provide an excellent teaching moment to students back home. One of the goals of the Shadow Program was to integrate what had been learned into the classroom experience. The moral to the story is that consistency matters! Even though the sticks met specifications, the inconsistency between each of the tapered ends was the culprit. That inconsistency caused a real and significant economic loss to all involved. The Chinese contractor lost their profit margin reworking the sticks. "FrenchCo" was losing money due to the delay in getting the line up-and-running.

The operations management professor formalized this experience in the form of an extensive case study for use in his classes. He reports successful use of the material in his coverage of process capability analysis, a topic that students typically struggle with.

CONCLUSION

The Shadow Program concept provided faculty members with the "hands-on" experience they needed to enthusiastically go home to internationalize their courses. The professors who participated integrated their experiential learning into their respective classrooms. Both the professors as well as their students benefited from the faculty shadow program experience. The program also provided a much needed and successful interface between the university and

businesses in the community. Professors had a better understanding of what community business leaders were doing internationally and the participating businesses attained the wealth of knowledge that the professors could offer them. It is hoped that this illustration of "faculty internationalization" will prove both insightful and beneficial to other educational institutions that are facing the challenging but exciting task of internationalizing their business curriculum.

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THE DECLINE AND FALL OF THE BUSINESS MAJOR: IS IT INEVITABLE?

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ABSTRACT

Business is a very popular major today. Numerous articles have been written attacking the business major claiming that it is not rigorous enough and does not teach what it purports to do, especially in areas such as ethics. This paper discusses some of the problems with business as a major. The authors conclude that the business major will decline if key changes are not made today. These changes include injecting more liberal arts material into business courses and thereby ensuring that students develop the skills -- creativity, communication, ability to collaborate, critical thinking, compassion, and character/integrity -- that make them adaptable to change in the Internet Age.
Keywords: business major, college majors, higher education, creativity, intellectual virtues.

INTRODUCTION

We are competing in a global marketplace, which requires highly skilled workers. A college degree but it does not guarantee success. There is much more competition in the global economy and "you can't gain a competitive edge with just any diploma from just any college." [6]. A report written by Georgetown University's Center on Education and the Workforce concluded that "not all bachelor's degrees are the same" and "while going to college is undoubtedly a wise decision, what you take while you're there matters a lot, too" [6]. In addition, the cost of higher education has increased dramatically and students graduate with a considerable amount of debt so that choosing the right major matters even more. Other important factors are the various technological, political, and economic changes that enable globalization [14]. Jobs in areas such as accounting, language services, architecture, medical services, or information technology are now routinely automated or done remotely.

As a result, institutions of higher learning are facing new pressures to not only prepare students for their first jobs in high demand occupations such as software development and business analytics, but to also prepare them to adapt to the unpredictability of the modern, dynamic workplace. Increasingly, firms are less interested in taking on the responsibilities of developing and training workers themselves. Companies want new hires to be able to make contributions in a shorter period of time and to be capable of evolving with the demands of the organization. Firms increasingly want new hires to be adaptable, flexible, creative, entrepreneurial, problem

solvers who can work both independently and as part of a team. "Adaptability" is becoming the new buzz word of the corporate world when it comes to hiring [33].

New metrics to measure the value of a college degree and a specific major have been introduced [3]. In Tennessee, two organizations – American Institutes for Research Knowledge and Matrix Knowledge – have produced a report ("The Earning Power of Graduates from Tennessee's Colleges and Universities") that merges education data with employment data. This report makes it easy to determine the average first-year wage of college graduates by major and by the institution they graduate from. For example, health majors graduating from the University of Tennessee at Knoxville earned an average of $46,770; business majors from the same school earned $39, 893. Surprisingly, health majors from Dyersburg State Community College earned an average of $52,042, more than senior college graduates. Apparently, a technical degree from a community college might be more valuable – at least in the short-run – than a similar degree from a senior college. Mark Schneider, vice president of the American Institutes for Research, one of the authors of the report observes: "I don't want students borrowing $100,000 for a degree in which they'll earn $25,000." The bottom line is that the time is coming when departments may have to provide the skills that are valued in the workplace. Indeed, Governor Scott of Florida made the point that "the state should allocate money to fields that are likely to lead to jobs instead of those, like anthropology, that he said do not serve the state's vital interest" [3]. Like it or not, academics have to face the fact that about 86% of incoming freshmen stated that the major reason they attended college was to obtain a better job [18].

COLLEGE MAJORS

The traditional belief is that the idea of an academic major dates back to 1877 and first appeared in a Johns Hopkins University catalog [16]. Today, virtually every college requires a specialized major. The amount of knowledge continues to increase exponentially which means that the number of departments, minors, and majors must increase. There are a large number of majors (and jobs) today that did not exist 20 years ago. Harvard College reorganized into six "departments" back in 1815. It should be noted that those were not actually departments as we define them today; the modern departmental structure actually dates back to somewhere around the 1890s [21]. Today, of course, colleges consist of many more departments and the more academic departments, the more majors.

There is a question as to whether majors make sense in education today. There are scholars that feel that the way colleges create majors, i.e., around disciplines, is the way to go. Some feel that majors should be interdisciplinary and should be built around problems [36] [39].

Taylor [36] is concerned that the modern university has ever-increasing specialization and very narrow scholarship. Taylor believes that the modern university has to be completely restructured. He feels that departments should be abolished and, instead, colleges should create problem-focused programs. These programs should have a sunset clause so that they can be revisited every 7 years and a decision made whether to keep them, change them, or close them. Programs that are problem-focused might include water, money, body, conflict resolution, etc. Thus, a water program would require experts from many areas including the natural sciences, business, law, medicine, and social work. In Taylor's words: "Through the intersection of multiple

perspectives and approaches, new theoretical insights will develop and unexpected practical solutions will emerge."

There are those who disagree with Taylor [36] and feel that established disciplines could address these problems. In fact, ethics and sustainability could and should be a theme that every department addresses. Glenn and Fischer [16] believe that it is unrealistic to expect colleges to so radically transform themselves so as to eliminate departments and create majors around problems.

The top 10 majors during the 2006-2007 academic year were about the same (with a somewhat different order) as those of the 1980-1981 academic year [16]. Approximately 20% of undergraduate students major in business areas such as accounting, entrepreneurship, finance, marketing, management, and general business [17].

CRITICISMS OF THE BUSINESS MAJOR

Arum and Roksa [1] claim that a significant number of college students barely improved their skills in the vital areas of critical thinking, writing, and problem solving/critical reasoning. Indeed, after four years, 36% had made no significant gains in those three areas. The average amount of time spent studying by college students is now less than half of what it was in the 1960s. Of all majors, business students had the weakest gains on the Collegiate Learning Assessment which tests writing and reasoning skills [1]. This result is not surprising given that the average business major spends barely 11 hours a week studying for courses outside of the classroom according to a National Survey of Student Engagement report [17].

The authors of *Academically Adrift*, Arum and Roksa, released a new study that demonstrated that there were two distinct types of college students. Students in one group, mainly consisting of students from well-off families, learn a great deal in college and have no problem finding good jobs. They often find spouses in college. Students in the other group, consisting mainly of students from poor backgrounds, graduate from inferior high schools and learn little while in college. These students tend to live with their parents, are unemployed, and unmarried [7].

If business majors do not improve their skills and capabilities in college, we are in real trouble; they come to college with serious deficits when it comes to several important subjects. In fact, the United States is trailing many other countries in reading, math, and science. The Program for International Assessment (PISA) exam is given to 470,000 15-year old students in countries all over the world every three years. Out of 34 OECD countries, the United States ranked 14 in reading, 17 in science, and 25 in math. Arne Duncan stated: "This is an absolute wake-up call for America…we have to deal with the brutal truth. We have to get much more serious about investing in education." Duncan also noted that these poor scores placed "our country's long-term economic prosperity absolutely at risk." Only 8 of 34 OECD countries had a lower high school graduation rate than the United States [35].

There have been several scholars who have been critical of the way business is being taught. Some researchers believe that group projects, an important component of marketing and management education, make it relatively easy for students to complete college without doing

challenging work.   Often, groups divide up in a way so that the student strong in one area, say statistics, does the statistical part of the paper. Another group member strong in, say English, does the writing. This way, there is very little learning. The free riders, of course, do almost nothing knowing that there is a group grade [17].

There is a strong belief among some scholars that business courses need an injection of liberal arts in order to improve the rigor of the business major [8]. At a conference organized by the Aspen Institute's Business and Society Program, various ideas were discussed in order to demonstrate how liberal arts areas can provide business students with new perspectives and approaches to examining problems. Liberal arts courses are especially useful when it comes to ethical decision making [4]. Several business schools have been praised for integrating the liberal arts into a business education [17]. For instance, the University of Virginia's School of Business offers courses that are team taught and integrated with the liberal arts. One class might have three instructors and, say, an accounting paper would be marked by both an accounting and communications professor. The accounting professor would be concerned with content and the communications professor with writing style. Offering team-taught classes, where one of the instructors is from the liberal arts, is certainly one way to introduce liberal arts material into a business course.

Lewis [24], a professor of management, also feels that business students need to learn more about the liberal arts. She discusses the case of the Gap which sold a T-shirt with the term "Manifest Destiny" on it. The executives did not realize that this term is offensive to anyone who knows something about American history as it was used to justify "massacres and the cultural destruction of Native Americans." This is just one example where a liberal arts foundation can bolster learning in business.

After the Great Recession of 2008, it became evident that business schools were not doing a good job teaching ethics. Many of the individuals responsible for the crisis had MBAs and had taken mandatory ethics courses. Some of the criticisms of the business degree revolved around the fact that business education stresses maximizing shareholder value but does not consider "ethical and social considerations essential to business leadership" [19]. Executives with business school training considers mainly maximizing shareholder wealth (as well as maximizing profit and maximization of utility) and managers do not see themselves as "long-term economic stewards." It is not surprising that one study found that 56% of MBA students cheated on a regular basis in college, more than students majoring in other areas [19]. Etzioni [11] believes that students who complete an MBA degree are less ethical at the end of the program than when they started.

Gardiner [15] also feels that more time needs to be spent teaching ethics in business schools. Students have to be taught to take a stakeholder rather than stockholder approach. Stakeholders include employees, suppliers, community, customers, society, and the environment. Nocera [27] avers that it is time to lay to rest the principle of "shareholder value." This belief that the only stakeholder that matters is the shareholder is misguided and has led to extremely short-term thinking.   It has resulted in executives acting like mercenaries who only care about themselves rather than building a strong and healthy company that will be around for many years.

There are many misperceptions about a liberal arts education that are making schools of business too complacent. One is that companies do not want students who have majored in liberal arts areas. Actually, one survey found that 89% of companies want to hire people who have the "ability to effectively communicate orally and in writing." They also are seeking employees with "critical thinking and analytic skills" and "the ability to innovate and be creative" [38]. If schools of business get too smug and do little to improve those skills, they might find that students with a business majors will be shunned by most employers.

Companies today believe the most important challenge is "finding people who could make good decisions in times of uncertainty, who can adapt to new opportunities and respond creatively to change" [31]. Robinson observes that in 1997, only 74 companies of the original Standard & Poor list of top 500 corporations (published in 1957) were still around [31].

According to a Millenial Branding and Experience Inc. survey of 225 employers cited by Moss [26], the 5 major skills/traits employers seek are communication skills (98%), having a positive attitude (97%), being adaptable to change (92%), having teamwork skills (92%), and being goal oriented (88%). This is why companies today are more interested in liberal arts majors than finance or accounting majors. According to Moss [26] "Companies are looking for soft skills over hard skills now because hard skills can be learned, while soft skills need to be developed." Another skill employers (29%) want is entrepreneurial experience. People with entrepreneurial experience are "goal-oriented" and can help companies innovate.

Selingo [33] reinforces the observation of Robinson [31] and Moss [26] and affirms that a key skill employers seek is adaptability. After all, most disciplines are constantly and rapidly changing thanks to technology. According to Selingo [33], employers complain that today's students are "lacking in interpersonal skills, problem solving, effective writing and oral communication, and the ability to think critically and analytically." Employers want to hire college graduates that have the ability to "sort through information to find the most critical pieces and come up with novel solutions to problems." Employers are approximately evenly split (45% vs. 55%) as to which major – practical, applied majors or liberal arts majors – do the best job of preparing students for the workplace.

David, David, and David [10] discuss some of the disparities between the research that is encouraged in business schools and what businesspeople find practical and useful. Clearly, business professors who want to be promoted and tenured should publish theoretical articles directed to academics and of no value to the business community. In fact, publishing in journals targeted to practitioners often do not count towards promotion and tenure. Bennis and O'Toole [2] make the point that practitioners see academic journals in business as a "vast wasteland."

David, David, and David [10] found that very little is taught in business schools that will actually have value to the corporate world. In fact, business schools do not teach technical skills that are valued by businesses. Students who go to private schools to obtain a license/certification will have a big advantage over the typical business school graduate and be much more marketable. Pfeffer [29] cites several studies that demonstrate that business schools have not been done a good job of creating business ideas that are actually useful to the corporate world. In fact, of the 50 most important management innovations, not one originated in academe.

The AACSB (Association to Advance Collegiate Schools of Business) expects Schools of Business to establish learning objectives and then show how they are measured. These learning objectives often include such concepts as ethics, communication, collaboration, problem solving, etc. However, many of these learning objectives are quite vague and do not solve the problem of ensuring that business majors learn what they are supposed to [17].

The business major is not the only major that has been criticized. Anne Neal, president of ACTA (American Council of Trustees and Alumni) says: "College tuitions have risen more than 440% over the last 25 years – and for what? The students who say that college has not prepared them for the real world are largely right" [25]. Apparently, most majors are not doing a good job in preparing students for the job market.

GOALS OF GENERAL EDUCATION

Many schools have lists describing the goals of general education. These lists include critical thinking, mathematical reasoning, ability to communicate, understanding the importance of cultural diversity, ability to make ethical judgments, appreciation of the fine arts, encouragement of lifelong learning, and more. Some feel that there are essentially three skills students must have in order to succeed in the knowledge economy: "the ability to do critical thinking and problem solving; the ability to communicate effectively; and the ability to collaborate" [13].

Many scholars are rethinking what education is supposed to provide students. There is a growing belief that education – K-12 as well as higher education – has to focus on instilling values, intellectual virtues, and character education [3] [37]. The education one receives in college may be of little value in disciplines where short product life cycles, the Internet, and globalization make everything one has learned obsolete in two or three years. Many disciplines are changing so rapidly that the information taught to freshmen is hopelessly obsolete by the time students graduate. Moreover, the conviction that students can succeed in life by only developing their cognitive skills (intelligence that can be measured by IQ tests) is incorrect [37] The traits that are going to make a difference in how successful a person becomes include ambition, conscientiousness, curiosity, grit, integrity, persistence, resilience, and self-confidence. People who have the ability and interest in always learning (i.e., lifelong learning) are much more valuable to an organization than employees who expect to solely depend on knowledge acquired as undergraduates. Tough [37] feels that individuals with the above-mentioned traits are adaptable and thus able to bounce back more rapidly from adversity and changing circumstances. These traits cannot be measured by IQ tests or Graduate Management Admission Test ("GMAT") exams. Multiple-choice tests that are so popular in education may not be able to measure the traits that actually matter.

Intellectual virtues, lifelong learning, and habits of mind – which focus on "curiosity, open-mindedness, and intellectual courage, thoroughness and humility"– are also traits that education must stress [5]. This view is consistent with what Tough [37] has been saying, that true education is more than the memorization and application of facts. Damon [9] is also a proponent of character education. He defines character education as "a broad range of efforts to promote positive values and virtues in students through explicit instruction." One can refer to it as grit,

character, values, integrity, intellectual virtues, sense of purpose, or all of the above. What education has to do is create citizens with values and integrity who have a thirst for knowledge and the ability to adapt to changing circumstances.

There is no question that the ability to communicate and collaborate is a crucial skill in an information economy. It is made more challenging by the numerous modes and channels through which individuals can engage each other. The disciplines of today are changing rapidly because of convergence. There are many more specialties today than in the past and there is much more "boundary crossing and interdisciplinary activity" [21]. This means that successful people will need the ability to work and communicate with individuals from other disciplines.

It is becoming apparent that the ability to work productively with others is an important goal of education. Collaboration, cooperation, and teamwork are vital in almost every enterprise. Hardly any occupation allows individuals to work alone without input from others. Learning how to communicate and work with others should also be a goal of education [32]. Solutions to problems will require creative people who think outside the discipline and are not constrained by the models and methods of a single discipline [12]. Pink [30] believes that "the defining skills of the previous era –'left-brain' capabilities that powered the Information Age -- are necessary but no longer sufficient." The skills that are valuable today, in the Conceptual Age, include such factors as creativity, empathy, happiness, and meaning.

The authors feel that a good business education should teach and encourage students in all of the following: Creativity, Collaboration/Cooperation, Communication, Critical thinking, Compassion for others, Corporate social responsibility, and Character. These "7 C's" are vital for a good business education and make an employee adaptable. The big question is whether business courses can teach these skills or can the liberal arts areas do a better job?

CONCLUSION

Business is a very popular major today. The authors, however, feel that the handwriting is on the wall and that the business major will decline if key changes are not made today. O'Shaughnessy [28] came up with eight reasons not to major in business. Skorton and Altschuler [34] are not fans of the business major. They state:

> the world's thorniest problems will not be solved—nor will our
> nation be secure—without an understanding of ethics, cultures
> other than our own, and what it means to be fully human. And we
> have seen first-hand that students who complete liberal arts
> degrees have deeply satisfying—and productive—personal and
> professional lives.

Numerous executives made the blunder of believing that their organizations and products would always grow (e.g., the railroads, AOL, WordPerfect, Lotus, Visicalc, Blackberry, MySpace, and Netscape). Of course, that is not the way the world works; product life cycles are becoming shorter and globalization has made competition even more intense. Many were taken by surprise when their products became outdated or were superseded by something else. In fact, Levitt [23]

coined the term "marketing myopia" to describe this phenomenon. It is not about choosing between a specialized, technical major that prepares one for the workplace and a broad-based, liberal arts major. According to Arum, author of *Academically Adrift*, you need both [33].

Changes to the business major that must be made include injecting more liberal arts material into business courses. This can easily be done, for example, using assignments in Blackboard. Students should be encouraged to minor or add a second major in liberal arts. Homework in business courses has to be rethought and made more valuable to students; it should teach students how to communicate and be creative; problem solving must be stressed. Finally, faculty in business programs should be encouraged to also have knowledge of liberal arts areas and even publish occasionally in those areas. It is important to bear in mind that it is not the strongest that survive—ask any dinosaur. Darwin found that it is those with the ability to adapt to a changing environment. This is what the business major has to provide.

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References available upon request.

USING MIND MAPS TO GAIN A NEW PERSPECTIVE ON STUDENT LEARNING IN BUSINESS SCHOOLS

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ABSTRACT

Recent criticism of management education has raised concerns about students' intellectual development and their readiness for management practice. To date, these arguments have been grounded in philosophical positions supported with mostly anecdotal evidence. Mind maps were used in this study to examine these criticisms by presenting advanced undergraduate and advanced MBA students, and business school faculty with a complex, ambiguous business problem. Results indicated that, consistent with criticisms of management education, undergraduate and MBA students demonstrated a limited understanding of business concepts that was exacerbated by simplistic thinking. In contrast, business school faculty generated rich, complex mind maps that were germane to the problem being analyzed.

Keywords: mind maps; student learning; management education

A spirited debate about the future direction of management education is evident in the recent literature.   At issue is the extent to which business schools are able to meet the expectations of an increasingly demanding and disparate stakeholders that includes students, alumni, the business community, and regulatory agencies. Indeed, it has been suggested that business schools have lost their way (Bennis & O'Toole, 2005) and calls for rethinking management education are not difficult to find (cf., Bennis & O'Toole, 2005; Datar, Garvin & Cullen, 2011; DeAngelo, DeAngelo & Zimmerman, 2005; Gosling & Mintzberg, 2006; Khurana, 2007; Kilpatrick, Dean & Kilpatrick, 2008; Mintzberg, 2004; Pfeffer & Fong, 2004; Starkey & Tempest, 2009).
Although this debate is multi-faceted and nuanced, there is strong agreement among critics of management education about deficiencies in student learning. Ackoff (2002)

stated the problem most succinctly by suggesting that business schools are teaching students the wrong things. Later critiques of management education have expanded this argument suggesting that there are serious deficiencies in business school graduates' skill bases and abilities (cf., Bennis & O''Toole, 2005; Mintzberg, 2004; Kilpatrick et al., 2008; Rousseau, 2012).

One stream of thought is focused primarily on undergraduate education in business schools.   Several writers have suggested that business school pedagogy limits students' intellectual development by focusing on small, structured problems that are easily solved with "canned" procedures (Kilpatrick et al., 2008; Starkey & Tempest, 2009).   As a result, undergraduate business majors are seen as deficient in higher-order cognitive skills such as synthetic reasoning and critical thinking. Indeed, business has been characterized as the default major on college campuses because it is not intellectually demanding (Glenn, 2011).

A second line of inquiry is directed to graduate education, most notably the MBA. In considering graduate education in business, the focus on deficiencies shifts from students' intellectual development to their ability to perform managerial work. Business school graduates' are cast as ill prepared for managerial jobs because business school faculty are out of touch with management practice (Bennis & O'Toole, 2005; Mintzberg, 2004; Khurana, 2007:Khurana & Spender, 2012). Consequently, MBA curricula are perceived as having little or no relationship to complexities and challenges of managerial work.

These serious criticisms are not easily cast aside. However, it is also important to emphasize that the critique of management education is based mostly on argument and inference so that it is not clear what business school graduates know (and do not know). For example, both Bennis & O'Toole (2005) and Khurana (2007) argue that research by business school faculty is abstract and divorced from management practice, yet they offer no evidence that the push for scientific legitimacy among business schools was detrimental to management education.

A case can be made, therefore, that if there is a pedagogy—practice gap in management education, it is also likely that there is an assessment—pedagogy gap as well. In this regard, while there is a greater emphasis on assessing student learning in business schools with the inclusion of assurance of learning in the AACSB Standards for Business Accreditation (AACSB, 2009), these assessments occur within the context of existing curriculum structures and are designed to track targeted learning goals (Kilpatrick et al., 2008).

Furthermore, if business school faculty are cast as part of the problem, a complete understanding of student learning seems to require an assessment of faculty as well as students.   Indirect assessment such as the perceived relevance of MBA curricula to management practice indicate that business school faculty might be (as critics suggest) out of touch (Rubin & Dierdorff, 2008), but we could not find a single study that

explored how business school faculty analyze business problems.   That is, there is hardly any evidence about how business school faculty frame and analyze business problems. The purpose of this study is to examine concerns raised by critics of management education. The issues they raise are important, but assertions have been substituted for data in many cases. For example, there is insufficient empirical evidence to determine if business school faculty are the abstracted researchers who know little about management practice that critics of business schools portray them to be.   Similarly, deficiencies in students' higher-level cognitive abilities have been asserted, yet few studies have addressed student learning in a manner consistent with recent critiques of management education.

Bringing an empirical dimension into the debate about student learning in business schools poses several challenges. To begin with, it is necessary to assess higher-level cognitive abilities in such a way that they can be compared across disparate groups. Further, the method of assessment must be meaningful for business school faculty. Finally, it is important that there is a tieback to improving pedagogy and learning. Mind maps were used in this study to gain a different perspective on learning in business schools. From a methodological standpoint, mind maps offer an holistic perspective about how people frame problems and integrate knowledge to understand and solve them (Buzan, 1995). They are well suited to both students and subject matter experts (cf., Lourdel, Gondran, LaForest, Bebray & Brodhag, 2007) and, as such, they can engage business school faculty. More importantly, from a philosophical standpoint, mind mapping is focused on how students assimilate and apply knowledge so that mind maps offer insights into critical thinking and synthetic reasoning (Budd, 2004; Buzan, 1995) that can shed light on issues raised by critics of management education (cf., Kilpatrick et al., 2008).

MIND MAPS

What are Mind Maps?

Mind mapping is a technique in which the thinking process is visually represented by connecting concepts and ideas related to a central issue or problem (Buzan, 1995). It provides insights into critical thinking through visual representation of the manner in which people deploy and organize concepts around a central issue (Kern, Bush & McCleish, 2006).   Mind maps, thus, capture concepts deemed relevant to a particular problem or process with a visual representation of how knowledge is structured and integrated.

Mind mapping begins by placing a thought or focus area in center of the map. This represents the problem or issue to be addressed. Branching from the central focus are groups of related concepts represented by keywords associated with them. These concepts are then linked with arrows that demonstrate associations among them.   Mind mapping allows the process of solving a problem to be viewed holistically and there is evidence that using mind maps as a learning tool encourages both left and right brained thinking (Wycoff, 1991).

Mind maps have been used to both assess and facilitate student learning in academia in several disciplines including the social sciences (Budd, 2004), nursing (Kern et al, 2006), engineering (Zampetakis & Tsironis, 2005), and business (Mento, Martinelli & Jones, 1999). Research in engineering education indicates that mind maps enhance student creativity (Zampetakis & Tsironis, 2005) while the use of mind maps in EMBA programs helped students to integrate diverse higher-order constructs and to develop metaphorical thinking (Mento et al., 1999). Mind maps have also been used to improve students' skills in reaching accurate diagnoses in nursing programs (Mueller, Johnson & Bligh, 2001).

Mind Maps and Learning

Mind mapping opens a window into student learning that is focused on how knowledge is assimilated and applied (cf., Buzan, 1995). Students are presented with a complex problem and a "blank canvas" that operates as the two-dimensional space in which a solution is developed.   The concepts brought to bear on the problem are idiosyncratic in that they represent each person's approach to analysis and diagnosis. Aggregation across individuals, in turn, opens a window into the breadth and depth of the knowledge (expressed as concepts) deemed relevant to the problem and the spatial relationships and connections among concepts offer insights into levels of cognitive complexity (cf., Lourdel et al., 2007).

Mind mapping has several characteristics that are well suited to addressing concerns about student learning in business schools. First, mind maps present students with complex, ambiguous problems that they must analyze and structure, properties that are consistent management practice (cf., Bennis & O'Toole, 2005). Further, mind maps capture the knowledge base that students use to understand and solve problems. If critics of management education are correct, aggregation of concepts from students' mind maps should be indicative of a thin, superficial knowledge base. Finally, mind maps open a window into how knowledge is organized and applied (Kern, Bush & McCleish, 2006).

THE STUDY

It is interesting that critiques of management education are focused on broad issues such as students' abilities to think critically and creatively yet assessment of learning is usually cast in terms of targeted learning outcomes (Kilpatrick et al., 2008). Further, while business school faculty are depicted as interested primarily in producing scholarly papers that have little relevance to management practice (Bennis & O'Toole, 2005; Khurana, 2007), there is sparse empirical evidence indicating that management scholars are out of touch with management practice.

As such, the extent of the problems that critics of management education raise with respect to student learning are not clear. Targeted assessments of learning might not adequately address potential problems with higher-level cognitive abilities. Further, if and how business school faculty contribute to these potential problems has yet to be assessed systematically.

Broad critiques of student learning in business schools can be distilled into several more focused concerns that are amenable to empirical study. The first rests with the notion that business school pedagogy presents students with small problems that are easily "solved" with simple algorithms (cf., Kilpatrick et al., 2008; Raelin, 2009). As a result, business students are seen as at a disadvantage in developing higher-order cognitive skills, a situation that some might find desirable since their courses are less intellectually demanding in comparison to other areas of study (cf., Glenn, 2011).

Since coursework is thought to be contrived (i.e., artificially simple), it is seen as having little relationship to management practice resulting in graduates who are poorly prepared for managerial work (Ackoff, 2002; Bennis & O'Toole, 2005; Khurana, 2007; Mintzberz, 2004). Finally, business school faculty are seen as part of the problem because their research is highly specialized and out-of-touch with management practice (Bennis & O'Toole, 2005; Khurana, 2007).

This study uses mind maps to gain insight into these potential problems. Mind maps capture how students assimilate and integrate knowledge so that it is possible to get a new perspective on the breadth and depth of the knowledge bases of business students. Further, mind maps can be used to examine if students can analyze complex, ambiguous problems. Finally, since faculty were included in this study, mind mapping opens a window to examining the extent to which faculty are subject matter experts in business.

METHOD

Study Participants

The sample was comprised of 42 advanced undergraduate, 24 advanced MBA students, and 15 faculty members. Data were collected from an AACSB accredited university located in the United States. All of the students were in their last year of study and completed or were enrolled in the capstone course in strategic management. Participation in the study was voluntary and students did not receive extra credit or other incentives for their involvement in this research. All faculty held terminal degrees in business or areas closely related to business (e.g., economics) and represented a cross section by rank and discipline.

These samples represented over 50% of the graduating classes for both undergraduate and MBA students, and 50% of the faculty of the unit in which data were collected. Although comparatively small, sample sizes are consistent with prior studies using mind mapping to assess student learning (cf., Lourdel et al., 2007; Kern et al., 2006). Data from the university's Office of Institutional Research were used to estimate sample characteristics. These data indicated that 28 percent of the graduating class of undergraduate students was female, it was 25% White, 25% Asian, 21% Latino, and 16% African American. The mean GPA was 2.62 on a four-point scale and the average combined SAT score was 1090. Eight five percent were full-time students. With respect to graduate students, 28 percent were female and 64 percent were full-time students. Their average GPA was 3.66 on a four-point scale. GMAT data were not

available. The class was 34% White, 29% Asian, 15% Latino and 13% African American.

Procedures

Approximately midway through a fifteen-week semester, students were introduced to the concept of mind mapping and were trained to develop mind maps. Following procedures similar to those used by Kern et al. (2006), a practice exercise was conducted during class time in which students mapped the process of finding a job. Students were introduced to mind maps by the researchers at this time and their mind maps were reviewed to ensure that they were familiar with the technique could apply it effectively. In a second session during class time, students were then asked to develop a mind map for the problem of defining a successful business. This concept was placed in the center of the map and students were instructed to identify and link the concepts that they thought were associated with the operation of a well-managed, successful company. They were given approximately one hour to complete the mind mapping exercise. It was made clear that this exercise was not tied course content, but rather should reflect what they had learned in their respective degree programs.

We chose a broad problem to assess the depth and the breadth of students' knowledge bases. A similar approach has been used to assess nurses' knowledge and analytical ability by focusing on patient well-being (Kern et al., 2006). Further, examining a firm in its totality, provides insights into the degree to which students think in terms of processes, structures, or functional areas as well as the degree to which knowledge is isolated (e.g., atomized) or integrated.

Faculty were recruited by e-mail and we made appointments to meet with them to explain the process of mind mapping. The same problem of finding a job was used to orient faculty members to mind mapping and we ascertained that they understood the process. Faculty members were asked to map the problem of running a successful business. Mind maps were returned at a later time (usually within one week) through campus mail.

Data Analysis

Mind maps generate set of concepts in relation to the problem at hand that are connected by linkages determined by the person producing the mind map. Analysis is driven by the aggregation of individual mind maps to find commonalities that reflect patterns of learning (Kern et al., 2006; Lourdel et al., 2007).

This is accomplished in two ways. First, in semantic analysis, the concepts used in the mind maps are aggregated and analyzed (cf., Lourdel et al., 2007). Semantic analysis was conducted by content coding the mind maps and then counting the number of times each category was present. Coding was based on primary and satellite concepts. Primary concepts were defined as those that were linked directly to the problem being mapped. Satellite concepts were defined second-order concepts that were used to amplify or expand primary concepts.

Both quantitative and qualitative analyses of mind maps were conducted. With respect to the former, differences among groups with respect to the number of primary concepts that defined the mind maps were assessed with t-tests. Further, differences among groups (undergraduates, MBA, and faculty) were examined by comparing the percentage of primary concepts that fell into the following categories: marketing, human resources management, strategy, and finance by testing differences between two independent proportions using the z statistic (Guilford & Fruchter, 1973).

Summaries of the primary primary and secondary concepts for each group are presented in Appendices 1, 2 & 3. Tabulations were generated using HyperResearch, a statistical software package that summarizes qualitative data based on researcher generated codes. These tables represent the composite set of knowledge that undergraduate and MBA students and faculty brought to bear on the problem. In the aggregate, these concepts represent the elements of the conceptual frameworks that were developed to analyze the problem being mapped. They can be viewed as the orienting and diagnostic categories and concepts that were used to understand and define a successful company. A rich array of relevant concepts is indicative of advanced analytical abilities that can be used to solve complex problems. Conversely, a constricted set of concepts suggests a superficial knowledge base and limited capacity for analysis and understanding.

As mind maps are developed in two-dimensional space, it is also possible to analyze their configurations. Configuration refers to placement and the connections among the concepts that define a mind map. These configurations are useful in examining thought processes and patterns of problem solving. For example, similar concepts tend to be placed physically closer to each other on mind maps (Buzan, 1995). For our purposes, discrete groups of concepts placed at or near the corners of a mind map is indicative of atomized knowledge. Further, closed loops among a series of concepts suggests the development of knowledge network that is indicative of deep levels of understanding (Lourdel et al., 2007).

RESULTS

Mind maps were analyzed in terms of primary and satellite concepts for all study participants. Primary concepts were reflective of more abstract concepts which were often (but not always) clarified or amplified with satellite concepts that were linked to them (see Figures 1,2 & 3). They differed across undergraduate students, MBA students and faculty with respect to the number of primary concepts brought to bear on the problem as well as the areas that these primary concepts represented.

Specifically, comparison of the number of primary concepts across the groups indicated that faculty members generated a greater number of primary concepts than did undergraduate students (mean = 7.26, sd = .64 vs. mean = 3.95, sd = .28; t = 5.47, p < .001) and MBA students (mean = 7.26 sd =.64 vs. mean = 4.50 sd = .19; t = 2.77, p < .001). Follow-on analysis indicated that there were also differences with respect to the definition of these concepts. As indicated in Table 1, undergraduate students exhibited a strong bias toward marketing in that concepts tied to the marketing function represented 37% of the total number of valid concepts (corrected for those that were irrelevant to the

problem at hand) versus 24% for graduate students (Δ= .14, z = 2.39, p < .05) and 25% for faculty (Δ= .13, z = 2.29, p < .05).   Further, MBA students demonstrated a strong bias toward strategy relative to undergraduate students with concepts related to strategy representing 21% of total concepts versus 10% for undergraduate students (Δ = .11, z = 2.52, p < .01).

Detailed coding of the content of the minds maps also revealed differences among the groups. (These codes are summarized in Appendices 1,2 & 3 and represent the diagnostic framework that was brought to bear on the problem to be analyzed.) The primary concepts generated by undergraduates were framed in terms of functional management areas (e.g., "marketing," "finance"). Satellite concepts were elaborations of subareas of the primary concepts and mostly were descriptive. That is, they tended to reflect a deconstruction of the primary concept to which they were tied.
It is also noteworthy that a large percentage of these satellite concepts had little relevance to the problem at hand or to the primary concept to which they were associated, and were coded as "other." For example, "have a good career plan" was a satellite concept associated with the primary concept of "management." As indicated in Appendix 1, with respect to the primary concepts, one third of the 91 satellite concepts associated with marketing were coded as other, 38 percent of satellite concepts linked to finance were coded as other, and 74 percent of those associated with management were coded as other. Unlike undergraduate students who developed a lexicon that was based on a wide array of functional areas, MBA students' mind maps indicated a more targeted focus on strategic management and the strategic elements of marketing. MBA students, thus, tended to personalize the idea of successful business and they presented themselves as key decision makers. Indeed, many replaced central problem in the mind maps of a "successful business" with "CEO," serving perhaps as an aspirational statement. Further, MBA students exhibited a deeper knowledge base than did undergraduates in that the number of primary and satellite concepts that had no relevance to the problem at hand dropped markedly reaching a maximum of 25 percent for the area of finance. Content of faculty mind maps differed considerably from both those of undergraduate and MBA students. To begin with, while students used words that were descriptive (e.g., naming functional areas of management) or were centered on outcomes (e.g., profits), faculty thought in terms of processes. Specifically, faculty saw managing a business in terms of sensemaking (Weick, 1995**)** so that markets were cast as entities to be analyzed and understood (e.g., market analysis) and finance was defined in terms of building effective capital structures (a notion that was absent from student mind maps). Further, none of the concepts generated by faculty were coded as irrelevant to the problem at hand. Finally, faculty relied less on satellite concepts to fill out their maps, but rather were able to generate a rich and varied array of primary concepts that guided their analysis.

Turning to configurational analysis, it is noteworthy that configurations of students' mind maps were uniform. Most undergraduate students placed primary and secondary concepts representing management functional areas on the outer quadrants of their maps and linked them directly to the problem to be mapped. This configuration provides a clear window into their thinking and reflects concerns about the atomization of

management knowledge in undergraduate management education (cf., Kilpatrick et al., 2008). Indeed, it appears as if students move through the curriculum and add knowledge in discrete pieces that are not fully integrated. It should be noted that such configurations are not a function of the mind mapping process and mind mapping in academia has produced elaborate, creative, and complex maps indicative of a synthetic reasoning and integrative thinking (cf., Budd, 2004; Lourdel et al, 2007).

MBA students maps also were indicative of knowledge silos and linear thinking, but they were more focused than were those of undergraduate students.   Specifically, mind maps of the MBA students also placed clusters of concepts at the corners of the map, but they tended to focus on strategic management. Thus, rather than deconstructing a broader business curriculum, MBA students tended to deconstruct the strategic management process, again with sum of the parts not augmenting the whole.

Faculty mind maps were markedly different (See Figure 3). First, faculty did not position concepts around the corners of the map, but rather used the entire physical space to place concepts around the central problem to be mapped. Thus, rather than organizing knowledge in discrete rectangular sectors, faculty tend to place concepts in circular patterns revolving around the center of the map. Further, unlike students' mind maps, connections between primary concepts that took the form of loops (cf., Lourdel et al., 2008) were significantly more prominent in faculty mind maps (feedback loops were present in 60 percent of faculty mind maps) indicating a more integrative perspective and a deeper level of understanding ($\Delta= .60$; $z = 4.74$, $p < .01$ for undergraduates; $\Delta = .60$, $z = 4.74$, $p < .01$ for MBA students).   Put simply, faculty mind maps were commensurate with the complexity of the problem to be analyzed while students' mind maps were markedly deficient.

TABLE 1

**Comparison of Content of Undergraduate, MBA, and
Faculty Mind Maps Across Management Disciplines
(Discipline Area Primary Concepts as a Percent of All Primary Concepts)**

Discipline Area	UG	MBA	Faculty	Δ UG/MBA	Δ UG/Fac.	Δ MBA/Fac.
Marketing	37	24	25	14[a]	13[b]	1
Finance	13	12	17	1	4	4
Human Resources Mgt.	15	21	22	6	7	1
Strategy	10	21	17	11[c]	7	4

[a] $z = 2.39$, $p < .05$;

FIGURE 1

Examples of Mind Maps

Undergraduate Student

MBA Student

Faculty Member

Social/Cultural Environment — Legal/Political Environment — Technological Environment (rapidly changing)

Communications

PR

Human Resources

Training

Recruitment

Performance Appraisal

Compensation & Benefits

Successful Business

Marketing

Research

Product

Segmentation

Promotion

Advertising

Globalization

Leadership

Motivation

Strategic Planning

Culture

R&D

Organization & Structure

Production

Technology

Planning

Quality Control

CAD/CAM

Economic Environment

Accounting & Finance

Budgeting

Funding Sources

Account Services

Information Systems

Competitive Environment

DISCUSSION

The controversy regarding student learning in business schools has generated considerable discussion, but comparatively few empirical studies. As a result, the extent of the problems raised by critics of management education is difficult to assess. Indeed, business school faculty and administrators are likely to wonder if they are doing as badly as their critics have suggested.

Our findings suggest that there is cause for concern about student learning in business schools. Results from mind maps consistently pointed to, as critics of management education have suggested, superficial knowledge bases that are not well integrated. It is especially worrisome that undergraduate business students were not able to generate concepts that were relevant to the problem they were asked to analyze. Rather, their mind maps were characteristic of "mind dumps" in which a blank canvas was filled with whatever concepts they could recall that day. As such, these findings did little to dispel the characterization of business as the default undergraduate major (Glenn, 2011). MBA students did not fare much better on the mind mapping exercise. They were better able to generate relevant concepts than were their undergraduate counterparts, but MBA students' mind maps were also indicative of a thin, superficial knowledge base. They did not demonstrate readiness for management practice (cf., Bennis & O'Toole, 2005; Mintzberg, 2004) nor did they show the higher-order thinking that is needed to understand business. Ironically, while strongly focused on strategy, MBA students did not show the depth of analysis and integrative thinking that is needed for effective strategic planning. Further, it is noteworthy th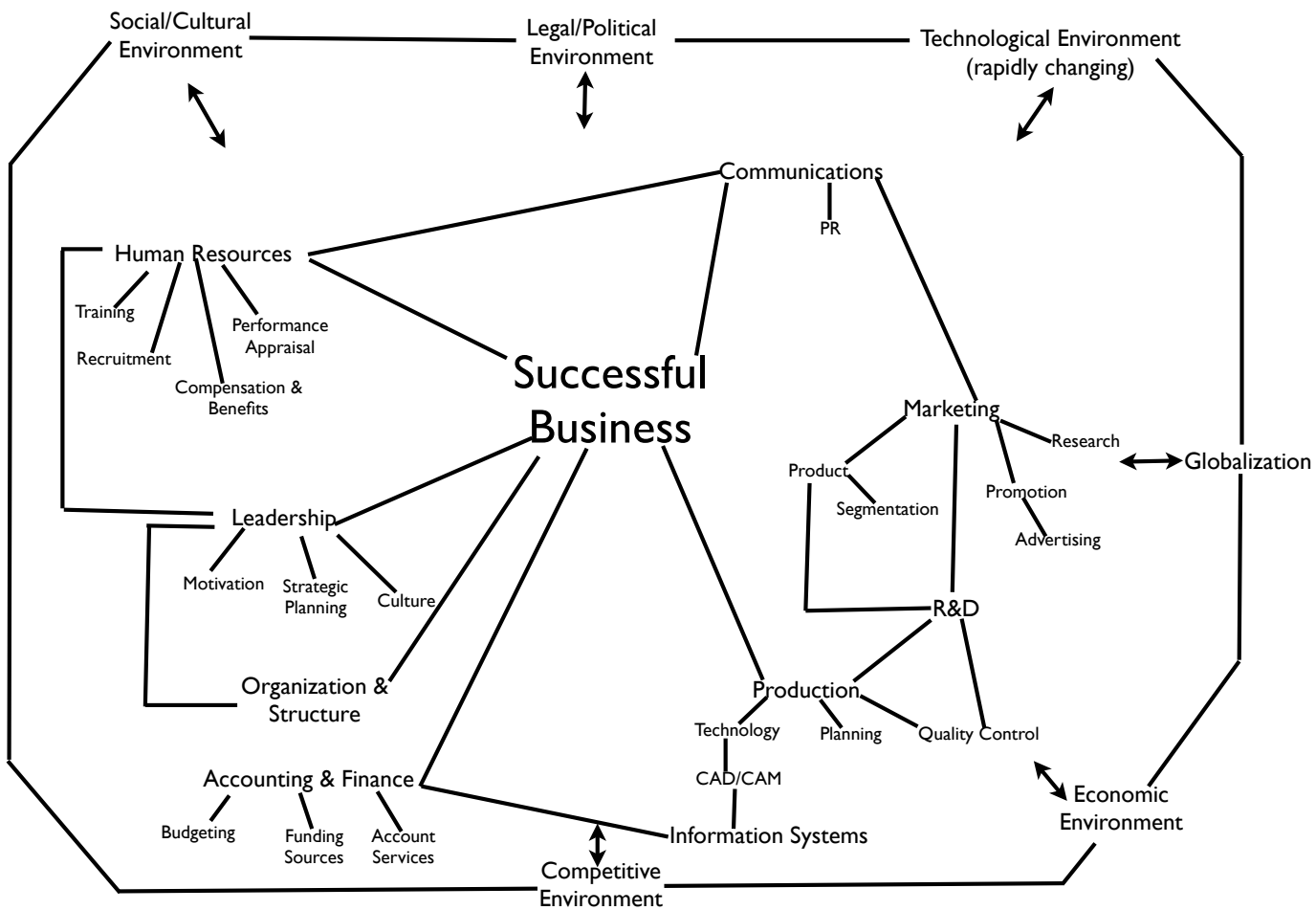at several students replaced the central problem in their mind maps with "CEO" supporting Pfeffer & Fong's (2004) notion that business students are mercenary and outcomes oriented.

These findings, while worrisome, should be interpreted with some caution. To begin with, it must be kept in mind that one study cannot provide definitive answers to the concerns raised by critics of management education so that our findings should be viewed as preliminary. Further, the comparatively small sample sizes in this study might also raise concerns about the generalizability of our findings. Finally, as is the case with all qualitative studies, there is an element of subjectivity in interpretation that must be kept in mind.

With the understanding that our results require confirmation, several factors mitigate concerns about methodology. First, the undergraduate students in our sample sat for the Major Field Test in Business and scored at the national average. Thus, they demonstrated a knowledge base in business that was consistent with that of a much larger sample of business students. Second, data were collected in an AACSB accredited school so that common standards for curriculum content for both undergraduate and graduate were in place. With respect to management pedagogy in MBA programs, it has been noted that there is very little differentiation among business schools so that most are teaching the

things with the same methods (Ridderstrale & Nordstrom, 2005: Somers, 2009). Finally, it is noteworthy that even with comparatively small sample sizes, there were statistically significant differences among groups, in a manner that was mostly consistent with criticisms of management education.

The one area of divergence in our findings concerned business school faculty. Critics of management education have characterized business school faculty as abstracted, overly specialized scholars with little knowledge of business (Bennis & O'Toole, 2005; Khurana, 2007). Our results, however, presented a different picture. Business school faculty developed rich conceptual frameworks to understand a business that went beyond their areas of specialization. Indeed, faculty members thought in terms of connections among business processes to respond to environmental trends. Their mind maps were, thus, reasonably consistent with their assumed roles of subject matter experts in business. However, and importantly, there is little question (for our sample, at least) that this knowledge was not effectively transmitted to students. Why this is so is not entirely clear, but our findings point to a teaching—learning gap that most likely coexists with assessment—learning and pedagogy—practice gaps. Most critiques of management education have focused on the latter (cf., Bennis & O'Toole., 2005; Khurana, 2007; Mintzberg, 2004) with comparatively less attention directed toward how learning in business schools is assessed (cf., Kilpatrick et al., 2008).

As such, the primary thrust in reforming management education has been on greater contact with practitioners through the use of clinical faculty and internships for students (cf., Bennis & O'Toole, 2005; Pfeffer & Fong, 2004). Our findings, however, indicate that solutions lie not in diminishing the role of traditional faculty in business schools, but rather in reinforcing it. The first step seems to entail unfreezing business school faculty and administrators so that they have a better sense of whether and where hypothesized deficiencies in students' higher-level cognitive skills are present in their institutions. This study suggests that initial efforts to use mind maps in business schools to guide and assess student learning (Mento et al., 1999) ought to be comsidered. Mind mapping captures how students integrate and apply knowledge so that faculty and students can (literally) see how learning is progressing. To be clear, we are not suggesting that traditional measures of student learning be abandoned, but rather that they be augmented. Closing the assessment—learning gap has direct implications for potential teaching—learning gaps. Augmenting measures of student learning with techniques such as mind maps can be used to reframe the assessment process such that it is not something that happens to students. Rather, it becomes a process that helps them learn. Including faculty by engaging them as subject mater experts (cf., Lourdel et al, 2007) can help business school faculty modify their instructional methods and course designs to mitigate observed problems with disjointed and superficial knowledge among their students. Put simply, techniques such as mind maps can be used to help faculty develop students who think like subject matter experts in business.

Once these gaps have been identified and closed, the question of if and how greater contact with practitioners can be introduced into management education can be addressed. Using the professions as a model, foundation knowledge precedes contact

with practitioners and preparation for professional practice. Our findings suggest that even advanced MBA students are struggling with foundation knowledge indicating that rapid restructuring of management education driven by a practitioner focus might be premature.

Business schools will ultimately be judged by the value of their graduates so that the debate about management education is important and necessary.   There is general agreement that change is needed if business schools are to stay relevant (Datar et al., 2011), but the pace and shape of that change remain an area for debate and discussion. An expanded empirical component is a welcome addition to this necessary and important conversation.

Appendix 1
Content of Undergraduate Students' Mind Maps
(N = 42)

Primary Concepts	n	%	Satellite Concepts	n	%
Marketing	61	32	Effective advertising	11	12
			Know target market	10	11
			Good product	10	11
			Proper pricing	5	5
			Develop new markets	4	4
			Good location	4	4
			Effective marketing plan	3	3
			Value added through customer experience	3	3
			Effective sales force management	2	2
			Research and development	2	2
			Differentiation	2	2
			SWOT	1	1
			Manage marketing channels	1	1
			e-commerce	1	1
			Gain market share	1	1
			Brand recognition	1	1
			Other	30	33
			Total	91	
HRM/OB	25	13	Employee productivity	7	13
			Hire talented people	3	5
			Committed employees	3	5
			Winning culture	3	5

			Reward systems	2	4
			High pay	2	4
			Ethical employees	2	4
			Participative management	2	4
			Openness to diversity	2	4
			Pursuit of excellence	1	2
			Training	1	2
			Succession planning	1	2
			Reduce turnover	1	2
			Other	26	46
			Total	56	
Management	24	13	Good team work	5	9
			Good leadership	4	7
			Effective communication	3	6
			Manage employee goals	2	4
			Other	40	74
			Total	54	
Finance	21	11	Outside investment	10	25
			Adequate capital	5	13
			Cash flow	2	5
			Cash levels	2	5
			Profitability	2	5
			Good accounting systems	1	3
			Cost control	1	3
			Risk analysis	1	3
			Debt analysis	1	3
			Other	15	38
			Total	40	
Strategy	16	8	Business plans and goals	5	14
			Industry analysis	2	6
			SWOT	1	3
			Adapt to change	1	3
			Vertical integration	1	3
			Mission	1	3
			Other	25	69
			Total	36	
Operations Management	5	3	Optimize value chain	2	33
			Other	4	66
			Total	6	

International Business	4	2	Outsourcing	2	33
			Cross cultural management	1	17
			Global business opportunities	1	17
			Cost control	1	17
			Other	1	17
			Total	6	
MIS	3	2	Data systems	1	17
			Internet	1	17
			Intranets	1	17
			Other	3	50
			Total	6	
Legal	2	1	Contracts and rights	1	50
			Other	1	50
			Total	2	
Ethics	1	1	Corporate social responsibility	1	33
			Fair pay	1	33
			Pollution control	1	33
			Total	3	
Other	27	14	Other	69	100
			Total	69	
Total	189		**Total**	369	

Appendix 2

Content of Mind Maps for MBA Students
(N = 24)

Primary Concepts	n	%	Satellite Concepts	n	%
Marketing	24	21	Product Development	7	21
			Advertising	4	12
			Brand	3	9
			Customer Retention	2	6
			Customer Service	2	6
			Pricing Strategy	2	6
			Market Demand	2	6
			Marketing Plan	2	6
			Marketing Channels	1	3
			Competitive Analysis	1	3
			Customer Feedback	1	3
			Data Mining	1	3
			Market Share	1	3
			Product Quality	1	3
			Other	4	12
			Total	34	
Strategy	24	21	Competitive Analysis	4	13
			Corporate Image	3	10
			Forecasting	3	10
			Adaptation	2	7
			Alliances	2	7
			Leadership	2	7
			Long-Term Goals	2	7
			Core Values	1	3
			Globalization	1	3
			M&A	1	3
			Strategic Plan	1	3
			SWOT	1	3
			Vision	1	3
			Other	6	20
			Total	30	

HRM/OB	21	19	Training and Development	5	16
			Employee Motivation	5	16
			Employee Benefits	4	13
			Expert Employees	4	13
			Employee Satisfaction	3	10
			Diverse Staff	2	6
			Company Culture	1	3
			Contract or Permanent Employees	1	3
			Decision-Making	1	3
			Interpersonal Skills	1	3
			Leadership Skills	1	3
			Loyalty	3	10
			Other		
			Total	**31**	
Finance	12	11	Sustainable Profit	4	20
			Capital Structure	3	15
			Cash	2	10
			Bank Loans	1	.5
			Asset Management	1	.5
			Backup Financing	1	.5
			Bonds	1	.5
			Profit	1	.5
			Start-Up Costs	1	.5
			Other	5	25
			Total	**20**	
Management	6	5	Two Way Communication	3	33
			Chain of Command	2	22
			Mission & Goal Alignment	2	22
			Strong Leadership	2	22
			Total	**9**	
Innovation Management	4	4	Innovation	1	33
			Other	2	66
			Total	**6**	

Operations Management	3	3	Production Efficiency	3	33
			SCM	3	33
			Business Process Analysis	1	11
			TQM	1	11
			On Time Deliveries	1	11
			Total	9	
MIS	2	1	Tech Support	1	100
			Total	1	
Legal	1	1	Contracts and rights	1	100
			Total	1	
Ethics	1	1	Ethical Behavior	3	75
			Philanthropy	1	25
			Total	4	
Economics	1	1	Cost of Government Regulation	1	100
			Total	1	
Corporate Social Resp.	1	1	Contribution to Society	1	100
			Total	1	100
Other	13	11	Other	20	100
			Total	20	
Total	113		**Total**	167	

Appendix 3

Content of Mind Maps for Faculty
(N = 15)

Primary Concepts	n	%	Satellite Concepts	n	%
Market Analysis	27	19	Product Development	11	28
			Competitive Analysis	6	15
			Price Sensitivity	5	13
			Product Quality	4	10
			Advertising & Promotion	4	10
			Customer Retention	2	5
			Channel Management	2	5
			SCM	2	5
			PLC	1	2
			Segmentation	1	2
			SWOT	1	2
			Barriers to Entry	1	2
			Other	0	0
			Total	40	
Human Capital	24	19	Performance Management	6	22
			Leadership	6	22
			Expertise	6	22
			Teamwork	3	11
			Experience	3	11
			Training	2	11
			Mentorship	1	4
			Other	0	0
			Total	27	
	18	18	Profit Projection	5	28
Financing			Capital Structure	4	22
			Cash Flow Analysis	4	22
			Efficient Use of Capital	2	11
			Working Capital Management	2	11
			Risk Management	1	5
			Other	0	0
			Total	18	

Strategic Planning	15	16	Competitive Analysis	6	32
			Long-Range Planning	4	21
			International Strategies	2	11
			Innovation	1	5
			Profitability	1	5
			Outsourcing	1	5
			Scanning	1	5
			SWOT	1	5
			Target Markets	1	5
			Quality Control	1	5
			Other	0	0
			Total	19	
Adapt to Environmental Conditions	13	14	Economic Environment	6	66
			Legal & Regulatory Environment	3	33
			Other	0	0
			Total	9	
CSR	5	6	Integrity	3	75
			Corporate Governance	1	25
			Other	0	
			Total	4	
IT	4	5	IT Infrastructure	3	75
			Knowledge Management	1	25
			Other		
			Total	4	
SCM	3	4	**Total**	0	0
Other	0	0			
Total Primary		109	**Total Satellite**		117

REFERENCES FURNISHED UPON REQUEST

A JOINT ECONOMIC LOT SIZE MODEL WITH SUSTAINABILITY CONSIDERATIONS

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ABSTRACT

This paper presents the development and evaluation of two joint economic lot size models including sustainability considerations. A first model including sustainability considerations and a second involving setup cost reduction in the first model are derived using classical optimization. Numerical results for both models, and a sensitivity analysis for the second model are given. Performance of these models is compared to that the classical JELS model, and some specific conclusions are drawn

INTRODUCTION

The co-maker concept has become accepted practice in many successful global business organizations. The basic tenet of this philosophy is that vendor (supplier) and purchaser are value chain partners in manufacturing and delivering a high quality product to the purchaser's customers. This viewpoint has led to the development of a class of inventory models known as Joint Economic Lot Size (JELS) models. These models consist of lot size formulas based on the joint optimization of vendor and purchaser costs.

The term JELS was coined by Banerjee [11] who used classical optimization to derive the joint economic lot size formula which is a function of demand, the annual inventory carrying charge, the vendor's annual production rate, setup cost, and unit production cost, and the purchaser's order cost and unit purchase cost. The JELS, in general, is not the optimal lot size for either the purchaser or vendor operating independently. Thus, some cost is involved on both parties' part to operate at this mutually beneficial level. Banerjee investigates the cost-tradeoffs involved in adopting the JELS from both the purchaser's and vendor's points of view. Essentially, one party will be at a disadvantage if the JELS is adopted. This situation can be ameliorated by the advantaged party offering some price concession to the other party. The JELS model presented in Banerjee [11] assumes that the vendor produces on a lot-for-lot basis in response to orders from a single purchaser, demand is deterministic, and the vendor is the sole supplier.

Since this early research many authors have worked at refining the JELS so that it is a better representation of what actually occurs in manufacturing practice. Affisco *et al* [7] integrate the concepts of joint economic lot size and vendor setup cost reduction. For the case of a single vendor and purchaser and assuming a logarithmic investment function, they derive relationships for the

optimal joint economic lot size, optimal vendor's setup cost, and the optimal joint total cost per year. Results of a numerical example indicate that significant savings in joint total cost can accrue from investing in decreased setup costs on the part of the vendor. As in the case of the JELS with constant setup cost, adoption of the joint economic lot size including investment results in one of the parties being at a cost disadvantage and a major question is the method by which joint cost savings may be equitably distributed. Further work by Affisco *et al* [6] extends this approach to the case of one-vendor and many-nonidentical-purchasers. Much the same results are achieved as in the single vendor and purchaser case.

Finally, Affisco *et al* [8] investigated the one-vendor, many-nonidentical-purchasers JELS model with vendor setup cost reduction and purchaser order cost reduction. The results indicate that there are significant cost savings for the JELS over independent optimization when such investments are made. This suggests that when an environment of cooperation between the parties has been established the JELS is a superior policy. Beyond this the JELS model was found to be superior to other integrated joint lot sizing models that appeared in the literature at that time.

Chikan [13] advances the proposition that due to fundamental changes in the global economy the classical inventory paradigm developed in the 20th century must be updated. Of specific interest to this research is one of the changes discussed by Chakin - Responsible Economy. In the Responsible Economy, actors within the economy are forced to consider not only their own interests but those of other stakeholders, including the human and natural environments. Sustainable development may be defined as development that meets the need of the present without compromising the ability of future generations to meet their own needs. Perhaps a 1989 Stockholm statement by Peter Wallenberg, the former President of the International Chamber of Commerce, best represents the challenge for modern manufacturing organizations:

> "The onus of proving that sustainable development is feasible rests primarily on the private business sector, as it controls most of the technological and productive capacity needed to conceive more environmentally benign processes, products and services, and to introduce them throughout the world."

One response to this charge was the development of ISO 14000 an international environmental standard patterned after the ISO 9000 international quality standard as detailed in Affisco [3], Affisco et al [5] and Affisco et al [4]. Today many manufacturing firms require suppliers to be certified to ISO 14000 as a prerequisite for doing business. Affisco [1] details the movement toward developing an equivalent international standard for energy management.

Recently there has been some initial research focused on modifying classical inventory mathematical models to include the issue of sustainability. Bonney and Jaber [12] examine some possible environmental consequences of common inventory activities and suggest that all functions within the product life cycle including inventory planning and control should be looked at from an environmental point of view. A simplified model was constructed to illustrate how, in principle, one could determine inventory parameters in an environmental context. This suggests that the parameters that we frequently use to determine inventory levels may need to be re-assessed.

Arslan and Turkay [10] develop a set of lot sizing models with different assumptions about environmental costs and how they could be included in individual EOQ models. One specific approach is that of modifying the classical Wilson EOQ for the carbon footprint of the inventory system. The carbon footprint consists of the set and amount of greenhouse gases released by an organization due to its operations. One approach to modeling this is through direct accounting which treats the carbon footprint as an additional source of economic cost. Estimates of these costs may be obtained from the cost accounting system. In this revised EOQ model the optimal ordering quantity is governed by the trade-off between replenishment and inventory holding costs with the only change of added environmental cost components. Due to this trade-off, the refined optimal ordering quantity may be larger, smaller or equal to the EOQ depending on the values of the cost components.

This work raises the following question that has not yet been answered in the literature: What is the impact of environmental costs on the Joint Economic Lot Size model. This research begins the investigation of this question.

THE BASIC MODEL

Consider a system in which a single vendor produces on a lot-for-lot basis in response to orders from a single purchaser, demand is deterministic, and the vendor is the sole supplier. Under these conditions the JELS may be obtained by minimizing the joint total relevant cost given by Banerjee [11] as

$$JTRC(Q) = \frac{D}{Q}(S + A) + \frac{Q}{2}r(\frac{D}{R}C_v + C_p) \qquad (1)$$

where

D = Annual demand or usage of the item,

R = Vendor's annual production rate for this item,

A = Purchaser's ordering cost per order,

S = Vendor's setup cost per setup

r = Annual inventory carrying charge, expressed as fraction of dollar value,

C_v = Unit production cost incurred by the vendor,

C_p = Unit purchase cost paid by the purchaser,

Q = Order or production lot size in units,

and $R \geq D, C_v \leq C_p$.

The result of classical optimization yields the following formula for the JELS, [*]

$$Q_j^* = \sqrt{\frac{2D(S+A)}{r(\dfrac{D}{R}C_v + C_p)}} \qquad (2)$$

And the corresponding optimal joint total relevant cost

$$TR \ Q \ = \sqrt{[\ r \ (S \ ) \ /_{P \ v \ p}]} \qquad . \qquad (3)$$

JELS WITH SUSTAINABILITY CONSIDERATIONS

In this section we consider the situation where the carbon footprint of the activities of the vendor and purchaser is considered when developing the joint economic lot size. The approach we use in this formulation is direct accounting by which we treat the carbon foot print as an additional source of economic cost. We let f_v represent the vendor's fixed cost of environmental impact per setup due to setup and its associated activities (i.e. movement of fixtures, dies, and other transportation costs); f_p represent the purchaser's fixed cost of environmental impact per order due to ordering and its associated activities; C_{ev} represent vendor's variable cost of environmental impact due to production and production related activities; and finally, C_{ep} represent purchaser's variable cost of environmental impact due to ordering related activities. The values for these cost parameters can be extracted from cost accounting of organizational environmental and energy management activities. Although these values have historically been difficult to obtain, they are more readily available in the current global economy due to ISO environmental and energy standards compliance efforts.

Including these additional cost parameters in our modeling results in the following relationships for vendor costs

$$TC_v(Q) = \frac{D}{Q}(S + f_v) + \frac{QD}{2R}r(C_v + C_{ev}) \qquad \textbf{(4)}$$

and purchaser costs

$$TC_p(Q) = \frac{D(A + f_p)}{Q} + \frac{Q}{2}r(C_p + C_{ep}) \qquad \textbf{(5)}$$

Combining (4) and (5) gives the following relationship for joint total relevant cost with

sustainability considerations

$$JTRC_E(Q) = \frac{D}{Q}(S + A + f_v + f_p) + \frac{Q}{2}r(\frac{D}{R}(C_v + C_{ev}) + (C_p + C_{ep})) \qquad \textbf{(6)}$$

The result of classical optimization yields the following relationships for the joint economic lot size

with sustainability considerations

$$Q_{jE}^* = \sqrt{\frac{2D(S + A + f_v + f_p)}{r\left[\frac{D}{R}(C_v + C_{ev}) + (C_p + C_{ep})\right]}} \qquad \textbf{(7)}$$

and optimal joint total cost

$$JTRC_E(Q_{jE}^*) = \sqrt{2Dr(S + A + f_v + f_p)(\frac{D}{R}(C_v + C_{ev}) + (C_p + C_{ep}))} \qquad . \qquad \textbf{(8)}$$

It should be noted that if the environmental costs are zero, Eqns. (7) and (8) reduce to Eqns, (2) and (3) respectively.

JELS$_E$ NUMERICAL EXAMPLES

The relationship between the JELS with sustainability considerations (JELS$_E$) and the traditional JELS depends on the values of the cost parameters. That is, the value of Q_{jE}^* relative to that of Q_j^* is determined by the tradeoff between the holding and replenishment costs including the addition of the environmental costs. To investigate this relationship we determine the indifference point by setting $Q_{jE}^* = Q_j^*$. Some simple algebraic manipulation results in the following three scenarios:

$$Q_{jE}^* = Q_j^* \text{ iff } \frac{S + A}{(D/R)C_v + C_p} = \frac{f_v + f_p}{(D/R)C_{ev} + C_{ep}}$$

$$Q_{jE}^* > Q_j^* \text{ iff } \frac{S + A}{(D/R)C_v + C_p} < \frac{f_v + f_p}{(D/R)C_{ev} + C_{ep}}$$

$$Q_{jE}^* < Q_j^* \text{ iff } \frac{S + A}{(D/R)C_v + C_p} > \frac{f_v + f_p}{(D/R)C_{ev} + C_{ep}}$$

If we consider a single inventory cycle then we may say that the two joint economic lot sizes are equal if the ratio of the traditional fixed replenishment costs (vendor's setup cost and purchaser's order costs) to the joint inventory value is equal to the ratio of the fixed environmental costs of vendor and purchaser to the joint environmental inventory value. The joint environmental inventory value reflects the vendor and purchaser variable environmental inventory costs for the production and purchase of one lot of goods.

Table 1 presents simple examples of each of these three scenarios. Consider the case of an inventory item provided to order by a vendor on a lot-for-lot basis. A single purchaser periodically orders and buys a batch of this item from the vendor, who is the buyer's sole source for this item. The vendor and purchaser have agreed to cooperate in accordance with the results of the JELS model. The following parameters are known: D=1000 units/year, R=3200 units per year, S = \$400/setup, A = \$100/order, r = 0.2, C_v = 20, and C_p = 25. In addition to the traditional inventory parameters, four environmental cost parameters $[f_v, C_{ev}, f_p, C_{ep}]$ take on three values in sets as follows [7,3,5,5], [400,20,100,25], and [150,6,75,5]

The results in Table 1 indicate that when the ratio of fixed to variable traditional inventory costs is equal to the ratio of fixed to variable environmental costs, the two joint lot sizes are equal but the joint optimal cost for the JELS with sustainability considerations is substantially greater than that for the traditional JELS. This is not surprising due to the added environmental costs. Of more interest is the finding that when the ratio of fixed to variable environmental costs is smaller than the corresponding ratio of traditional costs, the $JELS_E$ is smaller than the JELS and the joint optimal cost decreases by 10.37 percent.

Table 1

Comparison of JELS and JELSE

Traditional Ratio	Environmental Ratio	Traditional JELS		Sustainability JELS		% Cost Difference vs. JELS
		Q_j^*	Joint Optimal Cost (\$)	Q_{jE}^*	Joint Optimal Cost (\$)	
16	2.02	400	2,500	371.05	2,759.71	10.37
16	16	400	2,500	400.00	5,000.00	100.00
16	32.73	400	2,500	436.08	3,325.09	32.73

SETUP COST REDUCTION

In this section we consider the option of investing in vendor setup cost reduction in the $JELS_E$ model. We consider the vendor setup cost, S, to be a decision variable and pursue **the objective** of minimizing the sum of the investment cost for changing S and the joint total relevant cost with sustainability considerations. Specifically we seek to minimize

$$f(Q,S) = ia_S(S) + JTRC_E(Q) .$$ **(9)**

subject to

$$0 < S \leq S_0 \tag{10}$$

where i is the cost of capital, $a_s(S)$ is a convex and strictly decreasing function of S representing the cost of changing the setup cost to the level S, $JTRC_E(Q)$ is the joint total relevant cost with sustainability considerations given by equation (6), and S_0 is the original setup cost before the investment is made.

To obtain the $JELS_E$ including investment in setup cost reduction, we minimize (9) over Q and S by classical optimization techniques. Of course, if the optimal setup cost does not satisfy the restriction (10) we should not make any investment, and Eqn. (7) holds. When the investment function is sufficiently convex, f(Q,S) can be explicitly minimized. Such a case is that of the logarithmic investment function.

The Logarithmic Investment Function

The logarithmic investment function has been used extensively in the literature over the last thirty-five years. Here we assume that the setup cost S declines exponentially as the investment amount a_s increases. This results in the following relationship

$$S = S_0 e^{-\delta a_s} \qquad \text{for } 0 \leq a_s < \infty \tag{11}$$

where S_0 is the original setup cost and δ is the percentage decrease in S per dollar increase in a_s. Taking the natural logarithm of both sides of equation (11) gives

$$a_s(S) = a - b \cdot \ln(S) \qquad \text{for } 0 < S \leq S_0 \tag{12}$$

where

$$a = \frac{\ln(S_0)}{\delta} \qquad \text{and} \qquad b = 1/\delta \ .$$

We are now ready to prove the following theorem when $a_s(S)$ as represented in equation (12) is used in equation (9).

Theorem

If S_0 and δ are strictly positive, then the following hold:

(i) f(Q,S) is strictly convex iff

$$Q > DS^2/2ib(S+A+f_v+f_p)$$

(ii) The optimal vendor's setup cost and the optimal joint economic lot size are given by

$$S^{**}= \min(S_0, S_{jEI}^*)$$

$$Q^{**}= \min(Q_{jE}^*, Q_{jEI}^*)$$

where

$$S_0 = \text{original setup cost before investment}$$

$$S_{jEI}^* = \frac{i^2b^2 \sqrt{i^4b^4 + 2Dr\Gamma_E(A + f_v + f_p)}}{Dr\Gamma_E} \tag{13}$$

$$Q_{jE}^* = \sqrt{\frac{2D(S+ A + f_v + f_p)}{r\Gamma_E}} \tag{14}$$

$$Q_{jEI}^* = \frac{ib + \sqrt{i^2b^2 + 2Dr\Gamma_E(A + f_v + f_p)}}{r\Gamma_E} \tag{15}$$

and

$$\Gamma_E = (D/R)(C_v + C_{ev}) + (C_p + C_{ep}).$$

(iii) The resulting optimal total cost per unit time is given by

$$f(Q^{**},S^{**}) = \min (JTRC_E(Q_{jE}^*), JTRCI_E(Q_{jEI}^*, S_{jEI}^*))$$

where

$$\mathrm{JTRC_E}(Q^*_{jE}) = \sqrt{2Dr\Gamma_E(S + A + f_v + f_p)}$$

and

$$\mathrm{JTRCI_E}(Q^*_{jEI}, S^*_{jEI}) = ib \cdot \ln \frac{S_0}{Q^*_{jEI}} + \frac{Q^*_{jEI}}{2} r\Gamma_E + \frac{D}{Q^*_{jEI}}(S^*_{jEI} + A + f_v + f_j)$$

and

$Q_{jEI}{}^*$ is given by equation (15)

$S_{jEI}{}^*$ is given by equation (13).

Proof of Theorem

(i) Let

$$f(Q,S) = ia_S(S) + \mathrm{JTRC_E}(Q) \qquad\qquad \text{for } 0 < S \le S_0$$

where

$\mathrm{JTRC_E}(Q)$ is given by equation (6). $f(Q,S)$ is strictly convex if the minors of its Hessian determinant are strictly positive.

The first principal minor of the Hessian determinant is

$$|H_{11}| = \frac{2D(S + A + f_v + f_p)}{Q^3}$$

which, of course, is strictly positive. The second principal minor is

$$|H_{22}| = \frac{2D(S+A+f_v+f_p)ib}{Q^3S^2} - \frac{D^2}{Q^4}$$

It can be easily shown that $|H_{22}| > 0$, iff

$$Q > \frac{D \cdot S^2}{2ib(S+A+f_v+f_p)}.$$

Hence, part (i) holds.

(ii) The optimal values of the decision variables may be found by solving the two simultaneous equations given by

$$\frac{\partial f}{\partial Q} = \frac{-D(S+A+f_v+f_p)}{Q^2} + \frac{r}{2}\Gamma_E \qquad\qquad (16)$$

$$\frac{\partial f}{\partial S} = \frac{D}{Q} - \frac{ib}{S} \qquad\qquad (17)$$

The solution to these equations results in equations (15) and (13) respectively. The stationary point (Q_{jEI}^*, S_{jEI}^*) is a relative minimum if it satisfies the convexity condition of part (i). We may restate the convexity condition as

$$Q > \frac{DS}{ib}\left(\frac{S}{2(S+A+f_v+f_p)}\right)$$

further, we may solve (17) for Q which gives

$$Q = \frac{DS}{ib}$$

Therefore, the convexity condition will be satisfied if and only if

$$\frac{S}{2(S + A + f_v + f_p)} < 1.$$

Since S, A, f_v, f_p are all greater than zero, the condition is satisfied and we have a local minimum at, $(Q_{jEI}^{*}, S_{jEI}^{*})$, and part (ii) holds.

(iii) The proof of this part results from substituting the optimal values of Q and S into the appropriate joint relevant total cost formulas.

JELSI$_E$ NUMERICAL EXAMPLES

Assume all the parameter values presented in Section 4 remain in place. In addition, the vendor may invest in reducing setup cost according to a logarithmic investment function with parameters i = 0.10 and δ = 0.0005. Table 2 presents the results of calculations for the JELS with sustainability considerations (JELS$_E$) and environmental JELS with set-up cost reduction (JELSI$_E$). The results show the expected reduction in set-up cost and accompanying smaller lot

Table 2

Comparison of JELS$_E$ and JELSI$_E$

Traditional Ratio	Environmental Ratio	Sustainability JELS (JELS$_E$)		Investment JELS JELSI$_E$			Percent Decrease in		
		Q_{jE}^{*}	Joint Optimal Cost ($)	Q_{jEI}^{*}	S_{jEI}^{*}	Joint Optimal Cost($)	Lot Size	Setup Cost	Joint Optimal Cost ($)
16	2.02	371.05	2,759.71	202.51	40.50	1,964.17	45.42	89.88	28.83
16	16	400.00	5,000.00	326.25	65.25	4,440.79	18.44	83.69	11.18
16	32.73	436.08	3,325.09	319.37	63.87	2,802.14	26.76	84.03	15.73

size for all three scenarios originally presented in Section 4.

A closer look at Table 2 reveals that investment in setup cost reduction results in the greatest percentage decrease in set-up cost, lot size, and joint optimal cost when the environmental ratio is less than the traditional ratio. This suggests that it is plausible that there is a synergy between lower environmental costs and investment in set-up cost reduction. To investigate this further a basic sensitivity analysis is conducted. The environmental ratio is decomposed into its numerator, containing only fixed costs, and its numerator, containing only variable costs. Then sensitivity is investigated by holding one of this constant while varying the other.

Table 3 presents the sensitivity of both the JELS$_E$ and the JELSI$_E$ models to independent changes in the vendor and purchaser's fixed environmental costs. First, we investigate the change in the decision variables and the joint optimal cost for both models for a decrease in vendor's fixed

environmental cost, f_v, from \$400 to \$100, in 25% decrements. The findings are that the as f_v decreases the $JELSI_E$ achieves significant reductions in set-up cost, lot size, and joint optimal cost when compared to the $JELS_E$ model. Specifically, as the vendor's fixed environmental cost decreases from \$400 to \$100, the percent decrease in set-up cost increases from 83.69 to 88.22, the percent decrease in lot size increases from 18.44 to 29.58, and the percent decrease in joint optimal cost increases from 11.18 to 19.36. Second, we investigate the change in the decision variables and the joint optimal cost for both models for a decrease in purchaser's fixed environmental cost, f_p, from \$100 TO \$25, in 25% decrements. Similarly the findings show that as f_p decreases $JELSI_E$ achieves reductions in set-up cost, lot size, and joint optimal cost when compared to the $JELS_E$ model. However, these reductions are less than in the previous case. As the purchaser's fixed environmental cost decreases from \$100 to \$25, the percent decrease in set-up cost increases from 83.69 to 84.69, the percent decrease in lot size increases from 18.44 to 20.39, and the percent decrease in joint optimal cost increases from 11.18 to 12.59.

Table 4 presents the sensitivity of both the $JELS_E$ and the $JELSI_E$ models to independent changes in the vendor and purchaser's variable environmental costs. First, we investigate the change in the decision variables and the joint optimal cost for both models for a decrease in vendor's variable environmental cost, C_{ev}, from \$20 to \$5, in 25% decrements. The findings show that while C_{ev} decreases, the set-up cost, lot size, and joint optimal cost decrease significantly for the $JELSI_E$ when compared to the $JELS_E$ model, the percent reduction in these variables decreases. Specifically, as the vendor's variable environmental cost decreases from \$20 to \$5, the percent decrease in set-up cost decreases from 83.69 to 83.00, the percent decrease in lot size decreases from 18.44 to 18.27, and the percent decrease in joint optimal cost decreases from 11.18 to 10.90. Second, we investigate the change in the decision variables and the joint optimal cost for both models for a decrease in purchaser's variable environmental cost, C_{ep}, from \$25 to \$6.25, in 25% decrements. Similarly the findings show that as C_{ep} decreases $JELSI_E$ achieves reductions in set-up cost, lot size, and joint optimal cost when compared to the $JELS_E$ model, but once again the percentage of these reductions decreases. As the purchaser's variable environmental cost decreases from \$25 to \$6.25, the percent decrease in set-up cost decreases from 83.69 to 80.31, he percent decrease in lot size decreases from 18.44 to , and the percent decrease in joint optimal cost decreases from 11.18 to 9.84.

Based on these results one can draw the conclusion that while investment in set-up cost reduction in the $JELS_E$ is always worthwhile, there a stronger synergistic effect when such investment is accompanied by a program aimed at decreasing fixed environmental costs. Further programs should initially be directed at reducing vendor fixed environmental costs. Once these costs have been dealt with, the focus should move to purchaser environmental costs. Such programs might consist of working toward registering as environmental and energy standard compliant firms. That is working toward achieving ISO 14000 and the new ISO 50001 Energy Management Standard. Of course, in practice it is quite logical that both the purchase and vendor would cooperate in working towards achieving these certifications.

Table 3

Sensitivity to Reducing Fixed Environmental Costs

Vendor's Fixed Env Cost ($) f_v	Purchaser's Fixed Env Cost ($) f_p	Traditional Ratio	Environmental Ratio	Sustainability JELS		Sustainability JELS with Investment			Percent Decrease in		
				Q_{jE}^*	Optimal Cost ($)	Q_{jEI}^*	S_{jEI}^*	Optimal Cost ($)	Lot Size	Setup Cost	Optimal Cost
400.00	100.00	16.00	16.00	400.00	5,000.00	326.25	65.25	4,440.79	18.44%	83.69%	11.18%
300.00	100.00	16.00	12.80	379.47	**4,743.42**	299.29	59.86	4,121.08	21.13%	85.04%	13.12%
200.00	100.00	16.00	9.60	357.77	**4,472.14**	269.49	53.90	3,769.47	24.68%	86.53%	15.71%
100.00	100.00	16.00	6.40	334.66	**4,183.30**	235.67	47.13	3,373.60	29.58%	88.22%	19.36%
400.00	75.00	16.00	15.20	394.97	4,937.10	319.74	63.95	4,363.39	19.05%	84.01%	11.62%
400.00	50.00	16.00	14.40	389.87	4,873.40	313.08	62.62	4,284.38	19.70%	84.35%	12.09%
400.00	25.00	16.00	13.60	384.71	4,808.85	306.27	61.25	4,203.65	20.39%	84.69%	12.59%

Table 4

Sensitivity to Reducing Variable Environmental Costs

Vendor's Variable Env Cost ($) C_{ev}	Purchaser's Variable Env Cost ($) C_{ep}	Traditional Ratio	Environmental Ratio	Sustainability JELS		Sustainability JELS with Investment			Percent Decrease in		
				$Q_{jE}*$	Optimal Cost ($)	Q_{jEI}^{*}	S_{jEI}^{*}	Optimal Cost ($)	Lot Size	Setup Cost	Optimal Cost
20.00	25.00	16.00	16.00	400.00	5,000.00	326.25	65.25	4,440.79	18.44%	83.69%	11.18%
15.00	25.00	16.00	16.84	405.10	4,937.10	330.62	66.12	4,389.47	18.38%	83.47%	11.09%
10.00	25.00	16.00	17.78	410.39	4,873.40	335.18	67.04	4,337.46	18.33%	83.24%	11.00%
5.00	25.00	16.00	18.82	415.90	4,808.85	339.92	67.98	4,284.72	18.27%	83.00%	10.90%
20.00	18.75	16.00	20.00	421.64	4,743.42	344.86	68.97	4,231.23	18.21%	82.76%	10.80%
20.00	12.50	16.00	26.67	447.21	4,472.14	366.99	73.40	4,008.99	17.94%	81.65%	10.36%
20.00	6.25	16.00	40.00	478.09	4,183.30	393.89	78.78	3,771.50	17.61%	80.31%	9.84%

6. CONCLUSION

This paper investigates the joint economic lot size model with sustainability considerations. Initially, the classical JELS is modified by including in the joint total relevant cost function fixed and variable environmental costs for both vendor and purchaser. Classical optimization results in closed forms for the JELS with sustainability considerations ($JELS_E$) and the corresponding optimal joint total cost. An interesting finding from numerical examples is that when the ratio of fixed to variable environmental costs is smaller than the corresponding ratio of traditional costs, the $JELS_E$ is smaller than the JELS and the joint optimal total cost also decreases. Next the possibility of investment to reduce the vendor's setup cost is investigated. For this case, closed forms for the optimal sustainable JELS with investment, $JELSI_E$, the optimal setup cost, and the optimal joint total cost with investment are derived. Results of numerical examples reveal that investment in setup cost reduction results in the greatest percentage decrease in set-up cost, lot size, and joint optimal cost when the environmental ratio is less than the traditional ratio. This suggests that it is plausible that there is a synergy between lower environmental costs and investment in set-up cost reduction. To further investigate this proposition, basic sensitivity analysis is conducted. Based on the results of this analysis one can draw the conclusion that while investment in set-up cost reduction in the $JELS_E$ is always worthwhile, there a stronger synergistic effect when such investment is accompanied by a program aimed at decreasing fixed environmental costs. Further programs should initially be directed at reducing vendor fixed environmental costs. Once these costs have been dealt with, the focus should move to purchaser environmental costs. Such programs might consist of working toward registering as environmental and energy standard compliant firms.

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DISASSEMBLY SYSTEM DESIGN WITH OPTIMAL ENVIRONMENTAL AND ECONOMIC PARTS SELECTION USING LIFE CYCLE INVENTORY DATABASE BY INPUT-OUTPUT TABLES

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ABSTRACT

To prevent global warming by supply chain, End-of-Life (EOL) assembly products should be disassembled environmentally and economically for material circulation (Wang and Gupta, 2011). This paper proposes a disassembly system design with an optimal environmental and economic parts selection which harmonizes collected CO_2 volumes and recycling cost using a Life Cycle (LC) inventory database by the input-output tables (Yamada et al., 2012). The first step is to optimize the environmental and economic parts selection with the integer programming, and the second step is to carried out the line balancing for minimizing the number of stations.

Keywords: Low-carbon and closed-loop supply chain, **Recycling**, **Environmentally-conscious manufacturing**, **Sustainable manufacturing**, **Integer Programming**

INTRODUCTION

To prevent global warming by supply chains, End-of-Life (EOL) assembly products should be disassembled not only environmentally but also economically for material circulation [1]. With disassembly parts selection in recycling factories, parts/materials with higher CO_2 volumes should be disassembled for environment if the CO_2 volumes of each part can be estimated. On the other hand, ones with lower recycling cost should be also disassembled for economy if the recycling cost of each part can be estimated. In addition, a disassembly line balancing should be also carried out based on the optimal environmental and economic parts selection [2]. However, there is another design issue how to obtain product and environmental information such as the disassembly time and CO_2 volumes. To overcome this issue, the Life Cycle (LC) inventory database by the input-output tables [3] and Recyclability Evaluation Method (REM) software developed by Hitachi. Ltd. [4] can be used.

This paper proposes a disassembly system design with the optimal environmental and economic parts selection which harmonizes collected CO_2 volumes [3] and recycling cost [4] using the LC inventory database by the input-output tables. The first step is to optimize the environmental and economic parts selection with the integer programming [5], and the second step is to carried out the line balancing for minimizing the number of stations with the ranked positional weight heuristic [6].

DISASSEMBLY DESIGN PROCEDURE WITH OPTIMAL ENVIRONMENTAL AND ECONOMIC PARTS SELECTION USING LIFE CYCLE INVENTORY DATABASE BY INPUT-OUTPUT TABLES
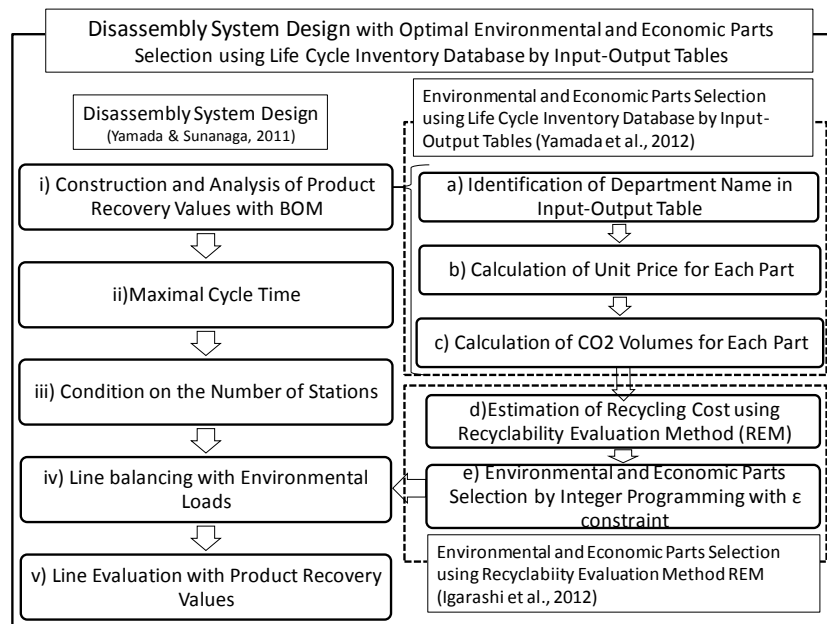
Figure 1 Design procedure for a disassembly system with an optimal environmental and economic parts selection using life cycle inventory database by input-output tables

This paper proposes a design procedure for a disassembly system with an optimal environmental and economic parts selection using LC inventory database by the input-output tables as shown in Figure 1. This design procedure consists of 2 main flows from upstream to downstream for the disassembly system design on the left side [3] and the environmental and economic parts selection on the right side [2]. In the environmental and economic parts selection, the LC inventory database by the input-output tables with the bill of materials [2] are adopted to estimate the CO_2 volumes for each part as the environmental loads, while the Recyclability Evaluation Method (REM) software developed by Hitachi. Ltd. [4] is used to estimate the disassembly times and recycling rates of each part.

The LC inventory database used in this study is calculated by the Japanese input-output tables [3]. In general, the input-output tables define economic relationships among sectors by matrix representation based on annual transactions among sectors, so that the carbon dioxide emission intensity is obtained by using the LC inventory database by the input-output tables. With the LC inventory database by the I/O tables, the CO_2 volumes at each part are estimated with the product information such as prices and weights [3]. On the other hand, the disassembly time and recycling cost of each part are estimated by inputting product information such as material type, weight and disassembly motion at each part to the REM software [4]. In the software, the recycling cost is the differences between the recovered material prices and costs, where the costs consist of disassembly, material process and disposal costs, respectively. If the recovered material prices are higher than the costs, the value of the recycling cost is negative which means positive profits earned by the recycling.

FORMULATION OF OPTIMAL ENVIRONMENTAL AND ECONOMIC DISASSEMBLY PARTS SELECTION

With the product disassembly data and CO_2 volumes obtained by the LC inventory database [3] and the REM [4], 0-1 integer programming [4] is used in this study for the selection of the parts disassembled or not in terms of the CO_2 volumes and the recycling cost similar to [2]. The combinatorial solution which

maximizes the collected CO2 volumes but minimizes the total recycling cost of the product is examined to satisfy the constraints of the disassembly precedence relation. The notation of the disassembly parts selection used for the integer programming is as follows:

c_j : Recycling cost at part j
e_j : CO2 volumes at part j
E : Total collected CO2 volumes at a product
E_{max} : Maximal CO2 volumes of a product in all parts disassembled
C : Total recycling cost at a product
N : Number of parts
x_i : Binary value; 1 if part i is disassembled, else 0
ε : Constraint of total CO2 volumes of selected parts
A_1 : An arc with constraints of disassembly precedence relation
A_2 : An arc without constraints of disassembly precedence relation
P_j : set of tasks that immediately precede part j

Similar to [2], the objective functions for minimizing total recycling cost and maximizing total CO2 volumes are respectively set as equations (1) and (2):

$$C = \sum_{j=1}^{N} c_j x_j \rightarrow Min \qquad\qquad (1)$$

$$E = \sum_{j=1}^{N} e_j x_j \rightarrow Max \qquad\qquad (2)$$

The constraint of the disassembly precedence relations are set as equations (3), (4) and (5) [2] based on Nof et al. [6]:

Subject to: $x_i - x_j \leq 0 \qquad i \in P_j$ (3)

               $A = A_1 \cup A_2 \quad (i,j) \in A$ (4)

To solve this multiple purpose optimization, ε-constraint method is used as well as [2]. The objective function E is made into the only objective function, a nonlinear optimization is performed to each of those combinations by changing ε gradually. The function E looks for the Pareto optimum solution set. Then E is transposed to

$$E \geq \varepsilon \ . \qquad\qquad (5)$$

DESIGN EXAMPLE OF DISASSEMBLY SYSTEM WITH OPTIMAL ENVIRONMENTAL AND ECONOMIC PARTS SELECTION USING LCI DATABASE BY INPUT-OUTPUT TABLES
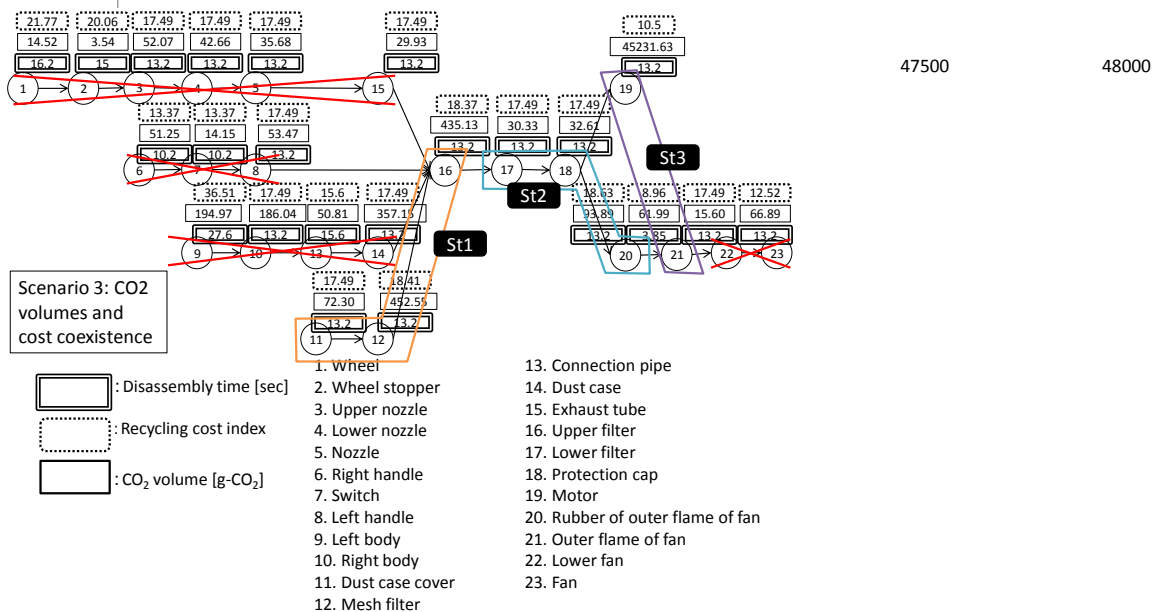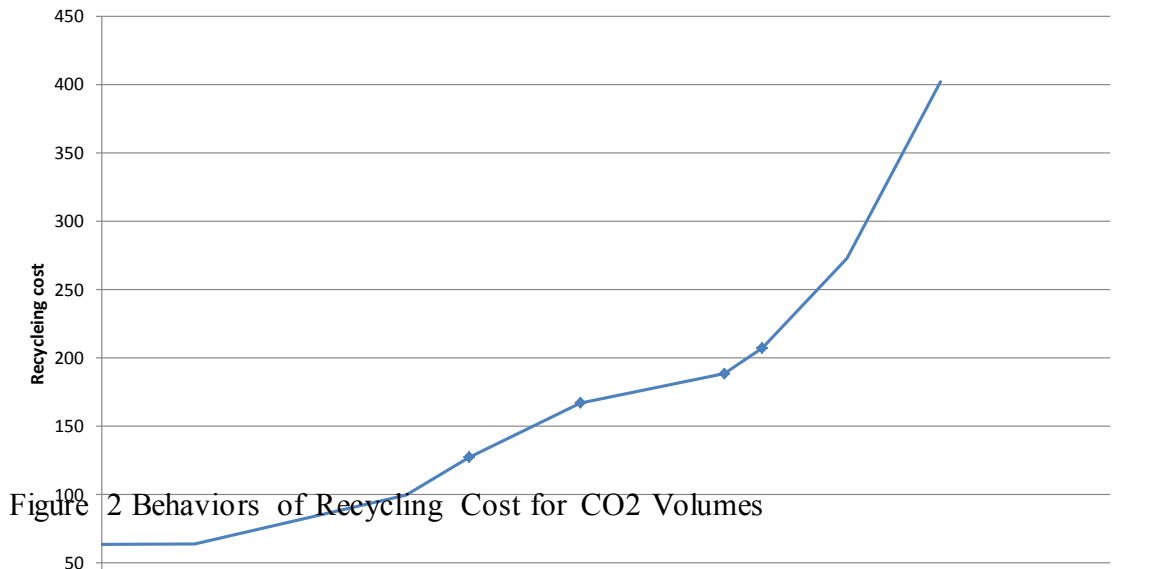
To validate the proposed design procedure of the disassembly system, an example of the assembly product is prepared. A cleaner is prepared as an example of 3D-CAD model [7]. The production plan is also prepared as shown in Table 1.

To harmonize the environmental and economic aspects in the obtained disassembly part selection with the integer programming [2][8], four scenarios as well as [2] are here considered and discussed for the

product evaluation as follows: 1) All parts disassembled, 2) CO_2 volumes maximum, 3) CO_2 volumes and cost coexistence and 4) Recycling cost minimum. In the scenario 2) CO_2 volumes maximum, a solution with the highest value of the total collected CO_2 volumes at the product, E, is selected within the candidates whom their collected CO_2 volumes is higher than 50 [%]. For the line evaluation, the disassembly line balancing is carried out by the ranked positional weight heuristic [6] for the selected disassembly parts at each scenario, respectively.

Table 1 Example of disassembly problem for cleaner

Production Planning Period T_0	Demands Q for Collected EOL products during T_0
8,400 [min] (= 20 [days] × 7 [hours] × 60 [min])	12,000

Figure 2 Behaviors of Recycling Cost for CO_2 Volumes

Scenario 3: CO2 volumes and cost coexistence

☐ : Disassembly time [sec]

⬚ : Recycling cost index

☐ : CO_2 volume [g-CO_2]

1. Wheel
2. Wheel stopper
3. Upper nozzle
4. Lower nozzle
5. Nozzle
6. Right handle
7. Switch
8. Left handle
9. Left body
10. Right body
11. Dust case cover
12. Mesh filter
13. Connection pipe
14. Dust case
15. Exhaust tube
16. Upper filter
17. Lower filter
18. Protection cap
19. Motor
20. Rubber of outer flame of fan
21. Outer flame of fan
22. Lower fan
23. Fan

Figure 3 Precedence relations among disassembly element tasks with optimal environmental and economic parts selection: Scenario 3) CO_2 volumes and cost coexistence
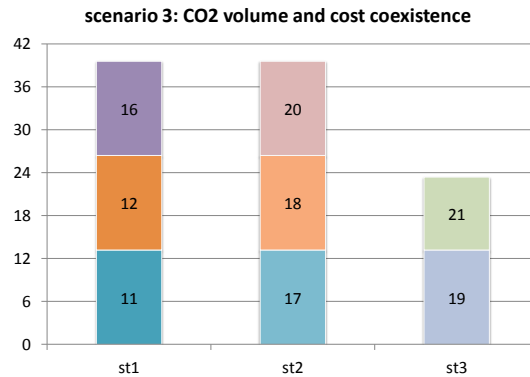
Figure 4 Pitch diagram with optimal environmental and economic parts selection:
Scenario 3) CO2 volumes and cost coexistence

Figure 2 shows the Pareto optimal solution for the recycling cost and CO2 volumes in the experiment. While the collected CO2 volumes from the disassembled parts in one product are shown on the horizontal axis, the recycling cost is shown on the vertical one, where each solution is obtained by each ε constraint. Figure 3 shows the precedence relations among disassembly element tasks after the environmental and economic parts selection in the scenario 2, CO2 volume maximum. "x" marks in the figure means the canceled disassembly tasks with the non-selective parts. By using the disassembly precedence relations among the selected tasks, the disassembly line balancing is carried out by the ranked positional weight heuristic [5]. The assignment of each task to stations are also shown in Figure 3, and the pitch diagram with the optimal environmental and economic parts selection are drawn as shown in Figure 4.

Table 2 Example of disassembly system design using LC inventory database with input-output tables

	Constraints		Scenario 1: All parts disassmbled	Scenario 2: CO2 volumes maximum	Scenario 3: CO2 volumes and cost coexistence	Scenario 4: Recycling cost minimum
Product Evaluation	Total disassembly time [sec]		316.2	219	102.6	52.8
	Number of parts		23	16	8	4
	Constraint of required CO_2 volumes [%]		100	90	50	10
	Actual CO_2 volumes [g-CO_2]		47579.28	47347.30	45729.71	46410.44
	Recycling cost index		402.17	272.89	127.34	63.85
Line Evaluation	Number of stations	Minimal	8	5	3	2
		Actual	8	5	3	2
	Balance delay (BD)		0.06	0.18	0.07	0.37
	Smoothness index (SI)		8.38	24.98	18.91	26.40

Table 2 show an example of the disassembly system design using the LC inventory database with the input-output tables. In the product evaluation, the total disassembly time and the number of disassembled parts basically decrease in order to reduce the recycling cost from scenario 1 to 4, so that the collected CO2 volumes also decrease as the recycling cost decreases. From the viewpoint of the CO2 volumes, there are a few differences between the scenarios within only 3.9%. However, the recycling cost at the scenarios 2 to 4 is 1.5 to 6.3 times lower than one at the scenario 1. One of the reasons is that a part "Motor" is the largest CO2 volumes among the all parts, therefore, the total CO2 volumes at the product is almost maintained as long as a part with the largest CO2 volumes such as the motor is selected and disassembled.

In the line evaluation, the disassembly line balancing is carried out by the ranked positional weight heuristic [6] for the selected disassembly parts at each scenario, respectively. As the total disassembly time and the number of disassembled parts basically decrease, the minimal and actual number of stations is decreased.

SUMMARY AND FUTURE STUDIES

This paper proposed the disassembly system design with the optimal environmental and economic parts selection which harmonized collected CO_2 volumes and recycling cost using the LC inventory database by the input-output tables and the recyclability evaluation method. The design example demonstrated that the recycling cost was minimized in spite of maintaining the total collected CO_2 volumes by selecting a disassembled part with the largest CO_2 volumes.

Further study should evaluate the CO_2 volumes of each part by the process base inventory database, use the LC inventory database by the input-output tables in the other countries, optimize the line balancing under the optimal environmental and economic parts selection, etc.

ACNOLEDGEMENTWS

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ELEMENTS OF MODELING WITH MIXED VARIABLES

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ABSTRACT

This paper discusses briefly models for mixed variables. In particular, suitable joint distribution of mixed variables is provided by reference to specific examples. Procedures based on model comparison are utilized to study the dependency structure pertaining to a categorical and a continuous variable. Estimation of parameters and computation of Likelihood function is addressed by providing the necessary code as an ADMB program.

Keywords: Models for Mixed Variables

1. INTRODUCTION

This paper highlights some aspects of models for mixed variables commonly encountered in data mining, but less emphasized in basic statistics courses. There are two points worth emphasizing here. First, variables measured on different scales occur more commonly in large data sets. When categorical and continuous variables are studied jointly, more specialized models are needed to accommodate these situations. Apart from modeling issues, segmentation of data arising in cluster analysis, requires special treatment for similarity metrics in the case of mixed variables.

Second, data mining projects typically consider many variables. Due to this high-dimensionally aspect of the data sets, the specification of suitable joint multivariate distribution function for mixed variables becomes a more challenging task.

Section 2, below, discusses log-linear models suitable for count (frequency) data. By reference to an example, we consider the alternative types of dependency for the variables considered, and illustrate schematically the dependency structure by using graphs. Section 3 considers briefly multivariate normal distribution, the classical model for the distribution of a finite set of continuous variables. Distribution for mixed variables is discussed in section 4 with reference to a simple example. Furthermore, we discuss parameter estimation and model selection procedures based on likelihood principle. A program using ADMB code is provided for numerical solution to the likelihood estimation for our example. Some concluding remarks are made in section 5.

2. CATEGORICAL VARIABLES

Salient information about categorical variables is summarized by a Table of Counts. The appropriate joint distribution of the variables is a multinomial distribution. The model of interest to discuss relationship among the variables is the log-linear model. The interested reader may refer to [2] [6] or [4] for further information regarding the analysis of categorical variables.

Categorical variables are labeled as A, B, C, etc. Let us consider an example involving three categorical A, B, and C taking values in respective sets {1,2}, {1,2,3}, *and* {1,2}. Information about these variables is summarized by Tables of Counts and Probabilities as follows:

Table 2.1 of Counts & Probabilities when C = 1

n_{111}	n_{121}	n_{131}	p_{111}	p_{121}	p_{131}
n_{111}	n_{121}	n_{131}	p_{111}	p_{121}	p_{131}

Table 2.2 of Counts & Probabilities when C = 2

n_{112}	n_{122}	n_{132}	p_{112}	p_{122}	p_{132}
n_{112}	n_{122}	n_{132}	p_{112}	p_{122}	p_{132}

The cell counts n_{jkl} $j = 1,2; k = 1,2,3; l = 1,2$ are known, but cell probabilities p_{jkl} $j = 1,2; k = 1,2,3; l = 1,2$ are unknown parameters. These probabilities need to be estimated from data.

Furthermore, the expected cell count is denoted by $m_{jkl} = N p_{jkl}$, *where* $N = \sum_{j,k,l} n_{jkl}$.

We shall use p to denote the number of categorical variables. In the above example p = 3.

A log-linear model for the above example is given by

$$\log(m_{jkl}) = u + u_j^A + u_k^B + u_l^C + u_{jk}^{AB} + u_{jl}^{AC} + u_{kl}^{BC} + u_{jkl}^{ABC} \qquad (2.1)$$

In equation (2.1), the components $u_{jk}^{AB}, u_{jl}^{AC}, u_{kl}^{BC}, and\ u_{jkl}^{ABC}$ are referred to as interaction terms.

Model (2.1) is referred to as the saturated model. Certain restrictions are placed on the interaction terms in order to avoid over parameterization problems, see [4].

Two models of interest related to (2.1) are:

$$\log(m_{jkl}) = u + u_j^A + u_k^B + u_l^C + u_{jl}^{AC} + u_{kl}^{BC} \qquad (2.2)$$

and

$$\log(m_{jkl}) = u + u_j^A + u_k^B + u_l^C \qquad (2.3)$$

Model (2.2) specifies conditional independence, i.e., given C, then A and B are independent. Model (2.3) specifies the situation where A, B, and C are independent.

Graphs are useful to show the dependency structure among variables as illustrated below.

Figure 2.1

Dependent (2.1)   **Conditional Independence (2.2)**   **Independence (2.3)**
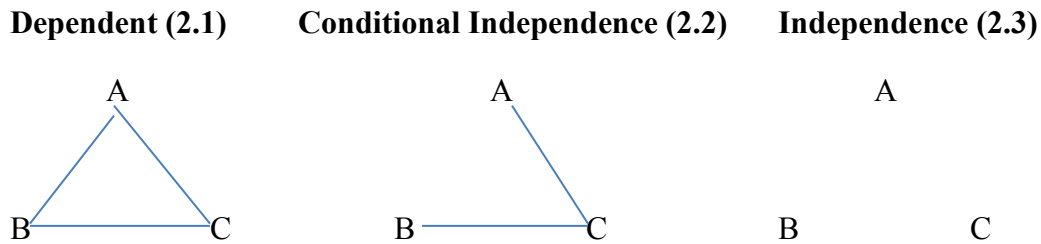
The interested reader may refer to [5] [8] or [11] for further exposition on Graphical Models.

Next, we consider variables measured on a continuous scale.

3. CONTINOUS VARIABLES

Continuous variables are labeled as $X, Y, Z, \cdots,$ or as $X_1, X_2, X_3, \cdots$. The classical distribution for a finite set of continuous variables is the multivariate normal distribution, see [3]. The number of variables is denoted by q.

Data is given by a $n \times q$ Table of observations with n denoting the number of rows of the Table. The entry in the ith row & j[th] column is denoted by $x_{ij}, 1 \le i \le n, 1 \le j \le q$.

The density of a multivariate normal is

$$f(x; \mu, \Sigma) = N(\mu, \Sigma)$$
$$= \frac{1}{(2\pi)^{q/2}} \det(\Sigma)^{-1/2} \exp\left\{-\frac{1}{2}(x - \mu)' \Sigma^{-1}(x - \mu)\right\} \qquad (3.1)$$

where x & μ are $q \times 1$ vectors, and Σ is a $q \times q$ matrix. The parameters of the distribution are μ, the mean vector, and Σ, the variance-covariance matrix.

In case of q=3, we have

$$\mu = \begin{pmatrix} E(X) \\ E(Y) \\ E(Z) \end{pmatrix} \quad (3.2a) \quad \text{and} \quad \Sigma = \begin{pmatrix} \text{var}(X) & \text{cov}(X,Y) & \text{cov}(X,Z) \\ \text{cov}(Y,X) & \text{var}(Y) & \text{cov}(Y,Z) \\ \text{cov}(Z,X) & \text{cov}(Z,Y) & \text{var}(Z) \end{pmatrix} \quad (3.2b)$$

If Σ is a diagonal matrix then $X, Y, and Z$ are independent. Y and Z are conditionally independent given X if the partial correlation of Y and Z given X denoted by $\rho_{Y.Z.X}$ is zero or equivalently if $Cov(Y,Z) = 0$, see [5]. Complete dependency among X, Y, Z is provided when all the elements of Σ are non-zero.

In many real life situations, the multivariate normal family of distributions is too restrictive to define the joint distribution for a finite set of continuous variables. The following three procedures tend to mitigate this problem: a) by considering a mixture of multivariate distribution, see [9]; b) using marginal distributions in conjunction with a specified copula to construct a multivariate joint distribution, refer to [10]; c) use a multivariate version of Box –Cox transformation, as given in [7].

Next we consider variables of mixed types, i.e., some categorical and some continuous.

4. MODELS FOR MIXED VARIABLES

Mixed variables problems involve the study of categorical as well as quantitative (continuous) variables. For example, consider the case where the variables are A, B, X, Y, Z with A and B as categorical (p=2) variables, and X, Y, and Z as continuous (q=3) variables.

Before we give an expression for the joint probability distribution of A, B, X, Y, Z, we need to introduce some necessary notations. The frequency Table associated with A, B will have #(A).#(B) distinct cells. For instance, if A can take values in the set {1,2} and B can take values in the set {1,2,3} then there are (2).(3)=6 possible cell labels. A typical cell address is labeled as *i*. Furthermore; we shall designate a possible value of the triplet X, Y, Z by $w = (x, y, z)$.

The joint distribution for A, B, X, Y, Z is

$$f(i, w) = f(i) f(w \mid i)$$
$$= p_i N(\mu_i, \Sigma_i)$$
$$= p_i \frac{1}{(2\pi)^{q/2}} \det(\Sigma_i)^{-1/2} \exp\left\{-\frac{1}{2}(w-\mu_i)' \Sigma_i^{-1}(w-\mu_i)\right\} \qquad (4.1)$$

where p_i is the probability for the cell i, and $N(\mu_i, \Sigma_i)$ is a multivariate normal of dimension q. In the example above q = 3. Note that for each i, there is a corresponding multivariate normal distribution $N(\mu_i, \Sigma_i)$ whose parameters depend upon i.

Here, the statistical issues of interest are addressed by reference to a simple example. Let us consider the case when we have one categorical variable A, and one continuous variable X, i.e., with p = 1, and q = 1. We shall write AX to designate this pair.

The data used for the statistical analysis of AX appears in [5, Table 4.2, page 70]. In this instance, A represents the "type of diet", with four different diet types; and X denotes realization of "coagulation time (seconds) for blood drawn" from 24 animals randomly allocated to different diets. The data is reproduced in the Appendix below.

The joint density of AX is given as

$$f(i, x) = p_i \frac{1}{(2\pi\sigma_i^2)^{1/2}} \exp\left\{-\frac{1}{2}\left(\frac{x-\mu_i}{\sigma_i}\right)^2\right\}, \qquad (4.2)$$

with $i = 1, 2, 3, 4$.

There are two statistical problems of interest for this example. The first problem is concerned with the estimation of parameters of interest namely $p_i's, \mu_i's, and \ \sigma_i^2$. The second problem relates to study of the nature of dependency between A and X.

The estimation of parameters is based on the method of maximum likelihood, ML. ML estimation is based on minimizing the negative of the log of likelihood function. The ML estimation requires solving a system of nonlinear equations whose solution is implemented by an appropriate algorithm. In the Appendix, we have provided the necessary code to accomplish this task using an ADMB program, see [1].

The dependency structure of A and X can be examined by performing a number of model comparisons. The model comparison is based on Likelihood Ratio Test, LRT.

If M_r (reduced) is a model nested within M_f (saturated) model, then the large sample Likelihood Ratio test statistics is

$$2\{[-\log(Likelihood_{M_r})] - [-\log(Likelihood_{M_f})]\} \qquad (4.3)$$

The asymptotic distribution of LRT is a Chi-square distribution with degrees of freedom equal to difference in the number of parameters in the two competing models.

The results for our model comparison are given in Table 4.1 below.

Table 4.1: Model Comparison

Case		Negative log of Likelihood	Comparison of Cases	Value of LRT statistic	p-value
1	Same $\mu_j = \mu$ & same $\sigma_j = \sigma$	98.4567	1 vs. 4	29.1556	0.000057
2	Different μ_j's & same $\sigma_j = \sigma$	85.1313	2 vs. 4	2.5048	0.474400
3	Same $\mu_j = \mu$ & different σ_j's	97.2028	3 vs. 4	26.6478	0.000007
4	Different μ_j's & different σ_j's	83.8789		NA[*]	NA[*]

[*]Not Applicable

Case 4, in Table 4.1 above, presents the saturated ("largest") model in our example. By contrast, Case 1 presents the "smallest" model in our example.

If Case 1 is valid then we have the same normal distribution for each value of i, i = 1,2,3 or 4. It implies that A and X are statistically independent in this instance. The LRT used for comparing Case 1 to Case 4 has a value of 29.1556 with a p-value of 0.000057 which is extremely small suggesting the data does not support the hypothesis that A and X are independent.

Comparing Case 2 with Case 4, the LR test statistics is 2.5048 with a large p-value of 0.474400. Based on the "usual" 5% significance level, then we cannot reject the hypothesis that σ_j's differ. [5] refers to this situation as "homogeneity of variance", analogous to analysis of variance situation.

Finally, comparing Case 3 to Case 4, the LR test statistic has a very small p-value (0.000007) which rules out the hypothesis that the same μ can be utilized in for all diet types.

Tables such as Table 4.1 above are helpful to study the dependency structure between categorical and continuous variables in mixed variables settings.

5. CONCLUSIONS

This paper discussed briefly models for mixed variables. In particular, suitable joint distribution of mixed variables is provided by reference to a specific example. Procedures based on model comparison are utilized to study the dependency structure pertaining to a categorical and a continuous variable by reference to a simple example. Estimation of parameters and computation of Likelihood function was addressed by providing the necessary algorithm using ADMB code.

Appendix: ADMB Program for MLE of Parameters (Case 4 of Table 4.1)

Part 1 – ADMB Program Code

```
DATA_SECTION
  init_int nobs
  init_vector a(1,nobs)
  init_vector x(1,nobs)
PARAMETER_SECTION
  init_bounded_number p1(0,.3); init_bounded_number p2(0,.3); init_bounded_number p3(0,.3)
  number p4
  init_number mu1;  init_number mu2;  init_number mu3;  init_number mu4
  init_number logs1;  init_number logs2;  init_number logs3;  init_number logs4
  sdreport_number s1;  sdreport_number s2;  sdreport_number s3;  sdreport_number s4
  number l1;  number l2;  number l3;  number l4

  objective_function_value f

PROCEDURE_SECTION
  int i;  const double pi=3.14159265359;
  p4=1-p1-p2-p3;
  s1=exp(logs1);  s2=exp(logs2);  s3=exp(logs3);  s4=exp(logs4);
  l1=0.0;  l2=0.0;  l3=0.0;  l4=0.0;
  for (i=1; i<=nobs; i++){
              if(a(i)==1) l1=l1+log(p1)-0.5*log(2*pi*s1*s1)-(0.5/square(s1))*square(x(i)-mu1);
              if(a(i)==2) l2=l2+log(p2)-0.5*log(2*pi*s2*s2)-(0.5/square(s2))*square(x(i)-mu2);
              if(a(i)==3) l3=l3+log(p3)-0.5*log(2*pi*s3*s3)-(0.5/square(s3))*square(x(i)-mu3);
              if(a(i)==4) l4=l4+log(p4)-0.5*log(2*pi*s4*s4)-(0.5/square(s4))*square(x(i)-mu4);
              }
  f = -(l1+l2+l3+l4);
```

Part 2-Data
```
24
1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4 4 4 4
62 60 63 59 63 67 71 64 65 66 68 66 71 67 68 68 56 62 60 61 63 64 63 59
```

Part 3-Parameter estimates & value of the objective function (Formatted ADMB Output)
Number of parameters = 11 Objective function value = **83.8789** Maximum gradient component =
2.41911e-005
p1:   0.166666740293
p2:   0.249999794993
p3:   0.249999832877
mu1: 60.9999996189
mu2: 66.0000003949
mu3: 67.9999999312
mu4: 60.9999994702
logs1: 0.458146186021
logs2: 0.948560431158
logs3: 0.423646914273
logs4: 0.895879132220

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OPTIMAL LOCATION PARAMETER OF UNIFORM YIELD DISTRIBUTION IN A QUALITY-ADJUSTED EOQ MODEL WITH QUADRATIC HOLDING COST

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ABSTRACT

This paper considers a variant of the traditional Economic Order Quantity (EOQ) Model with imperfect quality that treats holding cost as a quadratic function of the amount of time an item is held in inventory. Such model comprises a special case of perishable inventory models where the proportion of non-defective units in an ordered lot, referred to as yield, is a continuous random variable. Utilizing the basic framework of this model, combined with a logarithmic investment function, the paper analyzes the economic tradeoffs associated with efforts directed at improving yield by altering the location parameter of yield distribution for the special case where yield follows a uniform probability density function.

Keywords: Inventory; quality improvement

1. INTRODUCTION

The well-known EOQ square root formula, initially developed in early twentieth century by Wilson (1934), is based on a number of implicit and explicit assumptions. These assumptions impose serious limitations on the applicability of the EOQ formula for solving actual inventory problems. Two of these assumptions, which are the focal points of this paper, are the constant holding cost and the perfect quality assumptions. The constant holding cost assumption implies that items can be stored indefinitely to meet future demand, which is not true for perishable items. To account for this limitation, a variety of EOQ paradigms for perishable items have been developed by many authors. Nahmias (1982) provides an excellent review of the early work of a number of these researchers. Weiss (1982) considers a product facing a constant demand rate, constant replenishment lead-time, a fixed ordering cost, and treats the holding cost as a nonlinear function of the amount of time that an item is held in inventory. Specifically, the unit holding cost in Weiss (1982) follows a relationship that is increasing in time, t. This relationship is given by $H(t)=C_h t^\gamma$, where C_h and $\gamma \geq 1$ are constants. Ferguson et al (2007) uses the model developed by Weiss (1982) as an approximation of the optimal order quantity for perishable

goods such as produce and dairy products. It was shown the model presented by Weiss (1982) delivers superior results under a series of robust scenarios.

The authors of the papers discussed above assume that all items in a lot are of perfect quality, which is not always the case. Recognizing the significance of quality in operations, many researchers have investigated the relationships among order quantity and quality of ordered items. Rosenblatt and Lee (1986) and Porteus (1986) studied the effect of process quality on lot size in the traditional Economic Manufacturing Quantity (EMQ) and Economic Order Quantity (EOQ) models, respectively. In both these papers, demand is assumed to be deterministic. Moinzadeh and Lee (1987) investigated the effect of defective items on the order quantity and reorder point of a continuous-review inventory model with Poisson demand and constant lead-time. Paknejad *et al* (1995) extend this work to consider stochastic demand and constant lead-time in the continuous review (s,Q) model. Cheng (1991) develops a model that integrates quality considerations with the EPQ. The author assumes that unit production cost increases with increases in process capability and quality assurance expenses. Goyal et al (1993) provides a good survey of the early literature on integrating lot size and quality.

In all the papers cited above, the manufacturing process is assumed to be stable and in statistical control. That is, the process generates a known, constant proportion of defectives, *p*. Such an assumption induces a situation where the proportion of defective items follows a binomial distribution, and process quality, therefore, may be monitored by a proportion control chart. This assumption is also made in Affisco *et al* (2009) for the case of the EOQ and Affisco *et al* (2002) for the case of the joint economic lot size model.

Nasri, Paknejad, and Affisco (2009a) and (2009b) began to study the relationship between order quantity and quality for processes that have not yet achieved the state of statistical control in an EPQ and EOQ model, respectively, with backorders. Nasri, Paknejad, and Affisco (2009) extended the results to the case of EMQ model. Specifically, the authors assume that each lot contains a random proportion of defective units, which implies that the yield, defined as proportion of non-defective units in each lot, is also random. Furthermore, the holding cost in these papers is assumed to be a linear function of time. Paknejad, Nasri, and Affisco (2012) relaxed the linear holding cost assumption and investigated the relationship between quality and lot size in the EOQ model with nonlinear holding cost, originally formulated by Weiss (1982) and later applied by Ferguson et al (2007) to inventory management of perishable goods.

The results developed in Paknejad, Nasri, and Affisco (2012) reinforce the wide-spread understanding that yield is a major concern for all inventory systems, including those for perishable goods where holding cost is modeled as a non-linear function of time. However, the work in Paknejad, Nasri, and Affisco (2012) considers the parameters of yield distribution as known, constant, and uncontrollable by management. This is despite the fact that the managers of these systems routinely consider investing in yield improvement programs which may alter the parameters of yield distribution.

The main objective of this research is to study the effect of efforts devoted to yield improvement programs, by controlling the parameters of yield distribution, on the lot size in an EOQ model with random yield where holding cost is a quadratic function of time, t. Assuming that yield follows a uniform probability density function, the paper presents explicit relationships for the

optimal values of location parameter of yield distribution, lot size, and total cost for the special case of logarithmic investment function.

2. REVIEW OF BASIC MODEL

The basic model considered in this paper is the classic EOQ with deterministic demand, constant setup cost, and nonlinear holding cost, developed by Weiss (1982) and applied by Ferguson et al (2007) as an approximation of the optimal order quantity of perishable goods. Assuming that the cumulative holding cost for one unit held during t interval of time is quadratic and given by $H(t) = C_h t^2$, where the average inventory cost per unit time, $AC_{Weiss,Quad}(Q)$, the resulting optimal lot size, $Q_{Weiss,Quad}^*$, and the corresponding optimal average inventory cost per unit time, $AC_{Weiss,Quad}^*(Q)$, are given by

$$AC_{Weiss,Quad}(Q) = \frac{DK}{Q} + \frac{Q^2 C_h}{3D}, \tag{1}$$

$$Q_{Weiss,Quad}^* = \sqrt[3]{\left(\frac{3}{2}\right)\left(\frac{D^2 K}{C_h}\right)}, \tag{2}$$

and

$$AC_{Weiss,Quad}^*(Q) = \sqrt[3]{\left(\frac{3}{2}\right)^2 DK^2 C_h} \tag{3}$$

    D = demand per unit time (in units),
    K = setup cost per setup,
    C_h = cumulative holding cost per unit per unit time,
    AC(Q) = average inventory cost per unit time,
    Q = lot size per order,
    $T = \frac{Q}{D}$ = cycle time, time between two successive orders.

Please note that equations (2) and (3) are extensions of the corresponding square root results of the classical Wilson's EOQ model with linear holding cost.

3. THE YIELD-ADJUSTED MODEL

The basic model of previous section assumes that all units produced by the vendor, in response to the purchaser's order, are of acceptable quality. In what follows we consider the case where the proportion of defective items in each lot is a random variable. This assumption, obviously, implies that the yield, defined as proportion of non-defective units in each lot, is also random. The inspection policy in place requires the purchaser to inspect the entire lot upon arrival. It is further assumed that the purchaser's inspection process is perfect and all unacceptable items are returned to the vendor at no cost to the purchaser. In addition, we assume that the vendor is responsible for all the inspection related costs. Of course, it is likely that the vendor will recover some of

these costs from the purchaser either directly or indirectly. Based on this scenario, we now adjust the EOQ model with quadratic holding cost of previous section for the quality factor as follows: Let

λ = yield, being defined as the proportion of non-defective items in an order lot,

$\quad\quad \lambda \in [\alpha, \beta]$ for $0 \le \alpha < \beta \le 1$, a continuous random variable,

$f(\lambda)$ = probability density function of λ,

$E(.)$ = mathematical expectation,

$E(\lambda) = \mu_1 = $ mean of λ,

$$E(\lambda^3) = \mu_3 = \int_{\alpha}^{\beta} \lambda^3 f(\lambda)\, d\lambda \ ,$$

$y = \lambda Q = $ number of non-defective items in a lot,

$c(y)$ = total cost per cycle given that there are y non-defective items in the lot of size Q,

$T = y/D = $ cycle time, time between two successive placement of orders,

$EAC_{adjWeiss,Quad}(Q)$ = expected total cost per year.

Consider one cycle of length T=y/D. Note that the cumulative holding cost if one unit is kept in inventory during the cycle [0,T] is $C_h T^2 = \int_{0}^{y/D} 2C_h t\, dt$. During the cycle, the inventory level changes with time according to $I(t) = y - Dt$. Therefore, the total cost per cycle is

$$c(y) = K + \int_{0}^{T} 2I(t)C_h t\, dt = K + \int_{0}^{y/D} 2(y - Dt)C_h t\, dt = K + \frac{(\lambda Q)^3}{3D^2} C_h \tag{5}$$

The average cycle time and cycle cost are

$$E(T) = \frac{E(y)}{D} = \frac{E(\lambda Q)}{D} = \frac{Q}{D} \mu_1 \tag{6}$$

and

$$E(c) = K + \left(\frac{E(\lambda^3)Q^3}{3D^2} \right) C_h = K + \frac{\mu_3 Q^3}{3D^2} C_h \tag{7}$$

The expected average total annual cost is

$$EAC_{adjWeiss,Quad}(Q) = \frac{E(c)}{E(T)} = \frac{DK}{\mu_1 Q} + \left[\frac{\mu_3 Q^2}{3\mu_1 D} \right] C_h \tag{8}$$

In what follows we assume that the probability density function of λ is uniform with location parameter C and scale parameter $C^c = 1-C$. That is,

$$f(\lambda) = \frac{1}{1-C} \quad\quad for \ \ C \le \lambda \le 1, \ \text{where} \ \ 0 \le C < 1 \tag{9}$$

In this case

$$E(\lambda) = \mu_1 = \frac{1+C}{2} \tag{10}$$

and

$$E(\lambda^3) = \mu_3 = \frac{(1+C)(1+C^2)}{4} \tag{11}$$

Substituting (10) and (11) into (8) and using calculus, the optimal values for the order quantity, $Q^*_{adjWeiss,Quad,U}$, and the resulting expected total annual cost, $EAC^*_{adjWeiss,Quad,U}$, are found as follows:

$$Q^*_{adjWeiss,Quad,U} = \sqrt[3]{\frac{6D^2K}{C_h(1+C)(1+C^2)}} \tag{12}$$

and

$$EAC^*_{adjWeiss,Quad,U} = \sqrt[3]{\left(\frac{9}{2}\right)\left(1 - \frac{2C}{(1+C)^2}\right)DK^2C_h} \tag{13}$$

Please note that in (12) and (13), if the yield location parameter C = 1, then the yield scale parameter $C^c = 0$. In such case, the quality is perfect and the yield-adjusted model of this paper simply reduces to the corresponding results in Weiss (1982), for the special case of quadratic holding cost, given by equations (2) and (3).

4. THE OPTIMAL YIELD PARAMETER MODEL

The decision variable in the model of previous section is Q for a fixed location parameter of yield distribution, C. The value of this parameter determines the corresponding values for the first and the third moments of yield distribution, $E(\lambda)=\mu_1$ and $E(\lambda^3)=\mu_3$. As the location parameter, C, approaches one, both μ_1 and μ_3 approach one, and quality approaches perfection. In this paper, we assume that the option of investing to improve quality, by increasing C, is available. To evaluate the economic trade-offs associated with this investment option, we introduce a companion yield parameter, Ω, as follows:

$$\Omega = \frac{C}{(1+C)^2} \quad \text{for} \quad 0 \le C \le 1 \tag{15}$$

Please note that Ω is a strictly convex and increasing function of C for $0 \le C \le 1$. Furthermore, $\lim_{C \to 0} \Omega = 0$ and $\lim_{C \to 1} \Omega = 1/4$. Hence, as C increases from 0 to 1, Ω also increases from 0 to 0.25. Thus, increasing Ω implies increasing C and, hence, improving yield.

Now, we consider Ω to be a decision variable and seek to minimize the average annual cost composed of, investment cost to change Ω, ordering cost, and holding cost. Specifically, we seek to minimize

$$C(Q,\Omega) = ia_\Omega(\Omega) + EAC_{adjWeiss,Quad,U} \tag{16}$$

Subject to

$$\Omega_0 \le \Omega \le 0.25 \tag{17}$$

where i is the cost of capital, $a_\Omega(\Omega)$ is a strictly increasing function of Ω representing the cost of increasing the companion yield parameter to the level Ω, $EAC_{adjWeiss,Quad,U}$ is the sum of all inventory related costs given in (8) for the case of uniform yield distribution with μ_1 and μ_3 given by equations (10) and (11), and Ω_0 is the original companion yield parameter.

One way of dealing with this optimization problem is to use a rather unconventional approach, suggested by Porteus (1986). In this case, we hold Ω fixed, optimize over Q to obtain $Q^*_{adjWeiss,Quad,U}$ given by (12), and then optimize over Ω. That is, we seek to minimize

$$W(\Omega) = ia_\Omega(\Omega) + EAC^*_{adjWeiss,Quad,U}(\Omega) \tag{18}$$

where $EAC^*_{adjWeiss,Quad,U}(\Omega)$ is given by (13), modified for Ω, as follows:

$$EAC^*_{adjWeiss,Quad,U}(\Omega) = \sqrt[3]{\left(\frac{9}{2}\right)(1-2\Omega)DK^2C_h} \tag{19}$$

If the optimal Ω obtained in this way does not satisfy restriction (17), no investment is made to reduce Ω and improve yield and the results of the yield-quality model of section 3 holds. Of course the problem may prove to be intractable except for some special forms of investment cost function. The following section discusses one of these forms.

5. THE LOGARITHMIC INVESTMENT FUNCTION

This particular function is frequently used in the literature for problems dealing with quality improvement as well as setup cost reduction. In this case the yield companion parameter, Ω, increases at a decreasing rate as the investment amount, $a_\Omega(\Omega)$, is increased. That is

$$a_\Omega(\Omega) = a - b.\,ln\left(\frac{1}{2} - \Omega\right) \qquad for \qquad \Omega_0 \le \Omega \le 0.25 \tag{20}$$

where b is a positive constant and $a = b.\,ln\left(\frac{1}{2} - \Omega_0\right)$. Here our main objective is to minimize w(Ω) after substituting (19) and (20) into (18).

Theorem: If $0 \le \Omega_0 \le 0.25$ and $\left(\frac{0.25DK^2C_h}{3}\right)^{1/3} \le b \le \left(\frac{(1/2 - \Omega_0)DK^2C_h}{3}\right)^{1/3}$, then the following hold:

a) The optimal value of the companion yield parameter is given by

$$\Omega^{**} = min\left\{\Omega_0, \Omega_{imp,Quad,U}\right\} \tag{21}$$

where Ω_0 = the original companion yield parameter and

$$\Omega_{imp,Quad,U} = \frac{1}{2} - \frac{3b^3}{DK^2C_h} \tag{22}$$

(b) The resulting optimal yield location and optimal yield scale parameters are

$$C^{**} = \max\left\{C_0, C_{imp,Quad,U}\right\} \tag{23}$$

$$C^{c**} = \min(C_0^c, C_{imp,Quad,U}^c) \tag{24}$$

where C_0 and C_0^c are the original location and scale parameters, and

$$C_{imp,Quad,U} = \frac{1}{2\Omega_{imp,U}}\left[\left(1 - 2\Omega_{imp,U}\right) + \sqrt{\left(1 - 4\Omega_{imp,U}\right)}\right] \tag{25}$$

$$C_{imp,Quad,U}^c = 1 - C_{imp,U} \tag{26}$$

(c) The optimal values for the order quantity, Q^{**}, and expected total annual cost, EAC^{**}, are as follows:

$$Q^{**} = \begin{cases} Q_{imp,Quad,U}^* & if\ \Omega_{imp,Quad,U} \geq \Omega_0 \\ Q_{adjWeiss,Quad,U}^* & if\ \Omega_{imp,Quad,U} < \Omega_0 \end{cases} \tag{27}$$

$$EAC^{**} = \begin{cases} EAC_{imp,Quad,U}^* & if\ \Omega_{imp,Quad,U} \geq \Omega_0 \\ EAC_{adjWeiss,Quad,U}^* & if\ \Omega_{imp,Quad,U} < \Omega_0 \end{cases} \tag{28}$$

where $Q_{adjWeiss,Quad,U}^*$ and $EAC_{adjWeiss,Quad,U}^*$ are given by (12) and (13),

$$Q_{imp,Quad,U}^* = \sqrt[3]{\frac{6D^2K}{C_h\left(1 + C_{imp,Quad,U}\right)\left(1 + C_{imp,Quad,U}^2\right)}} \tag{29}$$

and

$$EAC_{imp,Quad,U}^* = \sqrt[3]{\left(\frac{9}{2}\right)\left(1 - 2\Omega_{imp,Quad,U}\right)DK^2C_h} \tag{30}$$

Details of the proofs are omitted.

6. CONCLUSION

This paper considered an imperfect quality EOQ model with quadratic holding cost and studied the economic trade-offs associated efforts aimed at improving yield, defined as the proportion of conforming items in each ordered lot, through alteration of parameters of yield distribution. Assuming that yield is a uniform random variable with location parameter C and scale parameter $C^c = 1 - C$, the paper developed explicit results for the optimal values of these parameters and the corresponding lot size and expected average annual cost for the case of logarithmic investment function.

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A Bayesian Approach for Estimating Confidence Intervals for DEA Efficiency Scores under Certain Inefficiency Distribution Assumptions

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ABSTRACT

In this paper we show how Bayesian data analysis can be used to estimate confidence intervals for DEA efficiency scores. We assume half normal and exponential distributions for inefficiency score likelihood distribution function and then use the inefficiency scores from a real-world software engineering dataset and Bayesian data analysis to compute posterior distribution of inefficiency scores and their confidence intervals. Confidence intervals for DEA efficiency scores are then directly computed from the confidence intervals of posterior inefficiency scores.

1. INTRODUCTION

Data envelopment analysis (DEA) is widely used as an efficiency analysis tool for ranking hospitals, fast food chains, academic departments, and manufacturing organizations. DEA is also used for statistical analysis [2], [4] and while its robustness for statistical analysis has been

demonstrated [2], [3] some researchers have argued that using results from standard DEA model are less desirable [13], [27] because DEA efficiency scores violate assumption of independence within the sample, assume no measurement errors and assume estimated production frontier as piecewise linear. Due to sensitivity of DEA scores to outliers, difficulty in measuring uncertainty (confidence intervals) in regards to efficiency scores was noted by prior researchers [13], [26].

To remedy some of the deficiencies of traditional DEA, a set of researchers introduced bootstrapping methods into the DEA framework [21], [22], [27]. Bootstrapping methods are statistically well defined, consistent and allow for estimation of confidence intervals on efficiency scores. Unfortunately there are some shortcomings of bootstrapping methods. Among the shortcomings, bootstrapping methods do not assume any particular statistical distribution making justification for bootstrapping method only asymptotic [17], [18]. The lack of knowledge of statistical distribution limits the inferences made from bootstrapping methods because accuracy and precision of a bootstrap method depends greatly on sample size and specific dataset [26]. A set of researchers have used Bayesian approaches in context with the DEA and stochastic DEA [1], [25], [26]. When compared to bootstrapping methods, Bayesian methods are simpler to implement and provide more precise inferences [1]. Bayesian methods do require an assumption about the distribution of likelihood probability density function (pdf). When this pdf is known, Bayesian techniques can generate random draws from entire parameter space to generate approximate values for parameters of interest. Inferences from Bayesian methods are consistent to the extent the assumptions about the likelihood distribution are correct. These methods are unique in that they allow decision-makers to combine their prior knowledge with the available data to generate inferences [12]. When pdfs of several competing distributions are available, information criterion such as deviance information criterion (DIC), introduced by [22] can be used to measure adequacy of a model for each of competing distribution to find the best model fit that has lowest DIC value.

Given that the robustness of DEA inefficiency score distributions is well established to follow exponential or half-normal distribution [2], [4]. Bayesian methods can be easily used to develop confidence intervals on inefficiency scores. Once the confidence intervals on inefficiency scores are available, converting them into confidence intervals of efficiency scores is a trivial exercise.

Thus, in this paper, we illustrate how Bayesian methods can be used to develop confidence intervals on DEA efficiency scores by assuming exponential and half normal inefficiency score distributions. The rest of paper is organized as follows: in Section 2, we provide an overview of variable returns to scale (VRS) DEA model and introduce Bayesian methods to develop confidence intervals on DEA efficiency scores. In Section 3, we describe a software engineering efficiency ranking problem, our model and dataset. In Section 4, we describe our experiments and results. Section 5 concludes our paper with a summary.

2. OVERVIEW OF DEA AND BAYESIAN METHODS TO DEVELOP CONFIDENCE INTERVALS ON DEA EFFICIENCY SCORES

We assume a dataset $D=(X,Y)$ of $n >2$ examples, where X is $n \times k$ matrix of observations on $k >0$ inputs and Y is $n \times m$ matrix of observations on $m >0$ outputs. We impose a restriction $n \geq max$ $\{k \times m, 3 \times (n+m)\}$ to ensure that n is sufficiently large to obtain meaningful results from the DEA analysis. Assuming that θ_i represents efficiency score for an example $i \in \{1,…,n\}$, y_i^T represents i^{th} row of matrix Y, x_i^T represents i^{th} row of matrix X and e an n-dimensional unit vector; the dual of input-oriented VRS DEA model can be written as follows.

For each $i = 1,…,n$, solve: $Minimize \{\theta_i | Y\lambda \geq y_i, \theta_i x_i \geq X\lambda, e^T \lambda = 1, \lambda \in \Re_+^n\}$. (1)

Once formulation (1) is solved then final solution vector $\theta^* = [\theta_1^*,…,\theta_n^*]^T$ represents efficiencies for each of n examples. An example $i \in \{1,…,n\}$ is said to be efficient when $\theta_i^*=1$. An inefficiency vector $\xi^*=[\xi_1^*,…,\xi_n^*]^T$ can be defined using $\xi_i^*=1-\theta_i^*$. Typical distributions for inefficiency vector ξ^* are either half-normal or exponential. Since both exponential and half-normal distributions are represented by a parameter α such that the expected value of the distribution is $1/\alpha$, we represent the distribution of inefficiency scores as exponential or half-normal likelihood function $l(\alpha)$.

To estimate posterior distributions of inefficiency scores, we use a hierarchical Bayesian model shown in Figure 1. Under the assumption that each of the inefficiency scores are independent, we assume that $\xi_i^* \sim l(\alpha_i)$ where $l(\alpha_i)$ is either exponential or half-normal distribution with expected value $1/\alpha_i$ for the ith example. If $\alpha =[\alpha_1,…,\alpha_n]^T$ represents a vector then posterior

distribution of this vector, given dataset D or more specifically inefficiency vector ξ^* and hierarchical Bayesian model in Figure 1, can be computed using the Bayes rule as follows:

$$P(\boldsymbol{\alpha}, a, b | \boldsymbol{\xi}^*) \propto P(a)P(b) \prod_{i=1}^{n} P(\xi_i^* | \alpha_i) \prod_{i=1}^{n} P(\alpha_i | a, b), \text{ and}$$

$$P(\boldsymbol{\alpha} | a, b, \boldsymbol{\xi}^*) = \prod_{i=1}^{n} P(\xi_i^* | \alpha_i) \prod_{i=1}^{n} P(\alpha_i | a, b).$$

The term $P(\xi_i^* | \alpha_i,)$ has either exponential or half-normal likelihood $l(\alpha_i)$. Since exponential and half-normal distributions have Gamma distribution as a conjugate prior, terms, $P(\boldsymbol{\alpha} | a, b, \boldsymbol{\xi}^*)$ and $P(\alpha_i | a, b)$ have Gamma distribution. The value of expression on the right hand side is obtained by Markov Chain Monte Carlo (MCMC) methods. The availability of open source software programs such as WinBugs[1] and JAGS[2] make applying MCMC methods very easy.
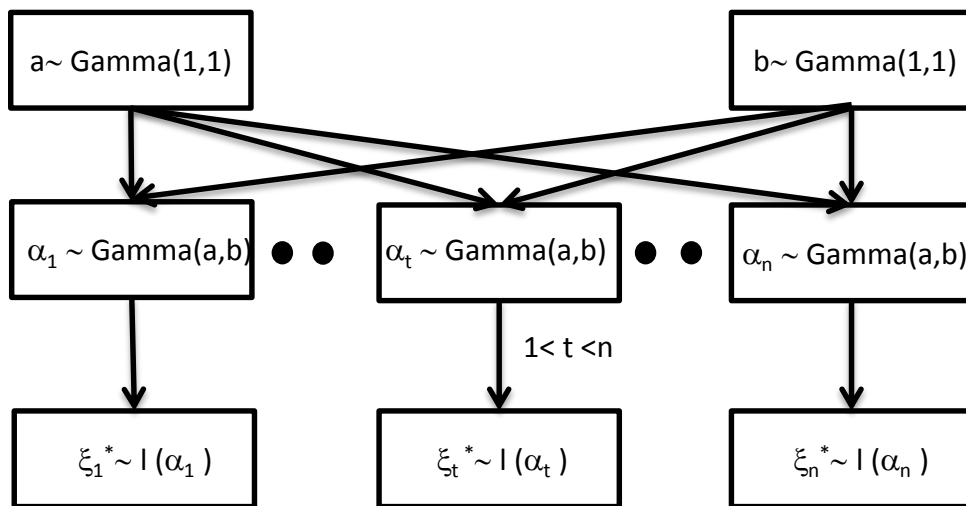
Figure 1: A Hierarchical Bayesian Model for DEA Inefficiency Scores

Once MCMC simulation is run and complete, if α_{iL} and α_{iU} represent lower and upper bounds on parameter α_i at 95% statistical level of confidence then the lower and upper bounds (confidence interval) at 95% statistical level of confidence on posterior mean efficiency score θ_i are represented as $\left[\frac{\alpha_{iL}-1}{\alpha_{iL}}, \frac{\alpha_{iU}-1}{\alpha_{iU}}\right]$. Additionally, posterior value of efficiency score can be computed

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[1] http://www.mrc-bsu.cam.ac.uk/bugs/
[2] http://mcmc-jags.sourceforge.net/

directly from the posterior mean of inefficiency score. If $E(\alpha_i)$ represents the posterior mean value of α_i then posterior mean value of efficiency score for is computed as: $\frac{E(\alpha_i)-1}{E(\alpha_i)}$.

3. RANKING SOFTWARE DEVELOPMENT PROJECTS AND DESCRIPTION OF DATASET

Software applications continue to play an important role for organizations but software development projects continue to be plagued by delays, cost-overruns, and quality issues. For instance, according to the recent Standish Group's report "CHAOS Summary 2009", only 32 per cent of the software development projects succeeded. The rest of the projects were late, over budget, or canceled. A software project is considered successful if it is delivered on time, within budget, and meets or exceeds the customer's requirement [14]. One way to increase the success rate of software development projects is to benchmark different projects against the best practice projects and identify the characteristics of such best practice projects. Jim Johnson, Chairman, The Standish Group states "Profiling one project against others to isolate costs is tricky and difficult at best, but this approach is much better than many of the alternatives [14]."

Learning from the best practices in projects is one of the crucial factors in improving software processes. The processes used for executing a software project have a major impact on the quality of the software developed and the productivity achieved in the project [15]. There have been several studies aimed at benchmarking software projects [11], [19], [20], [23], [28]. Many of these studies use software size measures such as function points (FP), and Source Lines of Code (SLOC). In addition, size measures for object-oriented development include counts of use cases, classes, etc. Card et al. (2001) provides a summary of many of them. The most widely applied productivity model in software development [5], [6], [8], [16] is the following univariate model:

$$P = \frac{Output}{Input} = \frac{Software\ Size}{Software\ Effort} \tag{2}$$

where, P is the productivity or product delivery rate; software size is measured in FP or SLOC, and software effort is overall project effort measured in person-hours or person-months (PM). Multiple input and multiple output models are used in ranking software development projects.

In our study, we use a two-input three-output model. Our two inputs are software development effort (SDE) and software quality appraisal effort (SQAE); and our three outputs are FP, total defects (TD) and software maintenance effort (SME) due to poor software quality delivery. All effort variables were measured in person-hours. Total defects included both pre-delivery defects and post-delivery defects. Figure 2 illustrates our software production process model.

Figure 2: Software Development Process Model

We collected project data from a large organization in software development outsourcing industry. The organization has formal structure dealing with software quality and process improvement initiative and has implemented a number of software engineering related methodologies, tools, and process initiatives. Managers in the selected organization focus on improving quality of their processes for effective defect management (i.e., defect detection, prevention, and removal). Data were obtained under the terms of nondisclosure agreements that placed some restrictions on the information that could be published. Our primary contacts were located in the software engineering process group (SEPG) of this organization and they were very knowledgeable about the best practices in software development. Our contacts interacted with project managers and project leaders and had access to various software development and management tools in the organizational tool repository for managing project. Most of these tools were proprietary and developed in-house (for example, defect tracking tool). The organization reported the use of tools for project management and tracking, defect analysis and reporting, sizing projects, and effort reporting. In addition to using tools for managing projects, the organization also had an extensive system of reviews for ensuring the integrity of various project-related data.

The organization reported the project size in FP. The international function point users group (IFPUG) specifications were followed for counting FPs. Project manager and project leader, supported by an estimation team, were responsible for FP counting at the end of a project. FPs were estimated at the start of a project. Furthermore, FPs were also re-estimated at the end of each phase of the systems development life cycle (SDLC), and whenever there were major changes in a project.

The actual hours spent by project team members were used in effort variables computations. The project team members included subject matter experts (SMEs), database experts, and developers. The effort spent on various tasks by a team member was entered through the activity report system (ARS). This online system, developed in-house, stored all activity reports submitted by team members in a centralized database. An ARS entry by a team member for a project consisted of a sequence of records. Each record consisted of a list of items with each item containing several fields, which included Program code, Module code, Activity code, Activity description. The activity code characterizes the type of activity and is a key piece of data as it helps in understanding the effort distribution for a project, which is needed to identify potential areas for productivity improvement.

The organization considers defects to be errors that prevent an application from meeting customer requirements. The organization has a defect management process which is followed by all the types of projects in the organization; hence, the definition of a defect is same across the organization for all projects. Software engineers use a common in-house developed tool for logging and tracking defects. If a defect is found during a review or testing phase, it is entered in the system, along with information about the defect, for the purpose of tracking defect to closure and for defect prevention. The organization, in general, provides warranty support to its customers for 60 days once a development project goes live into production. Hence, the post-delivery defect collection periods are the same for all projects.

Table 1: Distribution of projects

Application	No.	Platform	No.	Database	No.	Language	No.

	18	Client-Server	15	MS SQL Server	18	3rd Generation	40
Manufacturing	18	Client-Server	15	MS SQL Server	18	3rd Generation	40
Insurance	17	Windows	37	Oracle	42	4th Generation	11
Banking & Finance	14	Others	27	Others	19	Both Generation	28
Health	12						
Others	18						

All the projects in the sample were new application development projects which were completed in the years 2008-2009. To begin with, we collected data on 95 projects. We scrutinized the data thoroughly and when there were any discrepancies observed, we contacted the concerned organization for further clarifications. If the clarifications did not resolve the discrepancies satisfactorily, we dropped the project from our sample. Out of an initial sample of 95 projects, we dropped 16 projects from the sample due to reasons such as incomplete data or inconsistent data. We ended with a sample of 79 projects for further analysis. Due to the use of various tools and the enforcement of rigorous review procedures in participating organizations, as well as our own efforts in cross-checking data for inconsistencies, we believe that the data is of high quality with minimal biases. Table 1 shows the distribution of projects in terms of their business application, platform, database, and technology. Table 2 provides descriptive statistics for input and output variables.

Table 2: Descriptive Statistics of Input and Output Variables

	Inputs		Outputs		
	SDE	**SQAE**	**FP**	**TD**	**SME**
Mean	3,912	1,725	567	175	537
Median	2,004	937	284	91	271
Std. Deviation	5,133	3,146	637	208	829
Minimum	423	109	100	1	44
Maximum	37,035	25,608	3012	1,144	6,195

4. EXPERIMENTS AND RESULTS

For our experiments, we take the original dataset of 79 projects and compute efficiency of each project by using formulation from eq. (1). Next, we compute inefficiencies for each project and implement MCMC method described in Section 2 using WinBugs open source software. Figure 3 illustrates the WinBugs source code with all the data. WinBugs uses symbol "#" to highlight a non-executing line. The source code contains information about two inefficiency distribution assumptions. Line 4 implements exponential distribution and line 5 implements half-normal distribution. Depending on the inefficiency distribution assumption either line 4 or line 5 must have symbol "#" in front to negate that distribution assumption.

We computed posterior mean values and confidence intervals (C.I) for vector α under both exponential and half-normal distribution. Our simulation run consisted of 5000 iterations with first 1000 iterations as initial burn-in period. Thus, posterior means were obtained as an average over last 4000 iterations. Using the methodology described in Section 2, we computed posterior mean efficiency values and C.Is for efficiency scores. Tables 4a and 4b illustrate the results of our experiments. In both tables, first column lists project ID, which is same as the efficiency rank obtained from using eq. (1) formulation on 79 projects. The second column contains the original DEA efficiency score from eq. (1) formulation. Columns 3 and 4 contain posterior efficiency scores and 95% C.I of the efficiency score under exponential inefficiency score distribution assumption, and columns 5 and 6 contain posterior efficiency scores and 95% C.I of the efficiency score under half-normal inefficiency score distribution assumption. The posterior efficiency scores in 3rd and 5th columns of Tables 3a and 3b are considered as independent satisfying exponential or half-normal inefficiency score distributions. The DIC value for exponential inefficiency distribution assumption was 21.33 and the DIC value for half-normal inefficiency distribution assumption was 6.70. Since lower DIC value indicates better fit, half-normal inefficiency score distribution had a better fit than exponential inefficiency score distribution assumption. While DIC value indicates that half-normal inefficiency distribution is a better fit, we conduct a Bayesian difference in means test for efficiency scores under exponential and half-normal inefficiency distributions. Figure 4 illustrates the WinBugs source code and Table 4 illustrates the results of our experiments. Since the 95% C.I. contains negative values on lower side of the interval and positive value on the upper side of the interval, all 79 projects included the zero value on their 95% difference of means intervals. This indicates that

statistically there was no difference in means between posterior efficiency scores obtained under exponential and half-normal inefficiency distribution assumptions.

```
model;                                                        #line 1
{                                                             #line 2
  for( i in 1 : N ) {                                         #line 3
    #ea[i] ~ dexp(alpha[i])    # Exponential Distribution      #line 4
    ea[i] ~ djl.dnorm.trunc (0,alpha[i], 0, 500) # Half-Normal Distribution   #line 5
      alpha[i] ~dgamma(a,b)                                   #line 6
    }                                                         #line 7
a ~ dgamma (1,1)                                              #line 8
b ~dgamma(1,1)                                                #line 9
}                                                             #line 10
DATA list(N=79,
ea=c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.077,0.116,0.136,0.142,0.159,0.177,0.243,
0.254,0.272,0.278,0.292,0.301,0.306,0.319,0.321,0.326,0.336,0.365,0.380,0.396,0.398,
0.415,0.417,0.425,0.432,0.448,0.457,0.465,0.470,0.475,0.488,0.509,0.527,0.532,0.562,
0.569,0.585,0.589,0.595,0.597,0.597,0.613,0.624,0.626,0.635,0.656,0.663,0.695,0.698,
0.700,0.702,0.715,0.738,0.741,0.741,0.742,0.743,0.758,0.818,0.839,0.856))
```

Figure 3: WinBugs Source Code and Data

```
model;                                                          #line 1
{                                                               #line 2
 for( i in 1 : N ) {                                            #line 3
    dea[i] ~ dexp(alpha2[i])    # Exponential Distribution      #line 4
    dea[i] ~ djl.dnorm.trunc (0,alpha[i], 0, 500) # Half-NormalDistribution   #line 5
    alpha[i] ~dgamma(a,b)                                       #line 6
    alpha2[i]~dgamma(a,b)                                       #line 7
    effE[i]<- (alpha2[i]-1)/alpha2[i]                           #line 8
    effHN[i]<-(alpha[i]-1)/alpha[i]                             #line 9
    diff[i]<-effE[i]-effHN[i]                                   #line 10
   }                                                            #line 11
a ~ dgamma (1,1)                                                #line 12
b ~dgamma(1,1)                                                  #line 13
}                                                               #line 14
DATA list(N=79,
dea=c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0.077,0.116,0.136,0.142,0.159,
0.177,0.243,0.254,0.272,0.278,0.292,0.301,0.306,0.319,0.321,0.326,
0.336,0.365,0.380,0.396,0.398,0.415,0.417,0.425,0.432,0.448,0.457,
0.465,0.470,0.475,0.488,0.509,0.527,0.532,0.562,0.569,0.585,0.589,
0.595,0.597,0.597,0.613,0.624,0.626,0.635,0.656,0.663,0.695,0.698,
0.700,0.702,0.715,0.738,0.741,0.741,0.742,0.743,0.758,0.818,0.839,0.856))
```

Figure 4: Bayesian Testing of Difference in Mean Efficiency Scores for Exponential and Half-Normal Distribution

Table 3a: Original and Posterior Efficiency Scores with Confidence Intervals under Different Inefficiency Distribution Assumptions

Project ID Number	Original Efficiency	Exponential Distribution		Half-Normal Distribution	
		Posterior Eff.	95% C.I	Posterior Eff.	95% C.I
1	1.000	0.737	[0.18,0.88]	0.833	[0.36,0.93]
2	1.000	0.740	[0.18, 0.88]	0.838	[0.41, 0.93]
3	1.000	0.740	[0.15, 0.88]	0.833	[0.39, 0.93]
4	1.000	0.744	[0.16, 0.88]	0.832	[0.30, 0.93]
5	1.000	0.738	[0.16, 0.88]	0.838	[0.39, 0.93]
6	1.000	0.740	[0.15, 0.88]	0.834	[0.34, 0.93]
7	1.000	0.738	[0.13, 0.88]	0.831	[0.36, 0.93]
8	1.000	0.737	[0.11, 0.88]	0.834	[0.34, 0.93]
9	1.000	0.738	[0.20, 0.88]	0.833	[0.39, 0.93]
10	1.000	0.741	[0.17, 0.88]	0.833	[0.35, 0.93]
11	1.000	0.741	[0.18, 0.88]	0.834	[0.37, 0.93]
12	1.000	0.740	[0.16, 0.88]	0.833	[0.37, 0.93]
13	1.000	0.739	[0.15, 0.88]	0.831	[0.35, 0.93]
14	1.000	0.739	[0.16, 0.88]	0.832	[0.39, 0.93]
15	1.000	0.741	[0.19, 0.88]	0.834	[0.32, 0.93]
16	1.000	0.737	[0.12, 0.88]	0.834	[0.37, 0.93]
17	1.000	0.742	[0.21, 0.88]	0.831	[0.34, 0.93]
18	1.000	0.738	[0.19, 0.88]	0.835	[0.40, 0.93]
19	0.923	0.727	[0.14, 0.87]	0.833	[0.40, 0.93]
20	0.884	0.712	[0.10, 0.87]	0.832	[0.39, 0.93]
21	0.864	0.710	[0.05, 0.87]	0.833	[0.35, 0.93]
22	0.858	0.707	[0.04, 0.86]	0.832	[0.37, 0.93]
23	0.841	0.704	[0.09, 0.86]	0.829	[0.38, 0.92]
24	0.823	0.704	[0.05, 0.86]	0.830	[0.38, 0.93]
25	0.757	0.690	[0.01, 0.85]	0.828	[0.35, 0.93]
26	0.746	0.686	[0.00, 0.85]	0.823	[0.32, 0.92]
27	0.728	0.681	[0.00, 0.85]	0.824	[0.35, 0.92]
28	0.722	0.683	[0.00, 0.85]	0.825	[0.29, 0.92]
29	0.708	0.678	[0.00, 0.85]	0.822	[0.33, 0.92]
30	0.699	0.674	[0.00, 0.85]	0.820	[0.30, 0.92]
31	0.694	0.675	[0.00, 0.85]	0.821	[0.34, 0.92]
32	0.681	0.674	[0.00, 0.84]	0.821	[0.31, 0.92]
33	0.679	0.670	[0.01, 0.84]	0.820	[0.30, 0.92]
34	0.674	0.672	[0.00, 0.85]	0.818	[0.24, 0.92]
35	0.664	0.667	[0.00, 0.84]	0.816	[0.34, 0.92]
36	0.635	0.665	[0.00, 0.84]	0.818	[0.32, 0.92]
37	0.620	0.663	[0.00, 0.84]	0.814	[0.28, 0.92]
38	0.604	0.655	[0.00, 0.84]	0.813	[0.27, 0.92]
39	0.602	0.656	[0.00, 0.84]	0.812	[0.29, 0.92]
40	0.585	0.655	[0.00, 0.84]	0.811	[0.25, 0.92]

Table 3b: Original and Posterior Efficiency Scores with Confidence Intervals under Different Inefficiency Distribution Assumptions

Project ID Number	Original Efficiency	Exponential Distribution		Half-Normal Distribution	
		Posterior Eff.	95% C.I	Posterior Eff.	95% C.I
41	0.583	0.648	[0.00,0.83]	0.813	[0.30,0.92]
42	0.575	0.647	[0.00,0.83]	0.812	[0.26, 0.92]
43	0.568	0.653	[0.00,0.84]	0.809	[0.27, 0.91]
44	0.552	0.648	[0.00,0.83]	0.808	[0.29, 0.91]
45	0.543	0.645	[0.00,0.83]	0.808	[0.28, 0.91]
46	0.535	0.644	[0.00,0.83]	0.805	[0.26, 0.91]
47	0.530	0.642	[0.00,0.83]	0.804	[0.29, 0.92]
48	0.525	0.638	[0.00,0.83]	0.809	[0.23, 0.92]
49	0.512	0.641	[0.00,0.83]	0.801	[0.26, 0.91]
50	0.491	0.635	[0.00,0.83]	0.796	[0.15, 0.91]
51	0.473	0.631	[0.00,0.82]	0.798	[0.20, 0.91]
52	0.468	0.627	[0.00,0.82]	0.798	[0.18, 0.91]
53	0.438	0.621	[0.00,0.82]	0.792	[0.13, 0.91]
54	0.431	0.618	[0.00,0.82]	0.791	[0.22, 0.91]
55	0.415	0.616	[0.00,0.81]	0.790	[0.23, 0.90]
56	0.411	0.618	[0.00,0.81]	0.790	[0.22, 0.90]
57	0.405	0.616	[0.00,0.81]	0.787	[0.19, 0.91]
58	0.403	0.612	[0.00,0.82]	0.788	[0.20, 0.90]
59	0.403	0.621	[0.00,0.82]	0.792	[0.15, 0.91]
60	0.387	0.614	[0.00,0.81]	0.789	[0.14, 0.91]
61	0.376	0.607	[0.00,0.81]	0.786	[0.19, 0.90]
62	0.374	0.611	[0.00,0.81]	0.787	[0.17, 0.91]
63	0.365	0.610	[0.00,0.81]	0.784	[0.17, 0.90]
64	0.344	0.609	[0.00,0.81]	0.780	[0.14, 0.90]
65	0.337	0.598	[0.00,0.81]	0.777	[0.15, 0.90]
66	0.305	0.596	[0.00,0.80]	0.771	[0.12, 0.89]
67	0.302	0.598	[0.00,0.81]	0.772	[0.13, 0.90]
68	0.300	0.596	[0.00,0.81]	0.773	[0.07, 0.90]
69	0.298	0.592	[0.00,0.81]	0.778	[0.15, 0.90]
70	0.285	0.590	[0.00,0.80]	0.772	[0.15, 0.90]
71	0.262	0.588	[0.00,0.80]	0.763	[0.15, 0.89]
72	0.259	0.591	[0.00,0.80]	0.765	[0.05, 0.89]
73	0.259	0.586	[0.00,0.80]	0.759	[0.11, 0.89]
74	0.258	0.587	[0.00,0.80]	0.763	[0.13, 0.89]
75	0.257	0.585	[0.00,0.79]	0.760	[0.09, 0.89]
76	0.242	0.581	[0.00,0.79]	0.761	[0.03, 0.89]
77	0.182	0.571	[0.00,0.79]	0.748	[0.08, 0.88]
78	0.161	0.562	[0.00,0.78]	0.743	[0.04, 0.88]
79	0.144	0.559	[0.00,0.78]	0.747	[0.00, 0.89]

Table 4: The Difference in Mean Efficiency Scores Test for Exponential and Half-Normal Distribution

Project ID Number	Difference	95% C.I	Project ID Number	Difference	95% C.I
1	0.107	[-0.50,0.89]	41	0.016	[-0.71,0.81]
2	0.111	[-0.44,0.94]	42	-0.001	[-0.71,0.80]
3	0.119	[-0.46,0.93]	43	0.007	[-0.70,0.79]
4	0.102	[-0.45,0.90]	44	0.002	[-0.74,0.83]
5	0.103	[-0.47,0.93]	45	-0.009	[-0.74,0.84]
6	0.107	[-0.47,0.94]	46	-0.010	[-0.78,0.81]
7	0.102	[-0.44,0.95]	47	-0.015	[-0.76,0.77]
8	0.110	[-0.47,0.99]	48	-0.010	[-0.77,0.85]
9	0.105	[-0.49,0.86]	49	-0.015	[-0.79,0.84]
10	0.114	[-0.48,0.96]	50	0.022	[-0.68,0.91]
11	0.112	[-0.49,0.92]	51	-0.016	[-0.75,0.80]
12	0.109	[-0.46,0.97]	52	-0.017	[-0.77,0.81]
13	0.110	[-0.44,0.94]	53	-0.018	[-0.82,0.85]
14	0.109	[-0.45,0.86]	54	-0.016	[-0.78,0.86]
15	0.123	[-0.46,0.98]	55	-0.033	[-0.82,0.83]
16	0.110	[-0.48,0.93]	56	-0.035	[-0.80,0.79]
17	0.110	[-0.46,0.85]	57	-0.034	[-0.80,0.80]
18	0.117	[-0.47,0.92]	58	-0.016	[-0.77,0.74]
19	0.089	[-0.48,0.90]	59	-0.041	[-0.78,0.79]
20	0.076	[-0.53,0.87]	60	-0.032	[-0.78,0.89]
21	0.063	[-0.57,0.82]	61	-0.027	[-0.80,0.84]
22	0.069	[-0.55,0.86]	62	-0.038	[-0.77,0.76]
23	0.062	[-0.56,0.84]	63	-0.046	[-0.80,0.76]
24	0.068	[-0.56,0.92]	64	-0.035	[-0.79,0.81]
25	0.065	[-0.59,0.91]	65	-0.023	[-0.84,0.90]
26	0.061	[-0.57,0.93]	66	-0.061	[-0.88,0.77]
27	0.044	[-0.66,0.89]	67	-0.050	[-0.86,0.80]
28	0.054	[-0.65,0.89]	68	-0.062	[-0.92,0.83]
29	0.025	[-0.65,0.80]	69	-0.062	[-0.93,0.75]
30	0.046	[-0.61,0.88]	70	-0.051	[-0.87,0.88]
31	0.048	[-0.62,0.86]	71	-0.044	[-0.89,0.80]
32	0.035	[-0.63,0.89]	72	-0.058	[-0.92,0.80]
33	0.033	[-0.63,0.87]	73	-0.057	[-0.85,0.72]
34	0.242	[-0.62,0.84]	74	-0.081	[-0.92,0.72]
35	0.043	[-0.68,0.91]	75	-0.077	[-0.94,0.71]
36	0.005	[-0.70,0.81]	76	-0.062	[-0.94,0.79]
37	0.014	[-0.66,0.82]	77	-0.084	[-0.92,0.80]
38	0.005	[-0.73,0.78]	78	-0.080	[-0.93,0.75]
39	0.010	[-0.66,0.83]	79	-0.105	[-0.95,0.77]
40	0.017	[-0.74,0.83]			

Posterior efficiency score results from Table 3a and 3b can be used to rank projects by making assumptions about inefficiency distributions. Since these posterior efficiency scores assume independence assumption, they can be used as a dependent variable in a regression with inputs as independent variables to identify impact of different variables on increasing or decreasing efficiency scores. Since there is no statistical difference in means between efficiency scores generated under two inefficiency distribution assumptions, original and posterior efficiency scores can be combined into an average ensemble score that provides a 3-group consensus efficiency score.

An ensemble efficiency score provides a solution to *total weight flexibility* problem identified by [10]. The total weight flexibility (TWF) problem arises in original efficiency scores because formulation using eq. (1) is solved for each project where each project is allowed to use a different set of optimal weights. One of the problems with TWF is that the projects are not compared to same standard and many (18 projects in our case) projects are deemed efficient. There are situations (see [24]) where it is necessary to declare only project or site as the most efficient project. An ensemble score may provide a solution to the TWF problem. When computed, ensemble scores are semi-parametric, semi-independent efficiency scores that have lower variability than original efficiency scores. Table 5 illustrates the ensemble scores and project ranks based on the ensemble score. Based on the ensemble score, project #2 is the most efficient project. Among the top 10 efficient projects, five projects (#2, #4, #11, #15, #17) had the lowest number of defects that were removed efficiently leading to low SQAE. In general, the teams working on these projects were familiar with the application. Boh et al. (2007) argue that the experience gained from working on the same system enables developers to gain familiarity with the application, which has a positive impact on productivity. Additionally, these projects had experienced team members who had previous experience working with one another on the same team, which may have improved productivity of developers.

Figure 5 illustrates a plot of all efficiency scores. From the Figure 5, it can be seen that all efficiency scores follow similar decreasing trend. Original efficiency scores show high degree of variability and posterior efficiency scores with exponential and half-normal inefficiency

distributions show low variability. The ensemble efficiency scores have higher variability than posterior efficiency score and lower variability than original efficiency scores.
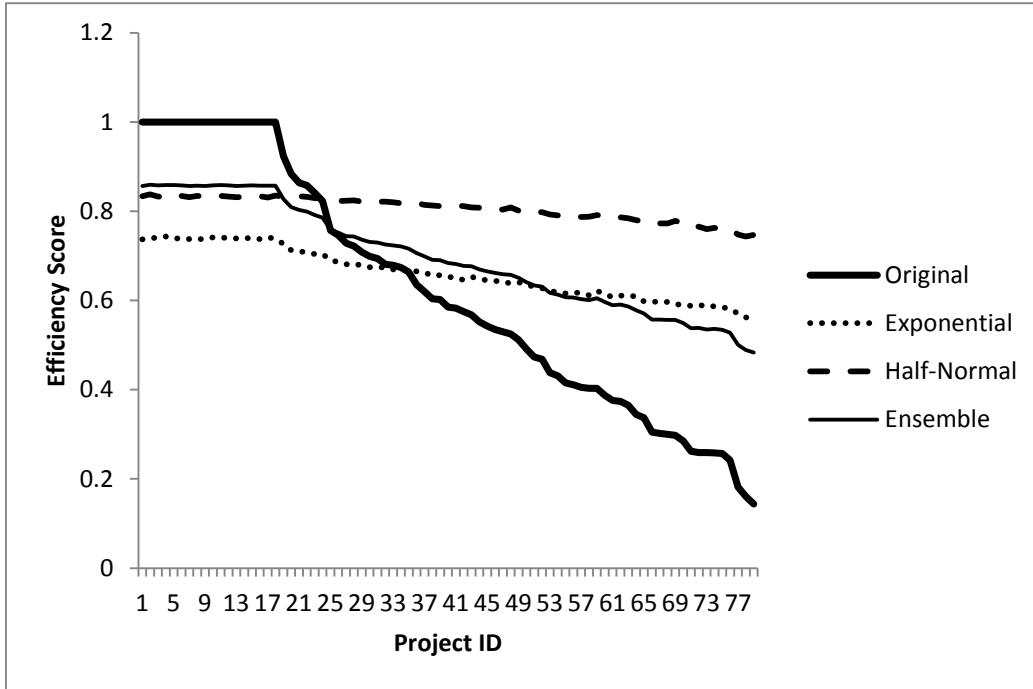
Figure 5: A Comparison of Different Efficiency Scores

Table 5: Ensemble Efficiency Score and Project Ranks

Project ID	Ensemble Eff.	Rank	Project ID	Ensemble Eff.	Rank
1	0.8568	17	41	0.6837	41
2	0.8593	1	42	0.6814	42
3	0.8577	8	43	0.6777	43
4	0.8585	3	44	0.6765	44
5	0.8586	2	45	0.6692	45
6	0.8580	6	46	0.6652	46
7	0.8564	18	47	0.6614	47
8	0.8572	13	48	0.6587	48
9	0.8568	15	49	0.6572	49
10	0.8579	7	50	0.6512	50
11	0.8584	4	51	0.6408	51
12	0.8576	9	52	0.6340	52
13	0.8568	16	53	0.6312	53
14	0.8572	12	54	0.6173	54
15	0.8582	5	55	0.6132	55
16	0.8571	14	56	0.6069	56
17	0.8576	10	57	0.6063	58
18	0.8575	11	58	0.6028	59
19	0.8275	19	59	0.6009	57
20	0.8094	20	60	0.6053	60
21	0.8025	21	61	0.5968	62
22	0.7991	22	62	0.5896	61
23	0.7914	23	63	0.5905	63
24	0.7857	24	64	0.5865	64
25	0.7585	25	65	0.5777	65
26	0.7517	26	66	0.5708	67
27	0.7443	27	67	0.5573	66
28	0.7431	28	68	0.5574	68
29	0.7359	29	69	0.5564	69
30	0.7311	30	70	0.5560	70
31	0.7300	31	71	0.5491	72
32	0.7254	32	72	0.5375	71
33	0.7230	33	73	0.5383	74
34	0.7214	34	74	0.5347	73
35	0.7158	35	75	0.5361	75
36	0.7062	36	76	0.5339	76
37	0.6993	37	77	0.5278	77
38	0.6907	38	78	0.5002	78
39	0.6901	39	79	0.4888	79
40	0.8568	40			

5. SUMMARY AND CONCLUSIONS

We proposed a Bayesian model to compute posterior values of DEA efficiency scores and C.I. on DEA efficiency scores by making assumptions about inefficiency score distributions. The posterior efficiency score values satisfy the independence assumption and may be used as a dependent variable in regression models to make inferences on the impact of input variables on software project efficiency. We have shown that posterior efficiency scores may solve the TWF problem and help identify the best software project that may serve as a model project.

We believe that our model is simple and can be easily extended to output maximizing DEA models. Our single dataset study shows that half-normal distribution assumption is more robust than exponential distribution of inefficiency scores. The result is not surprising because DEA inefficiency scores are heavily skewed towards the value of zero and half-normal distribution may provide a better fit for such values than exponential distribution. Since assumptions about distribution do appear to matter in our one dataset study, we believe that Bayesian approaches may be superior to bootstrapping approaches that do not make any distribution assumptions. Future research comparing Bayesian approaches to bootstrapping approaches may be a natural extension to our research.

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MANAGING THE HUMAN ELEMENT:
THE IMPACT OF A MERGER OR ACQUISITION

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ABSTRACT

Organizations that are acquired are done so with the intention of improving the economic position of the principals, yet, there are stakeholders who are negatively affected by a change in leadership due to a merger or an acquisition. How a company is assumed or acquired may have a positive impact on shareholders, but a negative impact on employees. The human aspect of mergers and acquisitions, and its impact on people and performance, is the focus of this paper. The authors will discuss the business related human behaviors such as management resistance, employee resistance, organizational transition, communication, and leadership's role.

Keywords: Mergers, Acquisitions, Human element.

INTRODUCTION

Organizations that are acquired are done so with the intention of improving the economic position of the principals, which can include entering a market, increasing market share, reducing competition, gaining talent or reducing startup time toward earning viable profit and a secured market presence [7]. Yet, there are stakeholders who are negatively affected by a change in leadership due to a merger or acquisition [3]. How a company is assumed or acquired may have a positive impact on shareholders, but a negative impact on employees. The opinions vary on whether a merger is desirable primarily because the financial benefits outweigh the costs [1]. The potential economic benefit of a merger or an acquisition, as well as the ease of combining organizations, may be overestimated [3]. The human aspect of mergers and acquisitions, and its impact on people and performance, is the focus of this research.

HUMAN ASPECTS AND IMPACTS

A target business includes the tangible and intangible assets of explicit employee knowledge and intellectual property, but also includes tacit knowledge, stored within the talents of the organization's employees [5]. An underestimation of the human element and employee knowledge is where missteps take place. Knowledge management research reflects the struggle in capturing and securing tacit knowledge [6]. A key employee may have knowledge that is

controlled by the company as a result of a contract or a non-compete agreement [2]. But, is the value of the key employee reduced if his or her cooperation has been compromised by a merger, acquisition or a hostile takeover [8]. If the loyalty of a critical mass of employees is shaken by the behaviors of new leadership, the value of the organization can be compromised. Acquisitions, or even a shift from being privately to publicly held, can change the leadership focus, moving the organizational mission away from the employees tightly held assumptions and beliefs and thereby damaging the intangible assets of the target business. Post-merger integration is essential, yet may focus solely on process, and not on the people. Poorly executed post merger integration has been cited as a cause for acquisitions ending up as divestitures within two years [3].

Corporate culture is a variable underlying the success or failure in a merger. Trust can be shaken, fear is created and security compromised when the culture shifts. Corporate culture is a pervasive influence on organizations and can increase or decrease the value of an organization, no different than other intangible assets, such as company reputation, customer loyalty, and analyst confidence. Trust, fear, and security therefore become relevant topics when researching the human element of a merger or acquisition. These human conditions are tightly tied to the influence of change upon the culture. Change management literature offers a context within which we can better understand employee fear, trust and security issues [4]. In brief there are psychological challenges that employees face related to the changes that occur when their source of security, their job, is acquired or is merged with another organization. This research will include discussion on the business related human behaviors such as management resistance, employee resistance, organizational transition, communication, and leadership's role.

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BABY ON BOARD: AN ETHNOGRAPHIC JOURNEY INTO NEW VENTURE FORMATION

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ABSTRACT

This paper describes a socially embedded approach to social entrepreneurship taken in response to recent critics who argue that the field, because of an undue focus on the traits of individuals, has paid insufficient attention to the social networks of individuals (Dacin, Dacin, & Tracey, 2011). We conducted a three-month ethnographic study of Opus, an infant social venture dedicated to saving printed books in a digital world where they are devalued and discarded. The founders of Opus hope to avoid the destruction of economic value by enabling people to freely take donated books that might have otherwise been thrown away. This also contributes to environmental sustainability by reducing strain on limited landfill space. In addition, Opus enhances the social fabric of the local community by creating culturally embedded relationships among printed book lovers. The birth of Opus sheds light on the visioning and development of social ventures united by a common purpose but with limited funds and other resources. Our findings may resonate with those who find themselves in similar situations or are contemplating such, and may help dispel some common myths about organization formation and planning.

INTRODUCTION

"There is no friend as loyal as a book."
– Ernest Hemingway

"I cannot live without books."
– Thomas Jefferson

In much of the management and marketing literatures, the unit of analysis is often the individual. The entrepreneurship literature has more or less followed this path, and a large body of insightful work has flourished under this agency perspective. McKay and Chung's (2005) discussion of benchmarking for entrepreneurial survival (and success) highlights the emphasis that has been placed on the individual – the entrepreneur – in question. Individual traits such as self-efficacy and locus of control have received much attention in the literature concerned with explaining entrepreneurial motivations in general (Shane, Locke & Collins, 2003), and personality traits such as openness and agreeableness have been found to positively influence social entrepreneurship in particular (Koe & Shamuganathan, 2010).

These studies draw attention to the critical role played by the entrepreneur with respect to entrepreneurial effectiveness. However, entrepreneurial endeavours cannot be fully understood without taking into account social forces. Consequently, an embedded social network perspective

offers an opportunity to build a more comprehensive understanding of entrepreneurial success (Dacin et al., 2011).

A SOCIALLY EMBEDDED APPROACH

Many researchers reject the notion that social behaviour is caused by an individual's attitudes and norms alone. Consequently, a strong research tradition has been established in the realm of network analysis, which emphasizes the effects of structural and social relationships on human behaviour (Emirbayer & Goodwin, 1994). Central to this social perspective is the idea that people become "embedded" in social relationships when they interact and form relationships with one another.

In fact, diverse studies, employing both quantitative and qualitative methods, conducted in different countries such as the UK, Sweden, Israel, Slovenia, Italy, Germany, Ghana, China and the US, have found that the social networks in which the entrepreneur is embedded has a tremendous impact on all phases of the entrepreneurial process, ranging from identification of an opportunity to emergence and growth (Van Ryzin, Grossman, DiPadova-Stocks, & Bergrud, 2009; Sharir & Lerner, 2005; Westlund & Gawell, 2012; Bagley & Ackerley, 2006; Bauernschuster, Falck & Heblich, 2010; Jack, 2005; Poon, Lianxi & Tsang-Sing, 2009; Slavec & Prodan, 2009; Cochrane, 2010; Pirolo & Presutti, 2010; Kuada, 2009). With respect to social entrepreneurship in particular, a large study using data from a U.S. online panel found that embeddedness in a social network was the single strongest predictor of success for a social entrepreneurship (Van Ryzin et al., 2009).

In this paper, we suggest that entrepreneurship studies would benefit greatly from taking a socially embedded approach. We report on an ethnographic study in which we take this approach, and provide an analysis of data gathered over a three-month period with respect to a social venture that we observed from inception to imminent launch.

METHOD

It is important to realize that people's understanding of their objective reality is subjective in nature, because they subjectively perceive and interpret their objective reality (Peter, 1992). Consequently, we used an ethnographic research method to get at the meaning of the social venture Opus from the perspective of its members. As Morgan (1983) notes, an open-ended, inductive approach is needed to "get inside the situation being studied and reconstruct it from the members' point of view." And as Belk, Wallendorf, and Sherry (1989) suggest, an ethnographic research approach leads to a deeper understanding of a phenomenon as it naturally exists, because its emergent design ultimately guides data collection and interpretation. Following Hill (1991), we shall first offer a thick description of the organization under study, and then discuss the interpretive themes that emerge from the analysis.

OPUS

Background

Opus (disguised name) is a social entrepreneurial venture that is being set up in southern Ontario. It uses as a role model a very successful operation that first began in the mid-Atlantic region of the United States over a decade ago. The US operation, *Save the Book* (disguised name), is a charitable organization established with a singular goal in mind – the preservation of books, specifically paper-based books. Over time, people accumulate numerous books in their collection, never giving

the growing mass of printed material a second thought. However, at some point in time, the bulky volumes need to be moved, such as when relocating or upon death. A common solution is to simply throw out the books, unless one fetches a decent price from a used-book dealer. Anyone who has ever tried to sell old books to bookshops can easily appreciate the moribund resale value of most used books. As a result, the local landfill often becomes a favoured destination. This is unfortunate, especially to book lovers and writers in general, since to many, the value of the printed word on a page is immeasurable. A little over ten years ago, an individual decided to do something about this, and *Save the Book* was founded. In time, his little start up became an important part of the cultural landscape of a substantial city in the mid-Atlantic region of the United States. Ten years on, *Save the Book* occupies several thousand square feet of warehouse space, and each day dozens of volunteers come in to help run the organization. Donated books are catalogued, cleaned, and shelved. Residents of the community come in to browse, and often take books (for free) that they find interesting. And the cycle perpetuates. In so doing, numerous books are spared a premature death, and numerous readers benefit from these books' second (or more) lease on life.

Save the Book inspired the organizers of *Opus*. Indeed, the work of organizations such as *Save the Book* probably resonates with many, especially those who have a fondness for physical books. With the advent of e-books, it is not uncommon to see books being published directly in electronic form. And almost every new book in print today is accompanied by an electronic version. In short, technology is changing the millennia-old process of reading. Yet, to many people, nothing compares with the sensory pleasure of reading an actual book, i.e., the smell and feel of an old text. Whatever the reason, many do not find e-books to their liking. Or as Fruhlinger writes in *The Wall Street Journal* (August 31, 2012), "handing a well worn, dog-eared book to a friend is a personal exchange. Sending a digital file? Not so much." Fruhlinger's sentiments are undoubtedly common, and one can surmise that there are those who flocked to e-books only to later find them wanting. Some may dislike them for privacy concerns, as Alter reports in *The Wall Street Journal* (July 19, 2012) in "Your e-book is reading you." Perhaps a good way to sum up the way book lovers view e-books and e-readers is found in Brezicki (2011), "If e-readers are reading, then e-reading is reading in the same way that Second Life is reality, in the same way that Epcot is nature and Wii is an Olympic sport."

At the time of this writing, the Ontario project – *Opus* – had grown from just an idea to something imminent. It had also grown in number, consisting now of a core group of four "founders" as well as a dozen or so others who have offered various forms of assistance to make *Opus* a reality. We intend to follow the project to fruition and possibly beyond, but the focus of this paper is the enterprise's creation stage.

This paper addresses only the initial stages of *Opus*' germination so to speak, and subsequent investigations will certainly yield more comprehensive data. However, we feel the birth of *Opus* itself is informative, and sheds light on the visioning and development of social ventures that come with limited (or nonexistent) funding and other resources, but united by a (sometimes) common purpose. Our findings may resonate with those who find themselves in similar situations, or are contemplating such. Furthermore, what we see from our observational data also dispels some common myths about organization formation and planning, and this is, in and of itself, valuable.

The Core

We begin with a brief description of the core group of people who are at the heart of *Opus*' formation. While we have tried to maintain the ethos of the enterprise, various details such as

names, gender, and operational details have been disguised to protect the privacy of the people concerned.

Mary, 55, has volunteered at *Save the Book* over the years, and as a lover of books, finds the enterprise to be a particularly worthwhile social project. Mary had a successful career in banking before deciding to stay home to rear her children. She continued to manage investment portfolios for a select group of clients for about ten years after her banking career. She is very active, engaging in various activities such as rock climbing, gardening, table tennis, home renovations, and of course, reading. She and her husband are empty nesters, as both their children have gone off to university in Canada. She describes herself as someone who "can never sit still for more than five minutes. There is always something more to do." During one of her visits to southern Ontario, she had a conversation with her son's former English teacher, Stephen (her son had gone to high school in Ontario).

Stephen, 65, has recently retired after 30 years of teaching. He is a serious writer and a Rhodes Scholar. He is also passionate about books. Indeed, one of his common refrains in the classroom is "Print is not dead." In his career, Stephen has written numerous articles on literature and education, and has organized various conferences on teaching, writing, and books. Prior to his retirement, he headed the English department of a prestigious private school in Canada. Divorced and without kids, he lives alone (with his cat) while working on his new novel. He is an avid runner (having completed several marathons and half-marathons) and golfer. Mary mentioned *Save the Book* to Stephen, and from that casual conversation, the stage was set for the development of a similar enterprise in southern Ontario.

Joyce, 30, teaches drama in the same school that Stephen used to teach in. She also runs the education technology department at the school. Known as a very dedicated teacher (and track team coach), she is also quite the activist. She organizes student activities in support of organizations like *Amnesty International*, and is closely connected with the school's community service regime of supporting local charities, etc. Her keen organizational skills and gung-ho attitude is widely acknowledged at the school. She also has a mentee/mentor relationship with Stephen, since he had taken her under his wings six years ago when she first joined the school. Stephen first suggested inviting Joyce into the fold, and she very quickly and gladly accepted.

Ann, 23, is a recent university graduate (majored in English) who is contemplating graduate school. She had Stephen as an English teacher, and thinks very highly of him. "A big fan," she remarks. She, too, loves books, and finds the possible demise of books worrisome. "I hate to see all these books being pulped," she says. Currently she does not live in the same city as Stephen and Joyce (she is actually some 120 kilometers away), which limits the extent that she can participate in *Opus* in its present form. However, while acknowledging the physical distance, she does not feel it is insurmountable, and adds, "I can envision one day *Opus* coming to Toronto (it having a population of millions) soon enough anyway. We may as well start thinking about that now." Ann also knows that Stephen has a strong network of writers and educators in Toronto, which makes Toronto an even more attractive eventual destination. To her, *Opus* "sounds like an exciting opportunity to contribute to the community."

Progress

The group began a dialogue in the middle of summer, culminating in three informal meetings by

August/September of 2012. These meetings and conversations had primarily served as venues where the participants exchanged ideas, and people then went away with the promise to "think through things" some more. This does not mean, however, that no action took place. Quite the contrary, because the participants separately and individually (and sometimes severally) undertook to investigate, explore, and network as they saw fit. And this "thinking through things" mandate turned out to be much more than a cognitive exercise, becoming rather behavioural in scope. While the observers recognized that such activities were going on during the latter part of July and into August, we did not know the extent of such activities until the group's first plenary meeting in early September. We report below what surfaced at that meeting.

Mary investigated legal requirements to establish a non-profit organization, and consulted with entities such as the *Foundation Center* (in the United States) as well as with charity and foundation lawyers about the legalistic issues of such. She also contacted the founder of Save the Book to learn more about his operations and the problems he had (and still has) with used booksellers. She also obtained some general idea as to the finances of such an operation, and has looked into grant-seeking activities that may help *Opus* down the road. Using her own connections, she reports that she can have access to the CEO of one of Canada's major book publishers, who may be willing to provide a supply of books to *Opus* once it is up and running. Meanwhile, she has been reaching out to potential volunteers (and possible donors) whom the group can call on.

Stephen reported on several church groups who are interested in serving as collection points for books from their members. He also noted that a college that serves the economically deprived regions of Northern Ontario is interested in participating, as a way to help its community secure books. Several writer groups he is connected with also expressed an interest in helping, both in terms of securing books as well as promoting and running *Opus*. However, the latter kind of involvement will likely not materialize until *Opus* is up and running in Toronto, since most of these people and groups operate there. He notes that there is a Lieutenant General's (the Queen's representative in Ontario) grant for supplying books to Northern Ontario, and that he will investigate it further.

Joyce had been busy as well, but doubly so as a new school year was beginning. She had looked into an educators' society (let's call it Phi Beta Alpha) whose members will likely want to participate. The group decided that this would be a very good partner to have. Joyce also alerted the group to using the school where she works as a resource and partner, since the school is very active in community activities, has lots of contacts in the area, and offers funds for such ventures. For instance, the local Member of Parliament has family members studying at the school, and the school has connections with former prime ministers and the like. She has also investigated a possible venue where *Opus* can initially operate out of, and reported to the group on the costs, etc. required. Low cost is of course key to *Opus*, both because of its lack of funding but more importantly, because the group believes that the whole point of *Opus* is to not be wasteful. Joyce also suggested that the group could work with the school to make *Opus*, at least the local chapter of it, a school-sanctioned activity for the students. As such, it would have access to the school's PR efforts, fund-raising activities from the school, volunteer support from students, etc. She indicated that she will be contacting the school's community service program coordinator to further explore this. She has also looked into working with the local Starbucks to get their financial support (often through the employees there donating their tips for a period of time). Lastly, she suggested that perhaps *Opus* could initially focus on certain kind of books, for example children's books, which may benefit from a more receptive audience.

Because of a job requirement, Ann was unable to attend the meeting. However, subsequent to the meeting, Ann had conversations with the other members, and in particular several telephone meetings with Mary. Through these conversations, an idea developed that Ann might contemplate a career move in *Opus*. Lacking any career-oriented employment, Ann has been doing some "soul-searching" as to what she wants out of life. Rather than working on jobs purely for a paycheck, she is keen to pursue something purposeful and meaningful to society. In one of her conversations with Mary, Ann thought it might be worth exploring the development of an *Opus* operation in Toronto, whether as part of or aside from the one in Nicholas, a town in southern Ontario. Ann's parents are well connected, and she feels that perhaps she should explore making use of these connections to build a non-profit organization based in Toronto. At the time of this writing, Ann had begun investigating such a possibility. Mary invited her to keep in contact with others in the core group, and promised to be an informational conduit when Ann is unable to attend meetings.

Status of Opus

At the time of this writing, the group decided to try out *Opus* in Nicholas, which accesses a population base of about 200,000. The group has identified key resources needed, where they may get these resources, and who would be contacting these sources. It was agreed upon that the school would be a great initial target for a partner, and that the group would approach government officials (e.g. the local MP, the mayor, etc.) to seek governmental help. The group also agreed to use the identified churches as collection points, and to look into the venue (a local enclosed market) that Joyce found as a temporary outlet for *Opus*. *Save the Book* will be contacted to get more information about starting *Opus*, and to see what lessons *Save the Book* can impart upon the group. Incorporation of the non-profit will also be initiated as well. The group also agreed that Toronto should be the next venue once the Nicholas operation is viable. At the same time, Ann will look into the feasibility of this parallel project.

Observations and Themes

A Common Cause. It is immediately obvious that the group is united by a common love of books of the physical kind. All four members of the core group express a strong affinity towards the printed page. The feel of paper and the sound that it makes as a page is turned provide pleasure quite apart from the eloquence of the beautifully crafted prose. Stephen said, "turning pages with my fingers reminds me that I am in a universe that still obeys the natural laws of narrative." As Queenan notes, physical copies of books "are sublimely visceral, emotionally evocative objects" and that some people engage "in an intense, lifelong love affair with books. Books that we can touch; books that we can smell; books that we can depend on (*The Wall Street Journal*, October 20 - 21, 2012)." Through their conversations, a recurring theme surfaces that the group shares the belief that e-books aren't real books, but merely a metaphor thereof. In addition, the group views the move towards digital books with a great regret that all the efforts that had previously been invested in producing physical books will simply be buried in landfills and be wasted and forgotten. This longing for physical books, and a desire to save what is already there, perhaps is the unifying force that brought these individuals together to form *Opus*. Thus, their relationships are 'culturally-embedded,' that is, characterized by shared collective understandings (Zukin & DiMaggio, 1990). Although a vision or a mission had never been formally stated or put on paper, the group members intuitively know what they are working towards. The absence of a documented vision statement in no way deters the group from their work. In fact, in none of the meetings and

conversations was the subject of a vision or a mission ever discussed. The group simply has no use for one.

Sense of Identity or Purpose. Coincidentally or not, many in the core group may well be engaging in the development of *Opus* in order to attain a sense of identity or purpose for themselves. Mary, for example, while very active in a myriad of activities, does not have a full-time occupation. In contrast to her earlier life as a senior banking officer, and her subsequent role as mother of school-aged kids, she no longer has an identity that defines her. She speaks of "searching for an identity," and often notes how people "see and treat me differently because I am just a housewife." Stephen, in a similar vein, was accustomed to a certain role and status as a teacher, department head, and active member of an academic community, but upon retirement no longer has a sense of purpose. He comments that his routine has changed completely, how time is not as consequential as it once was. He empathizes with a character in the TV program Downtown Abbey, a wealthy lady with no gainful employment, who said, "Excuse me, but what is a 'weekend'?" Ann, just finishing university, is in between roles, as she is now contemplating graduate school while working as a tutor. Her career does not yet define who she is. Perhaps the one anomaly is Joyce, who is fully employed in her job, and fully invested in it as well. Ostensibly she would have little need of identity definition, yet at the same time she is of the activism sort. *Opus* is another outlet for her to exercise her concern for the greater good. And certainly, teaching at a school with a tradition for substantive community service makes *Opus* a very attractive proposition for her as well.

We Are Who We Morph Into. As noted above, the group never developed (indeed they never even discussed) a vision or a mission. The whole project began more or less on a lark. Books? The group seemed to have asked simultaneously. Let's save them, they seemed to say. Notwithstanding this lack of a mission, the group moved forward, initially each in his/her understanding of the ultimate prize. At the September meeting, the group went back and forth on the scope that *Opus* would have in the beginning (only in small town Nicholas or in large city Toronto, for example), the status that *Opus* should enjoy (operating independently or under the wings of established charities, for instance), the channels of distribution they should employ (farmers' markets, mobile operations, church basements, and so on), funding issues (grants, donations, fees, yard sales, etc.), and a multitude of similar questions. Indeed, the group never quite established what *Opus* was supposed to be, or what it would look like in various conversations leading up to the September meeting. At the September meeting, Mary began talking about incorporating *Opus* as a charitable organization, while Joyce went along the lines of working under the auspices of the school. Stephen threw in the possibility of operating in conjunction with an outreach college for Northern Ontario. But the group filtered out options that were not immediately doable as the conversation went on, particularly in the September meeting. In the end, the conclusion (though never officially concluded) was to operate only in Nicholas in the beginning, to work with the school and local government, and so on. There was no grand plan, no deliberate strategy. In Mintzberg's (1987) words, the strategy "emerged."

Whose Baby Is It, Anyway? Even though *Opus* is about to launch, there has never been any discussion as to who should play what role. Even more interestingly, the group never had a conversation about leadership roles. Who will head up *Opus*, for example? A recurring sentiment that both Stephen and Mary voiced was, "this is not my baby." And when Stephen came up with ideas about *Opus*, he often qualified them by saying "this does not have to be my baby, you know." Mary indicated that she does not want to get entangled in the running or leading of *Opus*. She said, "I have a very short attention span. I am afraid I won't have the staying power. And besides, I'm not really a people person, and I don't particularly enjoy working with people at this point in my life." Mary sees her

role more as a "spark," and that Stephen would be the flame and Joyce would provide the fuel. She said this on two separate occasions, and it is interesting to note that neither Joyce nor Stephen said anything in response. Yet the reader should not get the impression that Joyce sees her role as subordinate to Stephen (or Mary, for that matter), as she was not hesitant to tell Stephen, "this is what you should do" during the September meeting. She was also the person who actually showed up with a checklist of things that needed to be done during that meeting. Ann, because she was not at the meeting, provided no data on any leadership capacity that she sees herself in. However, in her private meeting with Mary, she repeatedly noted that she just wants to "do her part." It seems that a leadership position is not on her radar screen. From our data, it appears that the real leader will either be Stephen or Joyce, though only time will tell as to what *Opus* will "morph" into.

The Ties That Bind. If a love of books unites the group in purpose, it is evident that social ties brought them together in the first place. And in this regard, Stephen is the central link. He taught Mary's son. That is how Mary came into contact with him. He taught Ann, hence her great willingness to participate as soon as she knew Stephen was involved. He mentored Joyce, and she was brought into the group at an early juncture at his initiative. And though he disavows any desire to be "in charge," he is also the one who in July and August initiated all sorts of conversations with members of the group on *Opus*, and he was the one who had spread the word beyond the town of Nicholas. In fact, he is beginning to work on a book, a collection of essays by well-known writers with a common theme about books and their significance to these writers. He wants to use the book as means to promote *Opus*. There is no money to be made in joining this start up. In fact, there is no gain but a lot of pain. Yet people have entered the core group willingly, and many others have expressed a desire to help out and volunteer as needed. And the common thread appears to be Stephen.

DISCUSSION

Our paper is a departure from the typical unit of analysis, where the individual entrepreneur is the central focus. Indeed, we propose that the phenomenon of entrepreneurship cannot be comprehensively studied without paying due attention to the interpersonal relationships that are a part of the human condition. In this respect, our paper contributes to the extant literature by highlighting the critical role that social forces play.

Although the field of social entrepreneurship lacks clear definitions and boundaries (Dacin et al., 2011; Smith & Stevens, 2010), most researchers agree that social ventures stem from a desire to fill an unmet social need, while commercial ventures create economic value (Light, 2008). *Opus* does not create economic value directly, but it avoids the destruction of economic value, in that books are re-read by others rather than thrown away. Moreover, it contributes to environmental sustainability by ensuring (admittedly, in a small way) that the needs of the current generation are met without infringing upon the needs of future generations: the amount of garbage in landfills does not increase due to discarded books. Further, *Opus* enhances the social fabric in the community by creating culturally embedded relationships among printed book lovers.

While *Opus* is still in its infancy (or more precisely, its embryonic stage), several factors may be considered in making predictions for its growth and survival. First, the fact that the core members of the group are not located physically close to each other might negatively affect the strength and frequency of interactions among them (Smith & Stevens, 2010). However, the distance between the northeastern United States (where Mary lives), Toronto (where Ann lives) and southern Ontario

(where *Opus* is located) is relatively short; thus, it can be predicted that the physical distance will not be an impediment to the continuation of their efforts.

Second, the culturally-embedded nature of the ties among the founders of *Opus* creates a kind of social capital defined by Gewirtz, Dickson, Power, Halpin, & Whitty (2005) as bonding capital, which consists of "dense, tight-knit, homogeneous social networks of family or friends who can provide practical, emotional and psychological support and a safety net in times of crisis" (p. 668). To sustain the venture in the future, it is critical that they form other kinds of social capital as well, i.e., bridging capital-- horizontal ties that serve as springboards to outside members and linking capital--vertical ties that would give them access to powerful people and institutions (Gewirtz et al., 2005).

Third, all of the founders are strongly embedded in their communities. For example, Joyce is involved in *Amnesty International* and her school's community activities while Mary volunteers with various nonprofit organizations. As we noted earlier, network embeddedness is a significant predictor of success for a social venture. Maintaining and cultivating these ties are likely to increase *Opus*' prospects for growth and survival. Moreover, some research suggests that the involvement of the beneficiaries of a social venture in the planning, organizing and delivery of the services provided by that venture can strengthen the social fabric of a community (Bagley & Ackerley, 2006). Thus, in the future, it is necessary for the beneficiaries of *Opus*' services, presumably, other book lovers, be involved in the management of *Opus* itself. This involvement might have a domino effect in terms of creating more culturally embedded relationships among book lovers in a community.

In the future, *Opus* would also benefit through exposures in venues such as the forums organized by the *Skoll Institute, Ashoka, the Aspen Institute* or *the Schwab Forum*. Sharing successful entrepreneurship stories through such venues ensures a more rapid diffusion of ideas and creation of similar social ventures in other communities. Eventually, such narratives and stories about successful entrepreneurship efforts create more social value by being recounted over and over again (Dacin et al., 2011). The fact that *Opus* got its inspiration from *Save the Books* is a case in point. Sharing this story further will strengthen the social fabric of the community around the love of books. Books of the physical kind.

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AN ANALYSIS OF ACADEMIC INTEGRITY TECHNIQUES USED IN ONLINE COURSES AT A SOUTHERN UNIVERSITY

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ABSTRACT

The trend of universities offering online courses is popular today. While students love the convenience that online courses offer, instructors are concerned with ensuring that academic integrity is maintained. Research suggests that students are using multiple ways to degrade the integrity of the course. While unethical methods have been used for years in traditional classes, it appears that online courses may be more susceptible to violations of academic integrity unless the instructor implements techniques to prevent these incidents from occurring. The purpose of this research was to analyze the academic integrity techniques used by instructors of online courses at a southern university.

Keywords: academic integrity techniques, online classes, cheating, unethical behavior

INTRODUCTION: THE CHALLENGES OF TEACHING ONLINE COURSES

Ask any instructor who has never taught an online course what their major concern would be if they were to teach one and they most likely would say "maintaining academic integrity of the course."   Another likely concern of these instructors would be the many different ways students can misrepresent themselves online. This can occur if the student enrolled has someone else take their exam or complete their assignments. In fact, this concern about academic dishonesty was so prevalent that the Federal government addressed this online issue in the Higher Education Opportunity Act of 2008 [12].

Changes affecting distance education are found in Title 1 and Title IV, part H of the act: "Recognition of Accrediting Agencies."   It states that accrediting agencies must require

institutions that offer distance education to have processes to establish that the student who registers is the same student who participates in and completes the work and gets the academic credit.   However, this act does not clearly address the problem of student cheating.   But concerns about the lack of face-to-face faculty-student interactions have forced online and distance education providers to continuously examine their programs and develop sophisticated approaches to ensure the academic integrity of their programs [4].

The problem of academic dishonesty

While there has been disagreement as to whether more academic dishonesty occurs in online classes compared to traditional classes, there is agreement that cheating on exams or assignments has always occurred, regardless of how the class is delivered [4] [5] [6] [10].

Some authors believe that our culture contributes to academic dishonesty.   Kitahara and Westfall [7] write about a growing problem in online courses in which students cheat on exams and assignments, then seek redress for wrongs against them when they are caught. "The McDonald's generation expects everything now and they don't want to work for it. They want it short and quick."   According to research Kitahara [7] has surveyed, up to 75 percent of students report engaging in some form of academic dishonesty.   Gomez [3] reported that many students view cheating as a victimless crime, and that students feel it's no big deal to cheat. McCabe [11, p. 304] reported that "graduate students in general are cheating at an alarming rate, and business school students are cheating even more than others."   According to Boehm et. al., [1, p. 10], academic dishonesty costs institutions administrative time, loss of integrity within the school, and student lack of respect for ethics and values.   Faculty members point to a failure of institutional leadership to establish integrity standards and practices across campus.

The purpose of this research was to investigate what instructors are doing to maintain academic integrity in online courses in a regional university in the south.   Different approaches and strategies will be discussed which could be used to deter academic dishonesty specifically when teaching online courses.

Boundaries of the research

An overview of techniques used by other universities to maintain academic integrity will be presented, but the primary research conducted will focus only on academic integrity techniques used by online instructors at Lamar University, a regional university located in southeast Texas. This paper will not discuss the reasons why students engage in unethical behavior, the methods that they use to cheat or misrepresent themselves, nor will it compare online cheating to traditional cheating in face-to-face classes. The paper will only focus on methods of preventing academic dishonesty and methods of maintaining academic integrity in online courses.

Data gathering methods used

Both primary and secondary research sources were used for this research. A letter explaining the survey was emailed to 120 instructors asking for their participation in this important research project. A link was contained in the letter indicating where the survey could be found and completed. The purpose of the survey was to find out what techniques, if any, these instructors

used when teaching their online courses. The survey consisted of 25 questions in close-ended format.   Approximately 25 percent of the instructors completed the survey.

Secondary research came from written and electronic sources. Any sources cited in the paper are listed at the end in the References section.

AN ANALYSIS OF STRATEGIES THAT CAN BE USED TO MAINTAIN ACADEMIC INTEGRITY IN ONLINE COURSES

There are several methods of providing security that will increase academic integrity in online courses [1] [3] [4] [5] [7] [8] [9] [10] [11] [15]. This paper will classify these methods as Prevention and Compliance Strategies.

PREVENTION STRATEGIES FOR ACADEMIC INTEGRITY

Use of multiple assessment techniques instead of major exams

Many online instructors use multi-faceted assessment strategies in place of major exams that are proctored [3]. These assessments are designed to be frequent, varied, and authentic to what is being taught. Instructors rely on interactive discussions, writing assignments, quizzes, capstone projects, group work, and online exams. These assessments are usually changed from semester to semester.

Greater reliance on written assignments and threaded discussions

Students can demonstrate knowledge of material through written assignments and interaction with the instructor via discussions. Instructors become familiar with students' writing styles through online discussions. The use of discussion boards allow students to share their ideas in a safe forum regardless of time and distance constraints.   Discussion boards may also contribute to the formation of a positive relationship between instructor and student, and research shows that students who believe they have this sort of relationship are less likely to engage in academic dishonesty [10].

Use of test banks and timed test delivery

Tests questions are randomly drawn from banks of questions, so each student gets a different set of questions. The sequence of questions are randomized, along with the answer choices for each question. Most exams are designed to be open-book, but once a student begins an exam, they have a limited amount of time to complete it, and usually have only one attempt. Some instructors design the exam to show only one question at a time [8].   The rationale for timing the exams or assignments would be that students who are knowledgeable about the material and have studied the prior concepts would be able to complete the exam/assignment in a reasonable amount of time, while those who were not knowledgeable would not have enough time to look up answers in the textbook or have someone not enrolled in the course complete the exam/assignment for them [14]. This eliminates much of the possible cheating that may occur during exam time.

Raising awareness among students about what constitutes appropriate and inappropriate academic behavior in an online course

Many cases of academic dishonesty arise from students' lack of awareness, such as when it is okay and not okay to collaborate on coursework. Many instructors now include in course syllabi a college's academic integrity statement and a link to campus policies; a description of academic dishonesty and information on the consequences for academic dishonesty; links to plagiarism information as well as acceptable sources, and descriptions of permissible and non-permissible collaboration. Some colleges even use an honor code approach where students discuss and agree upon honor codes for courses and the use of ethical decision-making case studies as a part of the curriculum.

COMPLIANCE STRATEGIES FOR ACADEMIC INTEGRITY

Plagiarism detection software and browser lockdowns

Plagiarism detection software, such as Turnitin.com, can be used for both written assignments and class discussion. The instructor can simply cut and paste a discussion board post or any written work into the software. Some instructors use browser lock-down software so the student cannot open additional screens during an exam [4]. A disadvantage of this is that the student could have another computer running, but experience has shown that if the student is not familiar with the material, it is very difficult to demonstrate the learning outcomes.

Experienced instructors know one key to recognizing cheating or plagiarism is to become familiar with a student's writing style. A paper or exam that is far above the student's usual ability level alerts the instructor to possible dishonesty [9]. More than 50 percent of the online instructors surveyed at Lamar University cited user dissatisfaction and lack of effectiveness (defined on the survey as "does not adequately monitor users or their behaviors") as potential problems for this security method. All of the instructors of online classes said they felt cost would not be a constraint with this method. In fact, almost 50 percent of the respondents used discussion sessions when teaching their online courses, although not for the purpose of detecting plagiarism. They used it primarily to start a dialogue with students on a specific topic of the course and to add a little more structure to the class.

Physical proctoring centers for exam delivery

If a course is designed to include major exams, then physical (human) proctoring may be appropriate and required. However, most online courses are not designed this way [4]. Physical proctoring in many ways defeats the purpose of distance learning and, for many students, it would be impractical for students to get to the proctored site. Instructors recognize this fact, and 83 percent of Lamar University's online instructors who completed the survey stated that they felt this method was not feasible because of the distance involved for many of the online students.

Remote proctoring devices

An example of this is found at Troy University where online students are required to purchase a monitoring device that connects to their computer and "watches" them take an exam [7]. It

requires periodic finger-print scanning, and turns on a microphone and 360-degree camera if noise or movement thresholds are reached. Students buy these devices for $150 through the online bookstore. The use of these devices is an expensive option for students, especially those taking only a single course, as well as for many institutions due to the associated costs of maintaining security for student biometric data. And this technique would place a heavy emphasis on testing, which could affect the richness of the learning environment.

Almost 90 percent of the Lamar instructors surveyed indicated that the primary problem would be the cost associated with purchasing the remote proctoring equipment. An additional hindrance to this option would be user dissatisfaction, as stated by 48 percent of all of the instructors who responded to the survey. Also, if a student had to move from one computer to another to complete the course material, the hardware would not be readily accessible.

Using a webcam is another form of remote proctoring. A webcam is a camera attached to the student's computer that can transmit video images in real time and can allow the instructors to monitor tests and communicate with the students. "Several online universities have been using webcams for some time now – with good results" [2]. According to the Director of Distance Learning at Lamar University, currently, the only hardware device used is the web cam, but only a few instructors require students to use it [12]. The reason more instructors at Lamar don't use webcams when offering their online classes is because of cost and privacy issues, according to more than 50 percent of the survey participants. Additionally, 40 percent of these participants also cited lack of effectiveness and user dissatisfaction as other problems with this device.

Western Governors University in Salt Lake City uses a different type of online proctoring. One of the most interesting aspects of WGU's online proctoring system (OLP) is its "keystrokes analytics," used as a biometric that ensures that the person taking the exam is the same throughout the exam, and that this person is the same as the one registered under that name for subsequent tests or assignments. "It turns out that typing is more unique than fingerprints" [10]. The OLP program measures the keystroke rhythms of a given user, creating a profile of that user's typing patterns.

Other student identity technologies

Large companies that provide data security for the banking industry have data mining systems that are being used in online courses. Students are asked multiple choice questions about their personal history, such as last street address, name of high school, or mother's maiden name. The student must answer the personal question in order to proceed with an assessment or assignment, and such questions may also appear randomly during an exam. Nearly two-thirds of the respondents at Lamar felt that the main problem with this method was lack of effectiveness, where the method does not successfully monitor users or their behavior. And 48 percent had concerns with reliability of the information from the source who was answering the questions.

Instructors in some universities require a pre-registration process so that students enrolled in online classes can be verified throughout the semester when audio, video or written information is exchanged between the student and instructor [7]. This verification would involve using hardware connected to each student's computer with the main purpose being used for monitoring and identification purposes. Some scanners can be connected to a campus network, capturing

data on a user from an initial interaction, then sending that data to a central database that runs the comparison, grants or denies access, and returns a red- or green-light message back to the scanner itself. This latter approach is used by institutions that wish to monitor which users are accessing a certain scanner. Biometric technology uses unique biological properties to identify individual users in a confined group. Since no two humans have the same handprints, fingerprints, or retinal impressions, these are the characteristics that best lend themselves to be used as identifiers [15].

Another method of verifying student identity is the fingerprint scanner. Students who are enrolled in online classes may pay other students to take their classes for them. The fingerprint scanners would require the pre-registered students to validate their identities by scanning their fingerprints on the scanners upon sign-in and/or at random intervals [6]. Of those instructors who participated in the survey, 91 percent cited cost as the main problem associated with this hardware. Conversely, 4 percent considered this equipment to have too many disadvantages associated with it due to possibly being incompatible with other technology and techniques.

Another way to verify student identity is by using microphones. "…many programs are now available for recording and transmitting audio. Students in an online course can be required to complete all or part of an exam or assessment orally and then send the file in some manner to the instructor" [9]. While 40 percent of survey participants felt that this would not be an effective way to communicate, the number was slightly higher for instructors who cited user dissatisfaction as the most common disadvantage with this communication method. User dissatisfaction was defined as "not a method students or instructors feel is convenient, comfortable, or useful."

The last technique discussed for verifying student identity is the retinal scanner, which is a device that uses a low-intensity light ray to scan the iris in the eye [15]. That scan would be used to identify the students upon logging in to the online class so the instructor would be certain the students participating in the class are who they are supposed to be, based on the information gathered during the pre-registration process. Since there is no way to reproduce a human eye with technology, this method would undoubtedly be one of the best at providing security, but the cost, according to 87 percent of the survey participants, would far outweigh the benefits that would be realized by this technology.

In summary, all of these methods would deter academic dishonesty and would probably be used more than they are now, if not for the cost involved. However, some techniques don't cost anything to use (i.e. multiple assessment techniques, discussion boards, and timing the test). The webcam was the only technique used by a small number of instructors at Lamar University. In reality, most students enrolled in online courses do not come to campus to take exams or submit projects where one set of monitoring devices is used. Therefore, if the students enrolled in these classes are scattered around the world, it would not be feasible to require that each student purchase a combination of these devices in order to maintain integrity of an online course.

CONCLUSIONS

It is important to note that even if an institution implements all of the techniques mentioned in this paper, a student who is determined to cheat will still probably find a way to do so. Of the

online instructors surveyed, more than 60 percent felt that academic dishonesty and unethical practices were not more prevalent in online classes than in traditional clases. Little research has been conducted to compare the cheating behaviors of on-campus and online students. However, the Lamar instructors who were surveyed saw no difference between the two delivery styles concerning academic dishonesty: students who were inclined to cheat would do so, regardless of the delivery style (face-to-face or online). However, 71 percent of the respondents agreed that the way the exams and assignments were designed (and if they were timed), could deter much of the dishonest behavior of students enrolled in online courses.

Currently, online instructors at Lamar University are using few techniques to maintain academic integrity. The findings revealed that 64 percent of Lamar University's online faculty is not using any of the techniques mentioned in this paper, other than some course management features found in Blackboard (timed exams) and some instructors requiring the use of a web cam. However, several of the methods mentioned in this paper improve communication between the students and instructors, which helps to increase student satisfaction taking online courses. As pointed out, many techniques are available for improving academic integrity in online courses; however, various factors deter their use, such as cost or inconvenience.

FINAL RECOMMENDATIONS

Several recommendations are proposed to promote academic integrity in online courses:

1. Make information about academic integrity easy to find for both face-to-face and online students. This information could be found on the university's web site, course website, on the syllabus, and within assignment specifics.

2. Make use of discussion boards in every online course. Ask students to reflect on the academic integrity policy and how it relates to education in a discussion board assignment.

3. Compare student writing on the discussion board with that on assignments; a writing sample collected at the beginning of the semester can be helpful.

4. Use a plagiarism detection service.

5. Give each student a different version of the exam. Change exam questions each semester.

6. Time all exams.

7. Lock down the student's browser during testing.

8. Use proctored test sites where appropriate.

9. If feasible, require the use of web cams in online courses. The cost is not prohibitive for using them and academic integrity would definitely be improved with the use of these devices.

Online instructors should work diligently to maintain a quality educational environment, despite the challenges presented in teaching online classes. The goal for any university should be to provide the best quality education to a growing number of students who want to take their classes online. Employers want to hire graduates who are knowledgeable, ethical, and honest. If there are few integrity techniques used in online classes, will graduates meet employer expectations?

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GENERATIONAL EFFECTS ON RECRUITMENT AND WORKPLACE PRODUCTIVITY

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ABSTRACT

The purpose behind this study is to analyze the current workforce, and depict generational differences within organizations. This is the first time in the history that the workforce has four generations represented who are working and competing against each other for similar positions. Collectively, their birth years span 1922-1989. With such a wide range, the characteristics possessed by those present in the workforce are largely different. These differences are exhibited through experience, education, perspectives, and overall work ethic. The study is meant to gain an understanding into generational effects on recruitment and the main focus of employers when screening potential employees.

INTRODUCTION

When it comes to recruiting prospective job candidates, each organization has its own process. Over time, the techniques used to recruit individuals have changed and developed to ensure that a company is able to target exactly the type of person needed to fill any vacant spots. Recruitment of talented and well-fit individuals is a main priority of most organizations due to the vast benefit that it provides for those already working for the firm. Failure to recruit the right individuals is detrimental to the overall success of the organization,

Since four generations are present in the workforce today, the recruitment process can no longer be one-size-fits-all. In fact, the range of age groups present today presents a challenge for most Human Resource departments, as they now must focus efforts on creating multiple plans to garner interest in open positions.

Organizational change is also occurring in the area of expectations for workplace productivity and approach to work. The model of bringing in new employees who come in as a blank slate and learn from experienced employees is not as desirable as companies attempt to make the most of their human resources in lean economic times.

Four generations working together simultaneously is a recent occurrence. It is an issue of concern because each generation has different attributes, skills, and attitudes that they are bringing to the workplace. Older generations are finding themselves competing against the younger generations who are bringing technology and change to the workplace, while the

younger generations are finding themselves competing with the older generations who have more applied knowledge and investment within a field. Managers are also finding that techniques that have worked in the past to effectively lead their employees are no longer successful as the younger generations begin to enter the workforce. Through research like this study, leaders in organizations can learn more about the different generations, how they are viewed by one another and how best to lead them in today's competitive environment.

IMPACT OF GENERATIONAL MEMBERSHIP   ON WORKPLACE EXPECTATIONS

As noted earlier, each of the four generations varies in terms of its experiences, attitudes, and workplace behaviors. The following paragraphs provide a description of these characteristics.

The first generation is the Veterans who make up the oldest group of employees and can be classified as anyone born between the years 1922-1943. These individuals lived through the Great Depression and survived World War II, events which greatly impacted who they are [1]. They value dedication, duty, loyalty, and conformity [7]. Family and community are very important to this generation and they look to money as their livelihood; or the basis of their success [5]. They make up about ten percent of the U.S. workforce [6].While this generation only makes up a small percentage of the workforce; they still play an important role because they have the most work experience, which gives them important applied knowledge, high work standards, and authority in the workplace [7]. They believe in the importance of corporate seniority and paying your dues in the workplace to gain respect [1]. They have strong interpersonal skills [5]. They also work well in teams where there is a leader to direct them in the task [3].

The second generation is the Baby Boomers. The members of this generation were born between the years 1942-1960. Unlike the Veterans, the Baby Boomers believe that the rules are meant to be challenged and changed. Because of the environment in which they were raised, they tend to be self-sufficient and individualistic [3].They value hard work, material wealth, recognition, and self-realization [1]. Baby Boomers make up about forty- six percent of the U.S. workforce [6]. Because they account for the largest segment of the population currently employed, they have a significant impact on the workplace. They have a "live to work" mentality resulting in a strong work ethic [7]. While highly competitive, when it comes to working with others in the workplace, Baby Boomers excel in teams and they prefer to make decisions based on consensus [7]. Although they are good team members, they expect to be recognized for their work and paid well for their efforts [4].

The third generation is the Gen Xers. The members of this generation were born between 1960-1980. The Gen Xers were shaped by drug-plagued and trying times of political and social upheaval [1]. They value family, quality of life, and are fiscally conservative. This generation tends to be pessimistic, pragmatic, and self-reliant [4]. They are able to readily adapt to change and would prefer to find their own way of doing things [7]. Gen Xers, make up about twenty nine percent of the U.S. workforce [6]. Unlike the Baby Boomer generation, they have a "work to live" mentality [3] and would rather invest in personal development than in company development [1] therefore, they work for a paycheck, and have very low company loyalty. They are competent and straightforward and work very well with multitasking [5].Gen Xers do not

like structure and they prefer to accomplish goals on their own terms, and in their own way, making them poor team players.

The fourth generation is the Millennials who were born between 1980-2000. This generation is tech-savvy [1] intellectually curious and confident, but give the impression of having a sense of entitlement [7]. They have optimistic attitudes, high expectations, and close ties with their families. They are idealistic and value and expect change and innovation [4]. Millennials make up about fifteen percent of the U.S. workforce [6]. As the most recent additions to the workplace, this generation is better educated, more tech-savvy, and more creative than the other generations of workers [1]. The Millennials are great at multitasking and can effectively complete multiple projects at once [7]. They enjoy working in teams and perform best when they have supervision and a structured environment [3]. Along with the Gen Xers, the Millennials also have a low sense of company loyalty. Instead, they place a high value on individuality and are motivated by time off from work [5].

EFFECTS OF GENERATIONAL DIFFERENCES ON RECRUITMENT

Due to these significant generational differences, the challenge to modify recruitment plans for an organization has become a daunting task. In order for a recruiter to find the best candidate he/she must be willing to create a plan that meets the expectations of all generations in the workforce [2]. One of the biggest differences that exist among individuals due to generational membership is the venues in which these individuals prefer to find information regarding employment opportunities.

For those Baby Boomers fortunate enough to attend and graduate from college, their four-year degree provided a marketable tool in the employment application. They were able to rely on this degree to further their career, and secure suitable employment. When it came to recruiting, companies utilized what is now seen as an outdated technique - published advertisements in print media such as newspapers. As occurred for Veterans as well, clear descriptions of the position were provided as were the desired qualities for a candidate; those applicants who felt they fit such descriptions would apply and interview for the position.

Similar to the process for Baby Boomer and Veterans generations, recruitment for GenXers also came in the simple form of print advertising; however, due to this generation's working knowledge of technology, it became clear that these individuals would be able to use online resources as opposed to just print media. This precipitated a shift from the traditional process of using printed want-ads, towards a combination of print and internet based job databases [4]. While these individuals were still able to rely on their basic college education to make them marketable and competitive, companies still used their own strategies to recruit them. To attract this generation, companies focused on promoting flexible work policies, a schedule that allowed for a balance between work and home life, and further learning opportunities [2]. Potential candidates would be provided with the job description and desired qualities then apply and interview. These individuals were still able to rely on their basic college education, however, to make them marketable and competitive.

For Millennials, the recruitment process has changed dramatically. Today, organizations use numerous online job databases such as Monster, Indeed, and USAjobs which have proven to be

effective in providing public access to job opportunities. Although access has improved, these individuals are also facing higher standards for recruitment than ever before. A four year college degree is no longer the key to success in job placement. The increased competition for employment, a result of high unemployment, has allowed organizations to set higher standards for the candidates they seek. For example, a job that was once held by a graduate of a four-year college now requires a minimum of a Master's degree; one to two years of experience have increased to five or six.

Therefore, major differences apply to the general process of seeking employment These components do vary based on generational differences, and will be examined during the results phase of this study. The literature suggests the following research questions:

Research Question 1 – Is the job seeking experience different according to generational membership?
Research Question 2 – How is the experience of working with members of other generations perceived?

METHODOLOGY

In order to obtain necessary data for this study, we developed a comprehensive survey consisting of several open-ended questions that allowed respondents to convey their own experiences more fully. We sought to collect data from a wide variety of participants including a range of ages and employment sectors. To recruit these participants, surveys where distributed both in person and via email at a University and in the surrounding community. Subjects were recruited using a snowball sampling method. The survey instrument was approved by the Human Subjects Review Board of the institution.

RESULTS

There were 97 respondents, with a minimum age of 18 and a maximum of 76. The mean age was 37. Generational membership was as follows: 49 percent were members of the Millennial generation, 21 percent were Generation Xers, and 31 percent were Baby Boomers. We were unable to attain any responses from the Veteran generation. The sample was closely split between college educated (44%) and non-college educated (56%) individuals. Most (88%) were employed. Due to the lack of sufficient respondents in each category, generational comparisons could not be made using statistical methods.

Research Question 1 sought to examine recruitment methods. Respondents became aware of the vacancy in their current position in a variety of methods as noted in Table 1 below.

TABLE 1

Methods of advertising for job openings

Method	Percent
Online job bank (i.e. Monster, Indeed, etc.)	13%
Social media	7%
Job Fair	3%
Newspaper	11%
Personal networking	56%

The majority (86%) completed an interview process. During this process, the focus of the interview was primarily on prior work experience (70%), and then evenly divided between involvement outside of academics and classes at 15 percent each. Most candidates (74%) were asked to send a resume prior to the interview. Very few, 8 percent, encountered a use of social media during the recruitment process.

Research Question 2 inquired about the nature of the workplace and the perceptions of the generational mix in the workplace. Most respondents, 84 percent, work with people from a mix of generations. Many, 41 percent, work with Veterans, 65% work with Gen Xers, 53% work with Millennials, and most, 70 percent, work with Baby Boomers (responses could include multiple generations). Most individuals, 86 percent, indicated that they found it helpful to work with members of other generations, a few (7%) felt there was no difference, and 7 percent found that it was not helpful. Although quantitative analytical methods could not be used due to the low response rate per generation, some general observations could be made from the qualitative as well as quantitative data.

An examination of the data collected from the Baby Boomer generation shows that the majority of this generation are college graduates and are currently employed. On average, they have worked at their current place of employment for fifteen years. Personal networking is very important to them as this is how a majority of the participants became aware of their current position. When going through the hiring process, almost all of the participants interviewed with the director of their specific department. They were asked to send a resume before meeting for the interview. During their interviews, the interviewer focused mainly on past work experiences in a specific field. As a result, participants felt that their past work experience was the main qualification they met to obtain the position. Another area of focus in in this study was workplace culture and productivity. When comparing themselves to other members in their workplace, the Baby Boomer generation were aware of being older than most of the other employees with whom they work. This age difference did not have a negative effect on them as a majority of Baby Boomers felt they were more productive than the other members of their workplace. They did not consider technology to be a distraction for them and estimated their average usage time to be two to four hours, with 80 percent being work related. The greatest advantage they felt that they had over the other members of their workforce was their long work history. These individuals find themselves working with a mix of individuals from Veterans to Millennials. A majority of participants found this mix to be beneficial to the workplace. Not only did they feel it brought a good variety to the workplace, it also allowed people to learn from one another. They also recognized, however, that the mix of generations brought difficulties as well,

mainly in the differing work ethics the lack of experience among the younger generations. Overall, respondents from the Baby Boomer generation indicated that their workplace was changing for the better as younger generations were entering the workplace.

A review of the responses received from individuals who fall under the generational category of Generation X yielded similar information to that which was collected from members of the Baby Boomer generation. It is important to remember, however, that the age differences and the environments in which these generations were raised differ drastically. All Generation X respondents were college graduates, all were currently employed, and their current employment has lasted an average of 10-15 years. This result contradicts the popular perception that members of this generation are not concerned about job security. When asked how they became aware of their current position, there was an overwhelming response indicating the use of personal networking. In fact, social media did not play a role in the employment seeking process for any of them. The job seeking experience for this generation with regard to their current employment was similar to that of Baby Boomers. A majority of all respondents were required to go through an interview process with a hiring manager or department head. Of those who completed an interview process, the majority, 78 percent, were required to submit a resume prior to the interview. In the interview, the focus of discussion was on previous experience as opposed to education. There was a difference compared to the results received from Millennials, however. Whereas Gen Xers were asked about their previous employment experience, Millennials were more often asked about their education, which could be the result of their new entry into the workforce. Responses to the questions regarding perceptions about the presence of multiple generations in the workforce appeared to reveal the most differences. Generations X individuals stated that more than 84% of them work in organizations where all four generations are present and, like the Baby Boomers, they view this diversity as a benefit to the organization. To them, the greatest benefit is the breadth of knowledge present; specifically, the various levels of intellect and education that exist among all members of the organization's workforce, which aids the company and its employees. Their biggest concern about the current work environment is the difference of opinions regarding work ethic. Regarding technology's effect on their productivity, Gen Xers utilize these resources for a minimum of 4 hours daily; with about 90% of that time being dedicated to work.

A summary of the data collected from individuals from the Millennial generation shows that a majority of this generation have not completed their college degree, but have been employed on either a full- or part-time basis. The majority of them have been employed for an average of one to two years. While personal networking was important to this generation, it was not the only way they became aware of their current positions. Online job banks, such as Monster and Indeed, were also very important resources for learning of employment opportunities. Regarding the hiring process, a large number of participants went through an interview conducted by the head of or a manager of a specific department. Prior to this interview, if a copy of their resume was required, the participants were asked to send it in prior to their interview. Their interviews where focused on their experiences in college, involvement on campus and their internships with other companies. These respondents felt that having obtained these experiences throughout their college career were what made them feel most qualified for the position.

With regard to the questions on workplace culture and productivity, when comparing themselves to the other workers in their organization, Millennials indicated an awareness of being younger and much more technology savvy. Despite their youth, they considered themselves more productive than workers from other generations. Although they used technology more than the other generations surveyed, they did not feel it took away from their workplace productivity. On average, technology was used five to six hours a day, with 80% percent of this time devoted to work related issues. The greatest advantage that these participants felt that they had over their fellow employees was their college experience.

When responding with their perception of the generational mix in the workplace, Millennials reported that they work with all generations, and as did those from the other generations, they felt that this mix within the workplace was beneficial. Other generational members bring different experiences, perspectives, and knowledge to the workplace that they could use to help develop their own skills in the workplace. The difficulties that they experienced were from differences of opinion regarding how things should be done and the lack of experience with technology among the older generations.

CONCLUSIONS AND RECOMMENDATIONS

After a final review of the results yielded from the study, it is apparent that despite some variations in responses that can be attributed to generational membership, there seemed to be no major differences with regard to recruitment and workplace productivity. However, some differences could be observed. One of the major differences yielded by the survey results was seen in the type of experience focused on by the employer. For the older generations, the Baby Boomers and the older Generation Xers, potential employers focused on prior work experience. For the younger generations, the Millennials, future employers focused on their experiences and involvement in school. Hiring individuals who achieved direct job experience while in school yields more productivity and costs less for the employer. There is also the alternative explanation that new hires that are directly from undergraduate school usually have less job experience; therefore, the interview process must focus on educational experience.

With regard to workplace productivity, the results yielded another difference that should be examined. The experiences within a multigenerational workplace have prompted individuals to reevaluate the efficiency of their job performance and how it may be affected by the presence of individuals from other generations. While a majority of respondents cited the beneficial effects, the results revealed that those who did list negative effects were primarily older members of the Baby Boomer generation and younger members of the Millennials. For the elder respondents, the major problem they found was the lack of understanding of the overall work ethic and lack of enthusiasm among younger workers. Younger respondents cited the major problem as being the lack of technological knowledge that they felt hindered the overall progress of the organization. This generation also reported that they had a hard time connecting with the older generation on a social level; this due to an obvious difference in life experience. In addition, due to their places in the human lifecycle, they lack common day-to-day interests.

In conclusion, our summative analysis of the generations currently in the workforce did not yield any major or dramatic differences among the groups present in the workforce today. Our small

respondent pool limited our findings in this regard. The differences that were revealed from our respondents were primarily in the areas of recruitment and the experiences of functioning in a multigenerational workplace. Ultimately, however, it is clear having completed this study, that not only is recruitment similar, but individual characteristics are remarkably similar among generations when it comes to workplace expectations and perceptions, despite the vast differences in life experiences among them. It appears that the multigenerational workforce has the potential to harness a wide variety of skills and knowledge to achieve organizational success. Employers would do well to stress generational similarities among workers to promote effective use of this skill and knowledge.

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THE EFFECTS OF SOCIAL MEDIA IN TODAY'S WORKPLACE

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ABSTRACT

This study examined the use of social media at work. Undergraduate students and professors were surveyed about their use of sites such as Facebook while working. We also examined the effects of Facebook postings outside of work could jeopardize a position at work. The results from our survey and research concluded that social media is an increasing problem but that there is a growing expectation that monitoring of social media communications by employees will occur.

Keywords: social media, employee monitoring

INTRODUCTION

Today we cannot go about our everyday lives without encountering some form of social media. The popularity of social media has grown as a result of the rapid changes in technology as computers are now more mobile and can be used virtually anywhere. Companies are increasingly using social media as a new way to reach customers more effectively and to spread news of their activities more rapidly. The ubiquitous use of social media has also brought new challenges to today's workplace. One of these is the apparent addiction that the Millennial generation has to Facebook and other social media applications like Twitter and Instagram.

In this research project, we examined increasing social media use and its intersection with workplace activities, with a particular focus on the Millennial generation. The use of email and the internet have become more commonplace in organizations and many have enacted policies regarding their use/misuse at work. The use of social media during work hours, particularly when accessed via a personal cell phone, brings a new set of challenges to employers.

There are advantages to be gained by using social media – for both prospective employees as well as employers. For example, new college graduates searching for work increasingly use sites such as LinkedIn to find potential employers, employers are utilizing social media to open their hiring pool to new applicants in new regions. One of the benefits of LinkedIn is the improved ability to find jobs anywhere in the country and in the world. On the downside, it makes the application process more competitive and adds new hurdles to the hiring process.

SOCIAL MEDIA USE BY ORGANIZATIONS

Social media can be considered a tremendous resource to the business world. For example, it has been credited with helping employees think outside the box [14]. Research has shown that employees who utilize social media are nine percent more productive in the workplace [3]. Sites such as Pintrest (a site where the user can "pin" the things he/she likes in a particular category to create a "board" to group them all together, for example, future wedding ideas) and Instagram (a site dedicated to taking pictures and allowing them to tell an entire story) allow members to instantly see the creative works of a friend and can help the user to brainstorm new ideas. These sites are a valuable resource that can really help spark new and exciting ideas for work.

Social media is not only helping employees become more productive; it is allowing them to stay current with market trends and issues important to consumers as well as the general public. By staying informed in these areas, employees are also better prepared to troubleshoot potential setbacks and are more likely to create good public relations through the work they are doing. By identifying the trends, they can then tailor their own work to incorporate them, providing consumers with the sense that they are buying from a company who is diligent in staying current.

Currently, about seventy percent of organizations around the world use social media [6]. Studies have found that firms that incorporate social media as a part of their business operations are most likely to grow faster than the companies who have not yet used it [6]. The key benefit to social media is that it is free. There is no cost to using these sites, other than the cost of the employee's time to update the company's site.

Social media is also amazing beneficial marketing tool and, if used properly, can boost a company's image and popularity. There are more than 140 million users of Twitter and more than 1 billion users of Facebook (600 million of whom access it through smart phones) [10]. It has been shown that consumers are more willing to buy when they have received consumer reviews and/or recommendations from friends/family; social media helps companies to take advantage of this phenomenon [11].

Employers can capitalize on this new market by having employees create company-related events and make positive statements on social media sites about the company's activities. By encouraging employees to utilize social media, an organization is not only marketing to a larger audience, but doing it in a way that is trusted and valued more than any other sort of advertisement [2]. These sites are not to be taken lightly; there has been a significant power shift in favor of the consumer, as stated by Jonny Spindler (Innovations Director at Abbott Meade Vickers BBDO).

SOCIAL MEDIA USE BY EMPLOYEES AT WORK

As more new and existing employees join social media networks it is apparent that, in general, organizations are still adjusting to and evaluating what they perceive to be the positive and negative aspects of social media. Some industries are further along in their understanding of the place of social media at work. For example, in the construction trades, there are concerns for safety [8].

During a discussion with a local union pipe fitter, he explained that the union has already taken a stance against social media use during work hours because it introduces variables that put workers' safety in jeopardy. He also stated that this new policy is an extension of the policy they have for cell phones on the job site (Personal communication, October 10, 2012).

Other industries are encountering different issues with social media use and have implemented policies that affect employee morale, rather than safety. KPMG International found that companies have become more open to the idea of allowing social media at the office and that there are greater costs to the organization for not adapting [6]. For example, one study found that employees are much happier with their employers when social media usage is allowed at work [6].

Social media can also help to establish strong bonds among workers by providing them with the ability to better understand those with whom they are working. This social connection could then help improve the working relationship. The improvement could include gaining a better understanding of what motivates the people around them, as well as allowing them to share what motivates them [5]. Having a better understanding of other employees is also important to creating a comfortable social environment at the workplace. Employees need to feel that the office can also be a social and fun environment [9]. If relationships are what drive a happy workplace, and increase job satisfaction, it is likely that companies may start to value the use of social media by employees. It is not out of the question that certain jobs may eventually require a certain number of "Friends" as a prerequisite so that companies may see just how social and welcoming the potential employee may be [9]. And it is not only employees who are beginning to benefit from the implementation of social media, studies have shown that the software needed to sustain these sites is growing into a booming business, and companies are more than willing to purchase the necessary software (Fraser, 2012). Recent data from Forrester Research indicates that the sales of software used to run corporate social networks will grow 61 per cent a year and will likely become a $6.4 billion business by the year 2016," [1][4].

One major concern that has arisen with regard to the relationship between employees' social media presence and their employers and that is invasion of privacy. An employer may claim that what is posted online is not private, but public information. As a result, employees' lives outside work are under scrutiny more than ever because of easy access to what they may post on the Internet. The lack of privacy on social media sites also presents a threat to employees who use that forum to discuss their jobs. Employees who are careless about comments they make regarding the firms risk losing their jobs. For example, this past summer a designer at Nike was in trouble because he insulted Derrick Rose for not wearing Nike gear [7].This statement effectively ended future deals that Nike could have made with Derrick Rose that could have been valued in millions of dollars [7].

Another issue in the workplace related to social media use is its effect on productivity. According to Pavlina, social media use has a negative effect [13]. He calculates productivity using the equation: Productivity = Value / Time. Productivity can be increased by increasing value and decreasing time required to create that value. Social media however, adds time and takes away value. In 2009, a study found that in the U.K employees spend an average of 40 minutes per day on social media sites, or the equivalent of one whole week a year on social

media [12]. The study also found 57 percent of employees surveyed at 1460 offices used the sites for personal use while at work. The total time used cost the firms more than $2.25 billion.

RESEARCH QUESTIONS

From reviewing the recent information regarding the use of social media by employees, we have developed the following research questions:

Research Question 1 – Do more individuals consider the use of social media at work to be a distraction or provide a boost to productivity?

Research Question 2 – Should employers discipline employees for material they post on their social media profiles?

METHODOLOGY

This study used a survey distributed via email and paper. It was approved by the Human Subjects Review Board of the organization. Respondents were solicited through snowball sampling.

RESULTS

There were a total of 115 responses, virtually all students. The gender breakdown was roughly equal with 52 percent male and 48 percent female. . The vast majority, 94 percent, use social media. Total weekly use of social media was reported as total hours per week. Responses were broken down as follows:

- 1 to 3 hours -   39%
- 4 to 7 hours - 36%
- 8 or more hours - 25%

For our first Research Question, we asked a series of questions regarding use of social media behaviors and their impact on work. Responses are in Figure 1 below:

FIGURE 1
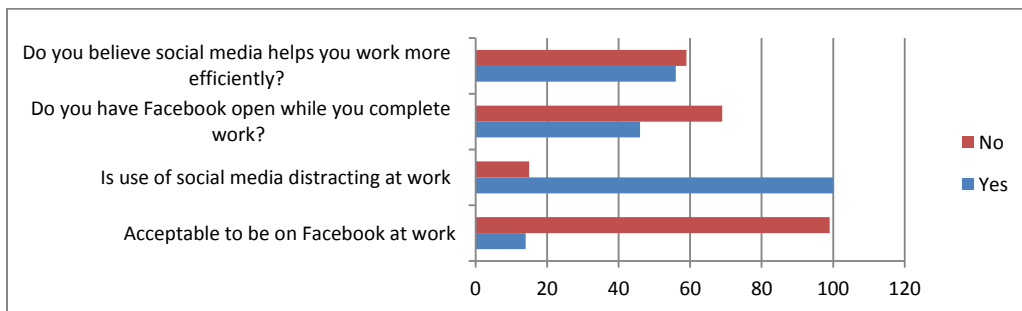
Other questions addressed use of social media on phones and opinions about its use at work. Ninety-one of the 115 (79%) respondents use social media on their cell phone. Most of the respondents, 87.5 percent, who use social media more than eight hours a week fell into this category. Only five people, however, agreed that it is okay to use social media at work; although 90 said it could sometimes be used for emergencies only. As to whether they would accept a job that bans the use of social media at work, 89 of the participants said yes. Another 96 said that they could work nine hours a day without using social media.

Responses to questions related to Research Question Two indicated support for employer monitoring of social media use. The first asked whether an employee should be fired for excess use of social media. The majority, 73 percent agreed that they should. The second asked whether employees should be judged by their employers on the basis of their social media activities. Again, the majority, 70 percent, found this acceptable.

DISCUSSION

Based on the data, indications are that the more a person uses social media, the less they feel it is a distraction and the reverse is also true. Some of the results are conflicting, especially as they relate to whether social media is a distraction at work. The great majority of respondents who are students in the Millennial generation, the heaviest users of social media, felt that its use was distracting at work, and that it is unacceptable to have Facebook open at work. Equal numbers indicated that they felt social media helped them to work more efficiently. It is difficult to determine whether some answers were driven by social response bias, for example, especially regarding the acceptability of being on Facebook at work. This dichotomy may also reveal awareness that the workplace is not yet a welcome venue for the use of social media, particularly for personal tasks, while acknowledging their inability to resist its use for a long time period during the day.

The results with regard to employer monitoring of employees' social media use is surprising when one considers the often used claim by younger employees that their Facebook account, for example, is private. There is also an acknowledgment that employers have the ability to exercise some control over employee behaviors, even those that take place outside of office hours. It is difficult to determine whether this realization will translate into a change in the ways in which younger employees use social media.

RECOMMENDATIONS

Social media use should be regarded as a privilege that can be taken away by one's employer. An open dialogue should take place with employees, to discuss appropriate use of social media in the workplace. One possible solution would be for the organization to install software that does not block social media, but rather monitors the amount of time it is used. In this way employers can keep employees accountable, but give them some freedom as well. Employees who are on these sites for an excessive amount of time would be subject to potential disciplinary action.

Businesses should begin to embrace social media in the workplace, rather than ban it. Employers can exercise some control over the use of social media at an organization by developing policies

regarding its use and informing employees about these policies. This action is especially important as younger generations or workers join the employee ranks because they do not recognize social media use as problematic, so they will continue to use it until otherwise informed.

Looking ahead, a new problem that the workforce will encounter as a result of increasing social media use is a decline in interpersonal skills. The impact is already seen in the younger generation of workers, who prefer to email colleagues instead of talking with them face-to-face. More individuals spend meeting times texting instead of contributing to the conversation in the room. The workforce continues to require people who have the interpersonal skills that enable them to communicate effectively with clients and coworkers. Whether employers will be able to develop these skills by default through restricting social media use remains to be seen.

The reality is that while at work, access to social media is nearly always available. The desire to check friends' latest posts is a major distraction and creates the temptation to check for updates, which was a common comment made by our respondents. Some firms block the sites, but this can actually add to the problem because the social media addict will spend time at work trying to get around the system. This is where the implementation of guidelines on social media etiquette in the work place would be beneficial [8]. By addressing the problem and clearly illustrating what is and is not appropriate in the workplace, it will be easier for employees to understand what is expected of them and adjust their social media use accordingly.

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LINKED INTO A JOB? THE ETHICAL CONSIDERATIONS OF RECRUITING THROUGH LINKEDIN

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ABSTRACT

LinkedIn‟s goal is to help business professionals meet, make business deals, inquire about jobs, and find careers through connections with people that members already know. This research study will investigate the ethical practices of LinkedIn recruitment. Students‟ awareness of the methods for effective use, as well as the damaging elements of a LinkedIn profile will be examined. LinkedIn is an effective, helpful tool for recruiting candidates and for job searching; however, the best results will come to those who use LinkedIn professionally and with caution. Our findings indicate that despite its risks, jobseekers and employers can benefit from using LinkedIn.

Keywords: recruitment, social media, human resources

INTRODUCTION

LinkedIn has come a long way since it was founded in 2002, becoming the "world‟s largest" professional network with more than "175 million members in over 200 countries and territories as of August 2012" [1]. LinkedIn‟s goal is to help business professionals meet, make business deals, inquire about jobs, and find careers, all through connections that members already know. The site also has company pages used to seek prospective recruits and provide organizational information. Companies post information about their organization and interact with candidates. LinkedIn offers a new tool directed at their fastest growing demographic of college students. LinkedIn partnered with PricewaterhouseCoopers (PwC) to create Career Explorer, which allows "college students to chart potential career paths, build a professional network and gather valuable insights into careers…" [4].

Although resumes, as well as preformatted applications, are still commonly used by human resource professionals to prescreen applicants, "nearly 50% of resumes contain factual errors" [22]. Therefore, employers are now using online searches as an alternative way to prescreen

applicants [14]. Human Resource (HR) professionals can verify an applicant"s age, employment history and other relevant information by browsing their profile pages [5]. A 2009 survey conducted by Career Builder concludes that because of the ability to cross-reference applicant"s profiles on-line, 45 percent of employers have successfully hired a candidate through social networks, an increase of 23 percent from the previous year [10].

DEMOGRAPHICS OF LINKEDIN MEMBERS

LinkedIn has managed to capture a diverse user population. The gender categorization of the site is 42.1% female and 57.9% male [16]. LinkedIn members are distributed among four generations in the workplace with 25.8% of users ages 18-24, 34.3% ages 25-34, 33.4% ages 35-54 and 6.6% ages 54 and older [16]. The fastest growing demographic of LinkedIn members, college students, represents slightly less than half of all LinkedIn users, 47%. Graduate students make up the next largest percentage of members with 27%. Those with no college comprise 25% [16].

USING LINKEDIN FOR RECRUITMENT

The Bureau of Labor Statistics (BLS) estimates that there are nearly one million human resource professionals in America and this number is estimated to increase by an additional 200,000 by 2018 [3]. Achievers, an online survey provider, conducted a survey of 527 HR professionals from May through June 2011. The survey found that a large number of HR professionals believe that social networking can reduce the cost of recruiting, reduce communication costs, and improve opportunities for career management. "More importantly, HR professionals saw an opportunity for social networking to enhance opportunities around employee engagement, employee satisfaction and employee retention" [19]. One of the leading recruitment platforms, Jobvite, polled over 1,000 HR and recruitment professionals on their recruiting experiences. Their responses indicate that they planned on continuously using social media sites for hiring purposes in the future. The survey, *Social Recruiting Survey 2012,* traces social recruiting trends since 2008. For example, nearly all (93%) of recruiters are using LinkedIn to discover talent. Furthermore, 89% of recruiters have hired through LinkedIn [13]. Devin Blanks, of DB Search Group in Minneapolis, MN, a staffing and recruiting firm, explained how LinkedIn has benefitted its recruitment process as follows:

> „"I have personally been a part of the LinkedIn community since my early career. Currently I have been using it frequently to connect with many hard-to-find professionals whom we may not have had the opportunity to connect with using more conventional means. Most recently, we wanted to fill a Senior Director of HR position. As this position was more complex than usual and called for a very specific skill set, I used two different approaches to using LinkedIn." I got great response, met with a few candidates, and filled the position with a LinkedIn member… I will definitely keep LinkedIn as a serious recruit networking source"""" [11].

THE LINKEDIN PROFILE

According to LinkedIn"s company profile, it currently has more than 175 million users, including executives from all 2011 Fortune 500 companies, and more than 130,000 recruiters. Because of

its purpose, a LinkedIn profile must be professional with content that is a valuable for employers. The profile should contain everything that would be included on a traditional resume. Recommendations on LinkedIn serve the same purpose as reference letters and can be provided by co-workers, fellow alumni, and other networking contacts with LinkedIn profiles.

The most important advice from websites devoted to social media recruitment is to include details that set one apart from the other users. "We are searching through tens of millions of people on LinkedIn, so include the thing that makes you different and unique," says Steven Raz, managing partner of Cornerstone Search Group [20]. He recommends having a professional picture. William Arruda the founder of Reach Personal Branding and author of "Career Distinction" agrees that a picture is necessary and states, "Your headshot is an important element of your online personal brand. It allows people to connect a face with a virtual identity" [2]. Though it is recommended not to include a picture with a traditional resume due to concerns about possible discrimination, there are several reasons recruiters provide for doing so online. Arruda feels that a picture makes the user's profile more credible because the picture makes the profile more personal [2]. Studies have shown that LinkedIn profiles that include a picture get clicked more often than those that do not, increasing the likelihood that a profile will be viewed by a potential employee [21]. In addition to updating the site, members should check their groups and connections frequently [12].

Leibman, a Career Expert and President of *Idealize Enterprises,* offers advice to first time users, and identifies several mistakes most users make:
- The user's profile is incomplete.
- The user uploads a resume filled with spelling mistakes.
- The user's profile picture is not professional or missing completely.
- The user has no contact information: email or mailing address, or even a disconnected phone number.
- The user fails to make connections or be involved in any groups.
- The user does not utilize all the page options available on LinkedIn such as groups, hobbies, and recommendations [15].

According to a survey conducted by Career Builder in 2012 [23], 37% of employers researched job candidates on social media before making a hiring decision. Of these, 63% of employers who use this method of candidate evaluation use LinkedIn for the following reasons:
- We want to see if the job seeker presents himself or herself professionally (65%).
- We want to see if the candidate is a good fit for our company culture (51%)
- We want to learn more about his or her qualifications (45%)
- We didn't offer candidates the job if we found provocative or inappropriate photos and information on the profile (49%).
- We have decided not to hire someone because of information about him or her drinking or using drugs (45%)

ETHICAL CONSIDERATIONS OF RECRUITING THROUGH LINKEDIN

Human Resource professionals have always performed background checks as a part of the interviewing process. Legal protection exists for the use of more traditional forms of recruitment

such as the resume; however, protection from implicit prejudice that may occur from the use of LinkedIn is still an issue. For instance, certain characteristics about a person including beliefs, social status, political stance and more, may be inferred by one‟s profile [8]. Though a recruiter or prospective employer may think he/she is looking at an applicant‟s profile in an unbiased manner, one is not always conscious of prejudice. This bias presents a challenge when recruiters use social media that reveals characteristics that may not otherwise be known about an applicant.

One of the two major concerns facing employers who use internet searches to screen applicants is the potential for a claim of discrimination. Title VII of the Civil Rights Act of 1964 makes it unlawful for any employer to make employment decisions based on color, race, religion, sex, and national origin [6]. According to Lawyer Matthew Effland the author of *Workforce Management*, there has been no decision thus far which states that the use of information available on web sites is a violation of employee rights [9].

The other ethical concern is invasion of privacy. Anyone who chooses to create a LinkedIn profile must be aware that this information can and will be looked at by HR professionals, recruiters and any other users. In a 2009 study conducted by Deloitte, 53% of employees considered it none of the company‟s business what was on their sites [7], however, it is a fast, cheap, informal way for employers to gather complete and thorough information.

LinkedIn, however, claims it is not responsible for content on its system. In fact, when users register on LinkedIn, they agree to the Terms of Service that states, "It is your responsibility to keep your LinkedIn profile information accurate and updated" [18]. "Being part of LinkedIn means sharing information about yourself with other professionals, communicating with them, as well as working privately on your own… your account is set up to share the information that we have found the vast majority of our Users are interested in sharing. But the amount and type of information you decide to share, and with whom you share it, is up to you" [17].

RESEARCH QUESTIONS

Because the fastest growing demographic of LinkedIn users is college students, this study focused on that population. Our questions addressed major areas of LinkedIn used by employers for recruiting. Specifically, this study asked the following research questions:

Research Question 1 – How do college students use LinkedIn?
Research Question 2 – Do college students view the use of LinkedIn by recruiters as ethical?
Research Question 3 – What is the nature of contact that college students receive through employers on LinkedIn?

METHODOLOGY

This study used a survey distributed via email and paper. It was approved by the Human Subjects Review Board of the organization. Student respondents were solicited through snowball sampling. Human Resource professionals were solicited through a member of the Society for Human Resource Managers.

RESULTS

There were 145 undergraduate student respondents, with a mean age of 21. Half were women and half men. There were an insufficient number of responses from Human Resource Professionals; therefore, no analyses were done for that data.

To answer Research Question 1, we asked students to select from a list of common uses of LinkedIn as presented in the literature. They could choose multiple items. According to our survey results, 56 percent of these students have a LinkedIn profile, 44 percent do not. Of 145 respondents, 103 (71%) answered that the number one reason they use LinkedIn is to search for job openings or to look for information on careers. The next highest usage category, totaling 99 (68%) respondents, answered that they use LinkedIn for networking opportunities. Lastly, only 31 (21%) respondents use LinkedIn to actively seek a job or career opportunities. The frequencies for each use are shown below in Figure 1.

FIGURE 1

**Frequencies for Use Types by College Student**
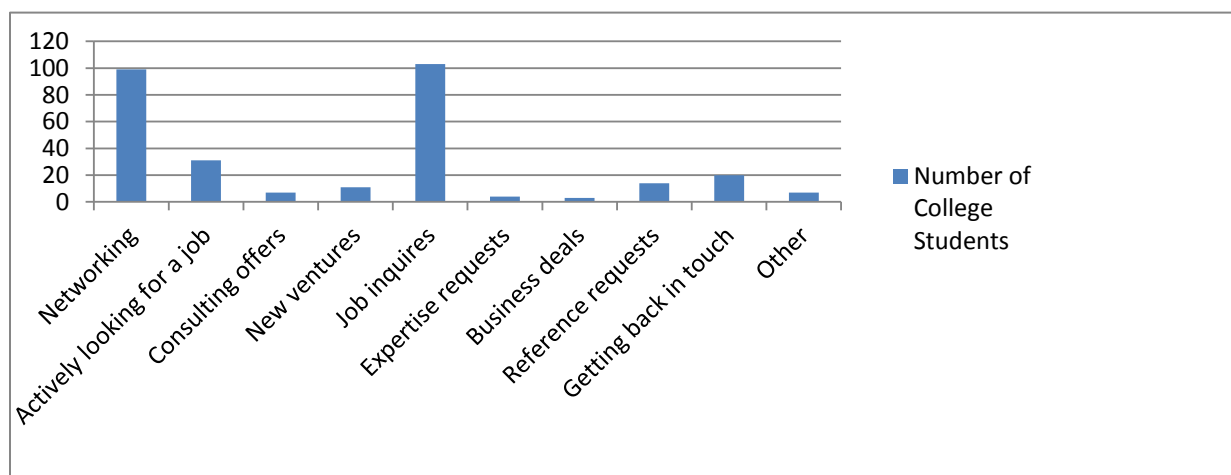
Our second Research Question asked whether students view the use of LinkedIn by recruiters as ethical. The data indicated that the majority of college students, 75.2%, believe LinkedIn and the LinkedIn recruitment process to be ethical, whereas 17% were unsure and 3.7% view it as unethical.

Our final Research Question sought to determine the nature of the contact that students have with employers on LinkedIn. The findings show that just over 51 percent have made connections with prospective employers. The next highest contact type was referring a connection; this means that 21% of college students in this survey referred a connection to a third party or were referred by a connection to a third party. Lastly, approximately 15% of survey respondents sent connection requests to employers. The breakdown of the nature of interactions between employers and students is shown below in Figure 2.

FIGURE 2

Frequencies for Levels of Contact with LinkedIn
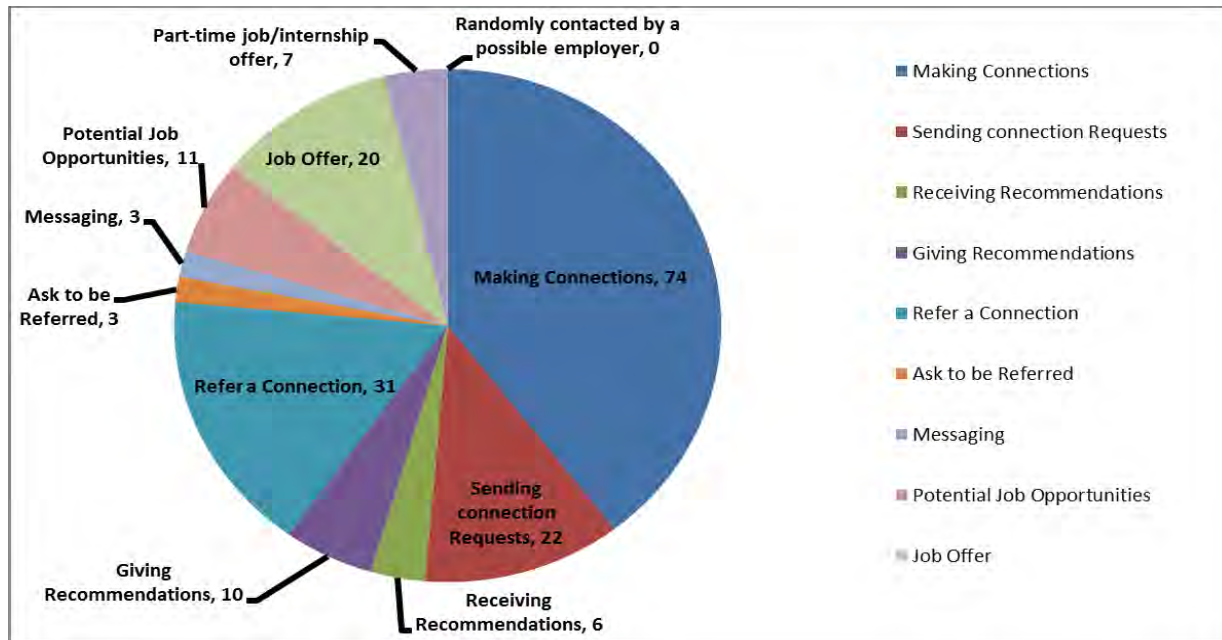
CONCLUSIONS AND RECOMMENDATIONS

As our survey results indicate, college students use LinkedIn for many different reasons. Based on the data, students are not properly employing all the resources available on LinkedIn. In order to be more successful in their job search, college students, especially those looking for a job, should maximize on these opportunities. They should also make use of those lesser employed features such as seeking expertise, actively looking for a job, and reference requests. These features promote further network development, one of the strengths that LinkedIn has to offer.

As one can see, there is a large discrepancy between the frequencies of interactions as reported by recruiters versus reported by students. It would appear from this result that employers using LinkedIn to screen students are finding negative information; therefore, the recruiter doesn''t follow up with the student, resulting in a lower number of contacts from the student''s side. We can infer from this data that college students will need to be more proactive in initiating contact with potential employers through LinkedIn. We also recommend that college students take caution in what they post on LinkedIn; so that a recruiter does not abandon their inquiry due to inappropriate content.

In summary, many college students use LinkedIn, but they do not utilize the many beneficial features that LinkedIn offers to help them succeed. The trend of recruiting via social media sites is here to stay, thus students must learn how to properly utilize all the resources at their disposal. Jobseekers are unlikely to receive contact from the employer first; thus students should help themselves by initiating a relationship with the employer via LinkedIn.

Also, although we found references to ethical considerations in the use of social media sites for recruitment, students did not exhibit these concerns. It may be helpful for employers to know that the majority of college students view LinkedIn recruitment as ethical as it may reinforce the continuing use of these resources.   This is not to say that a company should not protect themselves or remain aware of the potential that exists for discrimination when reviewing candidates; however, our findings support the recommendation that college students and employers can ultimately benefit from using LinkedIn.

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OCCUPATIONAL HEALTH AND SAFETY ISSUES IN THE DECISION-MAKING PROCESS

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ABSTRACT

Occupational health and safety (OHS) issues are mostly absent in the decision sciences, whereas the economic burden related to injuries, illnesses, and diseases is significant. This paper proposes to integrate OHS issues by linking well-being with efficiency and competency. The first part examines how well-being, knowledge, and competency are interrelated. Examples of the impact of decisions on well-being and the building of knowledge and competency are examined in the second part.

Occupational health and safety, decision, competency, knowledge

INTRODUCTION

The average adult spends between one quarter and one third of waking life at work [13]. The annual cost of occupational injuries in Canada is estimated at around ten billion dollars [12]; the impact of these injuries on the productivity, sustainability, and performance of organisation is significant [8]. What is important, therefore, is the ability to innovate in order to provide a favourable work environment and effective measures that can attract and retain employees, which is an acute problem in some sectors.

Nevertheless, OHS issues are mostly absent in the decision sciences; the number of papers dealing with these issues is marginal at best. In fact, OHS is often seen as a burden. The opinions expressed by some political leaders, for example, the British Prime Minister, David Cameron, strengthen this view in which OSH legislation and culture are seen as a brake to the economy: "…businesses are drowned in red tape, confusion and the fear of being sued for even minor accidents. A damaging compensation culture has arisen, as if people can absolve themselves from any personal responsibility for their own actions, with the specter of lawyers only too willing to pounce with a claim for damages on the slightest pretext." [21:4]

A report was then commissioned by the Department of Work and Pensions to a specialist in risk management to examine how this burden on companies could be alleviated [31]. Even

the president of the European Commission, José Manuel Barroso, asked to postpone planned improvements in OHS for 2013-2020.

In addition, casual observers of the OHS scene agree that emphasis is placed more and more on individual responsibility, even when the concept of the "healthy company" is advanced. For example, the Quebec Standard Board's "Prevention, Promotion, and Organizational Practices Favouring Health at Work" or the "Healthy Enterprise" (BNQ 9700-800) is basically a broad ISO-type standard with a strong focus on the individual, promoting, for example, healthy habits and personal accountability. Its goal is to incorporate personal health values in the management process.

Health is defined by the World Health Organisation [32] as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (adopted in 1946, entered into force in 1948). This definition has not been amended since 1948. However, the occurrence of accidents and occupational health diseases are still the main issues of concern for companies, and the concept of well-being is far from being put into practice. OHS is still rarely considered in strategic decisions, outside the necessity of following regulations and legal obligations, which, not surprisingly, is considered a burden.

Indeed, studies document mostly the economic burden related to injuries, illnesses and diseases. For example, the International Labour Office estimated that the losses due to compensation, lost work days, interruption of production, training and retraining, medical expenses, and so on, routinely amount to roughly 4 per cent of global GNP, and possibly much more [14:8]. Furthermore, the ILO probably undersestimates the impact of mental illness, a very complex issue [7]. The economic burden to the Canadian economy each year has been estimated to $51-billion. Coverage related to mental health leave would costs companies twice as much as it does for short-term physical disability leave [20]. Without discarding the importance of occupational illness and injuries, this paper proposes to broaden OHS issues by linking well-being with efficiency and competency.

1. WELL-BEING, KNOWLEDGE, AND COMPETENCY: THREE INTERRELATED CONCEPTS

1.1 Well-being

The achievement of well-being (or "living well") has been the concern of philosophers since Socrates. The various schools of philosophy—sophists, stoics, cynics, epicureans, etc.—have all brought their own perspective. The usual dictionary definition of well-being is "a state characterised by health, happiness, and prosperity." The science of "subjective well-being" suggests that, in addition to experiencing good feelings, people need: "… a sense of individual vitality; to undertake activities which are meaningful, engaging, and which make them feel competent and autonomous; a stock of inner resources to help them cope when things go wrong and be resilient to changes beyond their immediate control; to feel a sense of relatedness to other people, so that in addition to the personal, internally focused elements, people's social experiences— the degree to which they have supportive relationships and a

sense of connection with others—form a vital aspect of well-being" [24:9] .

These aspects have been particularly explored by Karasek and Siegrist. Both authors have developed questionnaires to assess various dimensions. In Karasek's initial Demand/Control Model [16] is based on psychosocial characteristics of work, including skill use, psychological demands of work and task control / decision latitude (i.e., workers' ability to control their own activities and skill usage). The model was later expanded to include the social support dimension (from co-workers and superiors) [15]. A high demand task with low latitude and low support will increase health' risks; Siegrist's model added the concept of effort-reward imbalance [28] [29]. The model considers that a high degree of effort combined with low rewards will lead to sustained stress reactions with negative long-term consequences for health. In both cases, a good number of studies have investigated and shown that expected negative consequence of high job demand combined with low decision latitude, lack of social support or low reward may have a negative impact on physical (mostly cardio-vascular) and mental health indicators [1].

1.2 Knowledge and competency

The concept of knowledge is complex in terms of its nature and process of production. Knowledge is usually differentiated according to whether it is explicit or tacit, individual or collective, internalised or externalised. However, there is no consensus on how knowledge should be organised or modelled [10]. In fact, knowledge can be modelled using various reference systems [23]: categorical, referring to its nature (e.g., tacit, codified); thematic, referring to its object (e.g., procedures); instrumental, referring to the means used to acquire it (e.g., experience, knowing-in-action); or based on how it is anchored or established (e.g., embodied, embedded). As a result, the terminology used to refer to knowledge is extensive: knowledge may be said to be declarative, procedural, circumstantial, conceptual, strategic, tacit, implicit, codified, explicit, official, and so on. Lastly, many languages have different words to refer to knowledge. For example, French, a language rooted within the Greek and Latin tradition, uses two words: *connaissance* and *savoir*. The latter has a broader meaning that integrates notions such as representations, reasoning modes, viewpoints, and perspectives (partly covered by the notions of embedded, embodied, and cultural knowledge)

In management, knowledge is defined "as the human faculty resulting from interpreted information; understanding that germinates from a combination of data, information, experience, and individual interpretation." [2]. Data are facts that, once sorted and organised, become information. This information, in turn, becomes knowledge when it is interpreted or put into context, or when meaning has been added to it.

1.3 Competency

Competency is a combination of in-depth knowledge, experience, and the capacity for action recognised in a particular field. It is defined by Le Boterf [18] as the "the mobilisation or activation of several types of knowledge in a given situation and context." Despite nuances - Gadbois and Leplat [9] made a review of this question -, competency is also characterised by its anchor, object and means. It is used to define aggregates of knowledge (and *savoirs*) in

a particular context and is necessarily multidimensional. It includes various types of knowledge and know-how: theoretical (understanding, interpreting), procedural knowledge (how to proceed) or know-how (proceeding, operating), experiential know-how (to adapt, to act), social know-how (to behave) and cognitive know-how (processing information, reasoning, naming what one is doing, learning, [23]).

1.4 Interrelationships

While knowledge may be seen as an object, persons possess this is primarily. Knowledge may be an independent object, but competency is necessarily rooted in the individual. The concept of well being concept is explicitly linked to the ability of individuals to use their competencies. Indeed, decisional latitude and recognition and reward by the organisation and co-workers are seen as protective of health in high-demand situations (with some limits).

For workers, competency is seen as a means to achieving two closely interrelated goals: protecting their health and safety (e.g., safety know-how, preventing knowledge / *savoirs de prudence*) and working effectively (i.e., ability to produce a desired result or effect). Building of competences allows achieving a third goal: working efficiently (ratio of effective or useful output to total input), without hindering others (maintaining harmonious social relations). An increase in efficiency is usually protective both for workers' health and for production.

When decisions are made by the organisation without understanding these competencies and their interrelationships, strategies related to efficiency developed over many years may be jeopardised. This can eventually put both effectiveness and the health and safety at risk.

2. IMPACT OF DECISIONS ON THE BUILDING UP OF COMPETENCIES AND WELL-BEING

In the next section, we will examine how decisions can hinder or invalidate the building of knowledge and competency.

2.1 Flexible work force vs. competency building

Flexibility has become an important goal to achieve. Europeans have invented the term "flexicurity" in reference to the Danish labour market model strategy to reconcile employers' need for a flexible workforce, and workers' need for security and confidence, i.e., not facing long periods of unemployment: "One side of the triangle is flexible rules for hiring and firing, which make it easy for employers to dismiss employees during downturns and hire new staff when things improve. About 25% of Danish private sector workers change jobs each year. The second side of the triangle is unemployment security in the form of a guarantee for a legally specified unemployment benefit at a relatively high level - up to 90% for the lowest paid workers. The third side of the triangle is the active labour market policy. An effective system is in place to offer guidance, a job or education to all unemployed. Denmark spends approx. 1.5% of its GDP on active labour market policy." [26] Europe

adopted this concept to encourage geographic and sectorial mobility (see the Web site "Employment, Social Affaires & Inclusion" of the European Commission and its publications *Social Agenda* and Online *Journal on Free Movement of Workers*).

Effectiveness and efficiency are built through a balance between the variety of experiences and exposures required to infer new knowledge and the stability of situations required to apply this knowledge. Stability may refer to various elements: the object of the work itself, the organisational environment, teammates and collective work, or the topographic sector and layout. Stability allows developing more efficient routines, know-how, strategies, and planning. There is numerous field studies showing how knowledge and know-how is built in situation involving repeated exposure and work stability [6] [19] [27]. The following example shows how one decision lead to a major crisis, while underscoring the importance of competence building.

Example : A regional poultry processing plant decided to increase its workforce by hiring through a metropolitan day labor agency. It hired workers as needed. The agency provided mostly inexperienced workers, which put pressure on experienced local workers. The latter were essential for keeping key workstations on track and maintaining work flow. For many fine repetitive tasks, it can takes months to develop the fine-tuning required to achieve quality and speed [30]. At some point, four key experimented workers took leaves for musculoskeletal disorders. Their absence triggered a major crisis (the company specialized in Halal meat, which must respect a specific time sequence). In the end, the company decided to upgrade the work to attract and retain a stable local workforce [11].

In addition, instability in staff allocation, and precarious employment, affect the process of transmitting knowledge and skills [3]. Workers are unwilling to invest time in training unless it is formally scheduled. They see it as a waste of time, especially when the organisation is unable to retain newly trained personnel. An aging workforce is of current concern because of the expected loss of knowledge and know-how. Transmission processes need a minimum of stability to be effective. In addition, the loss of memory in the organisation hinders transmission of accumulated knowledge and experience.

2.2 Stability in affectations vs. the development of knowledge and know-how

Knowledge is a recurrent theme discussed by workers. In a long-term hospital setting, orderlies consider that "half the job is done when you know the patient." Delivery workers emphasise the advantage of knowing a sector to better plan their routes. Manual handlers working with bulky materials emphasise the importance of being familiar with the loads and acquiring information. Aerospace workers emphasise the importance of working with the same tools. Team workers insist on the need to know their partners. Developing efficient routines takes time—and knowledge—but these are rendered ineffective when there is constant flux.

Example 1. In delivery work, knowing a sector means knowing its layout, the customer's habits, the best methods, the best unloading times, etc. Knowledge of the customer's topography and layout is important to optimise truck unloading positions - especially in the beverage industry, where trucks may be unloaded from side compartments. Knowledge of

internal layout helps optimise transport methods. Good relations with a casual customer may involve reward exchanges that allow skipping a control phase and significantly increasing material handling work (e.g., a customer may ask to unload goods to count them before reloading them); however, the accumulation of these small gains can also make the job easier and increase satisfaction and overall the well-being.

Example 2. It is acknowledged that the healthcare system is facing a shortage of professionals due to high employee turnover, transfers, retirements, and lack of available trained employees. One approach to address this problem is through knowledge continuity management [25]. However, instability in staff allocation (e.g., as implemented in Quebec since the 1990s) hinders knowledge of patients and decreases the efficiency of collective work and communications [3]. In chronic care or medium term hospitalisation, knowledge of patient is important for developing efficient strategies and enhancing patient safety. Unfortunately, the response to safety problems is often the development of standardised procedures and bureaucratic controls, both which increase staff workload.

2.3 Computerisation vs. use of knowledge

Nobody denies the benefits of increased computerisation at work or the introduction of related tools such as bar code scanners. These, however, may interfere with information at the base of efficient and preventive work strategies developed over the years. In previous sections, decisions were challenged. Here, the problem lies more in underestimating how such decisions increase the level of difficulty or workload for the various groups involved. The decision process must include a step that examines the impact that these changes have on how information is incorporated and used in work.

Example. A company decided to implement computer tools in its warehouse. Order process clerks must now scan bar codes to obtain information about boxes to complete an order. Previously, orders were provided on paper. Workers must now move from one location to another without knowing in advance the location, type, and quantity of boxes to load on pallets. Clerks are no longer able to plan the loading of stacks (which must be stable) or manoeuvre their (double pallet-type) electric carts, which is important for bringing the latter as close as possible to the loads. As a result, workers must work harder and less efficiently. Workers feel they are unable to achieve "nice" stacks, which are safer for the next worker. When boxes are depleted at a given location, workers must stop working and are unable to advance. If cart traffic is heavy, workers are unable to adapt by changing their loading sequence; they see this inefficiency as frustrating, especially experienced workers [4]. Of course, nobody questions the advantage of controlling inventory in real time through computer systems. The problem is that a tool (in this case, software) was implemented without identifying the knowledge required to perform the work efficiently.

2.4 Work schedules decisions

One of the most significant developments in the workplace, in the last 30 years, has been the deregulation of work schedules. In many countries, night shift work was restricted to sectors

where it was unavoidable; the eight-hour day shift was the norm. Longer shift work is now frequent (4 x 10-hour and 3 x 12-hour shifts) and is often applied to already demanding jobs. The result is increased risk of injuries [5] and errors, as shown in the hospital sector [17]. In addition, decisions related to work schedules, including longer shift work, may have also pervasive indirect impacts.

Example 1. A company in the beverage sector decided to move from a 5 x 8-hour schedule to a 4 x 10-hour schedule with full agreement of its workers. The latter were in fact pleased with the prospect of an additional day off. The longer shifts allowed acquiring larger trucks that could be loaded higher, which was seen as a gain in efficiency. However, height is a critical factor in manual material handling. The maneuver marge decreased in such way that small incidents had greater impact. The consequence was a dramatic general increase in accident rates and seriousness, in particular for shoulder-related injuries. The increase in absenteeism had a major impact on team organisation. The constant need to restructure the teams and manage inexperienced workers increased the workload for all [22].

Example 2. In the previous example of the poultry processing plant, the new outside workforce required daily bussing (2 x 100 km). The organisation decided to shorten total bussing time to replace the 5 x 8-hour shift by a 4 x 10-hour shift. For an already demanding and repetitive job, the increased daily exposure was a contributing factor to the general dissatisfaction. Overtime was resented and seriously affected family life. The company finally decided to return to a 5 x 8-hour schedule.

In both examples, interviews with supervisors and workers showed that both were quick to explain the domino effects of the decisions. These two examples are typical of decisions in which the impact on work activity is insufficiently analyzed. To the managers' credit, there is a lack of tolls to prospectively link decision with impact on work activity.

CONCLUSION

It is said that modern society is a knowledge society. At the same time, our view of knowledge and competency has become obstructed. Many of the major decisions and orientations of organisations have a profound affect on the construction, maintenance, and transmission of knowledge that is required to build effectiveness and efficiency at work; they also directly affect the well-being of workers. Decision having a potentially major impact on well-being are made without sufficient knowledge of work issues. There seems to be current misunderstanding of the nature of knowledge and competency and the conditions for using them efficiently.

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review and the case studies, however, indicate different types of deficiencies pertaining to current SR solutions, such as:

- The proposed solutions are problem-specific. They generally cannot provide generic quality improvement solutions [16].
- They are not applicable to all types of software, such as large-scale systems, enterprise information systems, embedded systems, off-the-shelf software products, etc. [3].
- The majority of these solutions look at a SR problem from the software engineer's or developer's point of view [4].
- These SR solutions cannot assure conformance to international software quality standards (ISO/IEC 2500n [7]).
- They cannot provide prescriptions leading to continuous software improvements after the delivery of a reengineered product.

METHODOLOGY

The purpose of this paper is to present a process model to improve the SR process. Through this model, we not only intend to improve process, but also present a quality-oriented method to SR. This aims to assure quality of any reengineered product by reducing its defects. SR in essence is a quality improvement process. We believe that any SR solution should have three mainstays: (1) a quality improvement philosophy, (2) an orientation to quality issues in any SR project, and (3) the assurance of software quality as confirmed against the standards. The novelty of this study is the integration of SR activities, Six Sigma, and the Software Quality Requirements and Evaluation (SQuaRE) standards to create a "quality-oriented SR model" (Figure 1). The Six Sigma program establishes the process framework for improvement; software engineering provides the tools and techniques for software process; and the SQuaRE standards includes the quality models, descriptions, and specifications required for a quality-oriented SR approach.

Although Six Sigma can be regarded as a single process, it is typically divided into five phases, referred as the "DMAIC". This is an acronym for: "define", "measure", "analysis", "improve" and "control" phases. Six Sigma encapsulates the quality-oriented process framework. A Six Sigma project is usually aimed towards achieving a "breakthrough improvement", such as "reengineering" [5]. SR activities include software engineering tools, techniques, and practices. Finally, the SQuaRE provides the "software quality requirement" (ISO/IEC 2503n [10]), "software quality measurement" (ISO/IEC 2502n [9]), and "software quality evaluation" (ISO/IEC 2504n [11]) procedures, standards and metrics needed for our proposed model. It is an approved series of standards for software quality. It helps software developers, acquirers and evaluators by providing descriptions associated with requirement specification and the measurement and evaluation of software quality (ISO/IEC 2501n [8]). However, it is only devoted to the system and software product quality as a quality reference model. It naturally does not include a ready-to-implement process framework. Therefore, it has to be emphasized that the DMAIC process provided the framework needed for our quality-oriented SR approach.
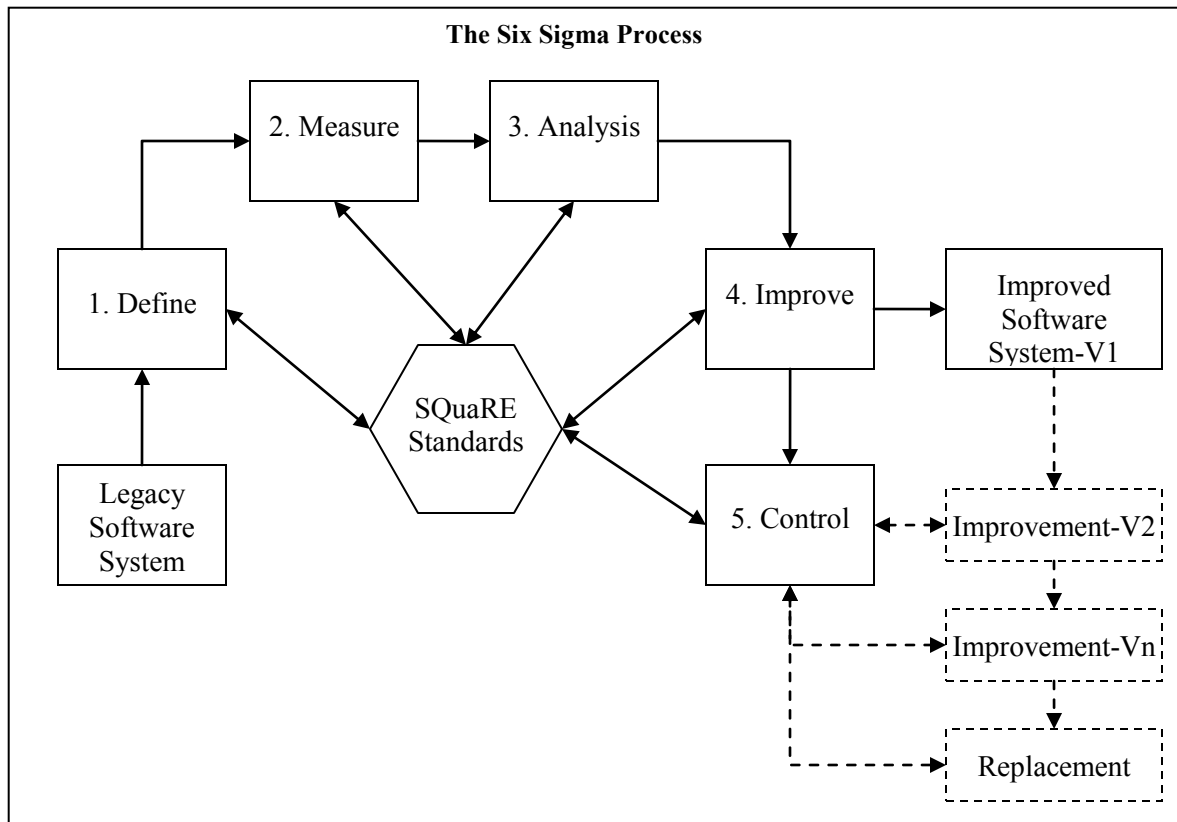
Figure 1.The quality-oriented software reengineering model

Figure 1 depicts SR activities aligned with the DMAIC processes. The quality requirements of a SR process are expressed in the problem statements at the "define" phase. The "measure" phase identifies the current quality of the legacy software and its performance. The "analysis" phase helps SR teams to understand the nature of the problems and find their root causes. The reengineered version of the legacy product is produced through a series of software transformations and modifications at the "improvement" phase. The "control" phase includes both the control techniques and software maintenance activities. The arrows in Figure 1 represent the main process sequence and the data flows during a quality-oriented SR. The bidirectional arrows between the elements of the DMAIC process and SQuaRE indicate the references of SR teams to the SQuaRE standards at each step. This enables SR teams to define, measure, and control the software quality in terms of approved standards. Thus, a dynamic interaction is established amongst the customer requirements, the project requirements, and the software quality requirements through out a project lifecycle. The dotted arrows indicate that software improvements continue even after delivery of the reengineered product. The "replacement" phase indicates that a brand new system is designed after several improvements. We believe that this SR model would have a great value for customers and software professionals, as well as anyone who is responsible for defining and evaluating the quality of a reengineered product by providing a quality-oriented framework. The next sections present the phases of this quality-oriented approach to a SR process.

Define:

In this phase, a project charter is created and the mission statements, objectives, deliverables, and responsibilities are clearly stated. A quality-oriented SR approach requires not only a methodology, but also a philosophy change. The quality is viewed from the perspective of the customer to the systematic integration of people and the software process. Along with the assignment of a champion to the SR project, certain roles (master black belts, black belts and green belts) are described depending on the project scope and budget. In addition to the responsibilities the project charter also defines how the Six Sigma tools and techniques are applied and by whom. Important to this phase is defining software quality issues in the form of Six Sigma methodology. They are expressed as clear statements with measurable, attainable and problem-specific terms. It is worth noting that a Six Sigma project generally focuses on a single quality problem while a SR project may include several. Therefore, a number of Six Sigma SR teams can be established regarding the software quality problems. These teams solve software quality problems using the framework of ISO/IEC 2501n standards [8]. For example, using ISO/IEC 2501n standards, the "internal quality" is the degree to which static attributes of a legacy software product satisfy the stated and the implied needs (i.e., code complexity, number of faults, lines of code). The "external quality" is the degree to which this product enables the behavior of the system to satisfy the needs in a testing environment. The "quality in use" determines whether this product meets the requirements of specified users in a realistic environment. In these standards, the "quality in use" depends on the "external quality", and the "external quality" depends on the "internal quality". This interdependency naturally forms the quality lifecycle of our SR process model. Since customer-driven quality is fundamental to Six Sigma, our model puts emphasis on the customer needs and listens to the "voice of customers".

Measure:

The main objectives of this phase are to gather information and to confirm, quantify and revise the problem. The focus is on how to measure the software product and the characteristics influencing its quality. It is vital to understand the causal relationships amongst software performance and the external, internal, and quality-in-use attributes of the product. When performing the measurements, appropriate software metrics, key input and output variables are determined as well as how these metrics would be tracked over time. The current software performance may need to be benchmarked.

For measuring the current software quality, we follow the guidelines provided by the ISO/IEC 2502n standards [9]. In these standards, the "quality measure elements" are defined as the base measurements used to obtain the "quality measures." These elements may belong to internal quality characteristics, external quality characteristics, or quality-in-use characteristics. In other words, these characteristics measure the static representation of the software, behaviors of the software, and performance of the software respectively. Generally, it may not be practical to obtain all of the internal and external measures of a large legacy software system, and the "quality-in-use" measures within all possible user-task scenarios. Therefore, the ISO/IEC 2501n and 2502n quality standards should be tailored to the needs of a SR project. The priority should be given to customer requirements; it is fundamental to the Six Sigma philosophy.

Analysis:
This phase refers to the two-dimensional examination (process and software) of why the problems occur. The first dimension, which is the process analysis, relies on fact and data-based analysis of the business processes of the legacy software system, because we have to understand the nature of the problem and find the root cause without jumping to a quick solution. This is especially important for identifying improvement opportunities for the next phase. All work occurs in a system of interconnected processes and software modules within a legacy system. At this point, statistical techniques provide the means to draw accurate quantitative conclusions on business processes and software product. Six Sigma software teams try to identify potential root causes of a quality problem, and they try to validate the cause-effect relationships [15]. Since legacy software systems usually have poor documentation, we may need tools such as the "process maps" or "cause-effect diagrams" for the analysis procedures.

The second dimension, which is the software analysis, includes the software evaluation guided by the ISO/IEC 2504n standards [11]. This document describes the procedures for evaluating software quality from a broad view, for applicability to software developers, software acquirers, and software evaluators. It is also used for the analysis of different types of software, i.e., pre-developed software, commercial off-the-shelf software, and any custom software. This standard therefore complements our quality-oriented SR model by providing the evaluation procedures. The reengineered software product is categorized into static or dynamic. The static product involves the analysis of software design specifications and program source code. It is important to capture the design and architecture while identifying the relationships between the components of the system. The architecture and the functionalities are modeled to understand the rationale behind the legacy system. Often the static analysis may call for reverse engineering to extract information from the code. The dynamic analysis refers to the testing of the legacy software, both in a testing and operational environment. For both types of the software analysis, the primary objective is to identify the parts of the software responsible for the quality deficiencies and violations. These violations may belong to "internal quality", "external quality" or "quality in use" measures of the legacy software. Thus, software analyses help SR teams detect error-prone code.

Improve:
In this phase, now that the root causes of the problems have been identified, the potential solutions are identified and implemented. The SR team(s) generates ideas for improving the software quality measures. The solution(s) may necessitate process and/or software product improvement. In either case, the chosen solution(s) should address the root causes. Furthermore, they have to be cost-effective and implemented within a reasonable time. It is also important to prevent a recurrence of the problem. The team(s) naturally gives the priority to the critical quality requirements and customer needs when eliminating defects and low quality. Process improvements can be accomplished in away similar to classical Six Sigma phases, and the software improvements are achieved using software engineering tools and techniques.

In terms of software reengineering, we can assume that requirement analysis, software modeling and software analysis procedures have been completed during the first three phases (define, measure and analysis) of our proposed model. The parts of the legacy software responsible for the poor quality have been identified. At the improvement phase, the customer requirements,

how to assure the quality standards, and the new business requirements need to be reviewed carefully before starting to improvement activities. It is worth noting that different types of requirements may have interdependent relationships and potentially conflicting goals [3]. However, all these requirements have to be satisfied with the new version of the legacy software. Therefore, it is important to specify a target software structure and software quality goals. This will guide the SR teams when eliminating the design and source code defects, while focusing on the target quality. An iterative and incremental software process model can be selected for applying software modifications and transformations [2] [14]. During the improvement phase, quality evaluation procedures are applied to each of the transformed parts of the code. This is done for determining whether the "internal quality" requirements, "external quality" requirements, and "quality-in-use" requirements are satisfactory met. This quality improvement cycle continues until the specified SR quality goals are achieved, and the targeted version of the legacy software is produced.

Control:
The control phase ensures that the improvements will be sustained by both tracking the software performance and carrying out proper maintenance activities. Controlling the product serves as the basis for an effective software management. This includes prescriptions and techniques pertaining to the period after delivery of the reengineered software product. Statistical methods and tools may greatly help perform the control activities. For example, Statistical Process Control (SPC) techniques, such as control charts, can be used to determine the stability of the product and process. SPC techniques have been shown to be effective when applied to software engineering [12]. A control chart can adopt different types of software quality indicators and control limits for monitoring the quality characteristics of a reengineered product. If one or more of these values fall outside the limits, an assignable cause of low quality is assumed to be present. Hence, collecting the measures and metrics during the phases of a quality-oriented SR project provides a strong insight and control over the evolution of software quality.

Controlling a reengineered product also means planned software maintenance. As we already know, in practice poor maintenance results in low quality software. Therefore, the control phase should also focus on software maintenance (Figure 2). IEEE defines software maintenance as "*the process of modifying a software system or component after delivery to correct faults, improve performances or other attributes, or adapt to a changed environment*" (IEEE 1219-1998 [6]).

A QUALITY-ORIENTED APPROACH TO SOFTWARE REENGINEERING

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ABSTRACT

Legacy software systems can be regarded as the products with defects, which do not conform to quality standards. Their mission-critical functions make them valuable for organizations. Software reengineering (SR) has been used as a primary method for the improvement of these systems. However, the current SR models or solutions are thought to have different types of deficiencies. The purpose of this paper is to present a quality-oriented SR methodology. We integrate software engineering activities, the Six Sigma process, and the Software Quality Requirements and Evaluation (SQuaRE) standards. We believe that this model would have great value for customers, software professionals, or anyone who is responsible for defining and evaluating the quality of a software product to be reengineered.

Key words: Software reengineering, six sigma methodology, SQuaRE standards.

INTRODUCTION

A great majority of software in the industry has been built over the past decades and they are now considered "legacy" systems. Even though the age of software could be the major determinant for being a "legacy system," a relatively new software system could be considered legacy due to its poor maintenance. As time passes, keeping these systems up-to-date becomes complex and time-consuming [2]. Their source code may not be comprehensible and it may no longer be an easy job to maintain these software systems [1] [13]. However, discarding or re-developing these systems has many risks [15] [17]. Their mission-critical functions, and possibly undocumented business and programming logic make them valuable for organizations. This type of system generally represents the accumulated knowledge, experience, or familiarity of technical teams, users and managers. Software reengineering (SR) allows for the analysis, design and improvement of these systems.

PROBLEM

SR is a complex process. It intrinsically aims to improve the quality of a legacy, as well as reduce performance variations resulting from poor quality. A legacy system can be regarded as a software product with defects and non-conforming to quality standards, which leads to unsatisfied users [18]. SR could be one of the primary options for improvement. The literature
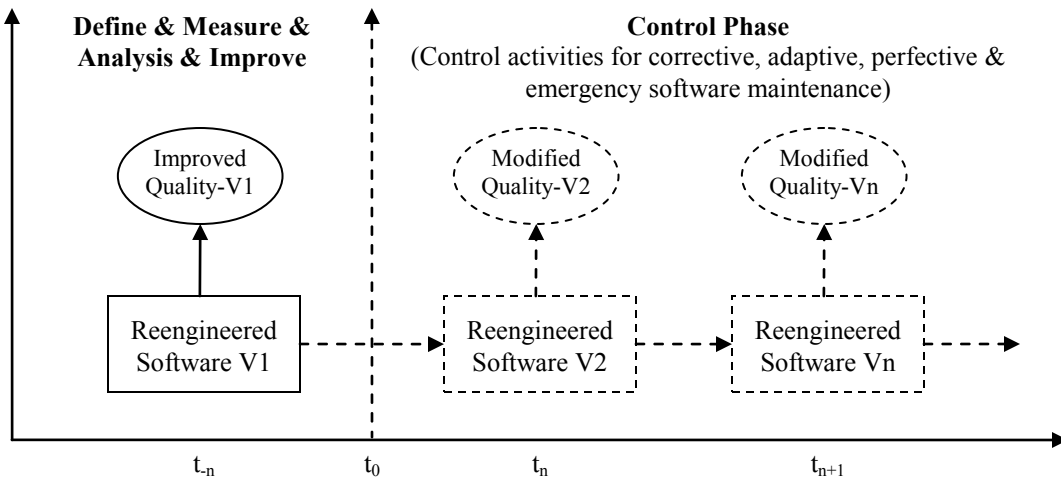
Figure 2. The evolution of software quality through software maintenance

IEEE puts software maintenance activities into four categories. "Corrective maintenance" deals with diagnosing and fixing errors in the source code after delivery. "Adaptive maintenance" aims modifying the system to cope with changes in the software environment. "Perfective maintenance" concerns functional enhancements to the system because of new or changed user requirements. "Emergency maintenance" is unscheduled corrective maintenance to keep a system operational. Based on these definitions, our quality-oriented SR model is capable of meeting these maintenance requirements. For example, our standard and measurement-based quantitative approach makes it easy to diagnose and fix errors during corrective maintenance. Its continuous improvements lead to software modifications required for adaptive maintenance. Since the focus is on customer satisfaction, a "perfective" maintenance is achieved. In Figure 2, the quality evolution of a reengineered product is given along with its possible versions.. The phases, define, measure, analysis and improve, have already produced the reengineered product. Thus, the first version (V_1) is obtained by the quality-oriented SR process at the time of t_0. However, a software product usually has different types of requirements during its lifecycle. Therefore, the x-axis in Figure 2 represents the time and includes possible versions of the reengineered product in the future. As a result, .these imaginary versions (from V_2 to Vn) are assumed to be present at t_2 and t_n after the delivery of the V_1. This is, of course, achieved by the Six Sigma tools and techniques, as well as software maintenance activities.

CONCLUSION

Although there could be various technical and organizational reasons for replacing a legacy software system, there is a rationale for keeping a legacy system running as well. Over the past few years, organizations have been looking for the means by which they can improve these systems. SR is the primary method for improving quality while providing cost effective solutions and reduction in time and risk. There are various SR solutions in the literature. However, they generally focus on the development paradigms, and they are not applicable to all types of software. They also cannot provide prescriptions for the period after the delivery of a

reengineered product. Furthermore, these models cannot assure conformance to international quality standards and satisfy all the stakeholders.

In this study, we proposed a quality-oriented SR method based on three important knowledge domains. The Six Sigma domain established the process framework and paved the way for the use of statistical methods for fact-based decisions. The software engineering domain provided the tools and techniques for a SR process. Finally, the SQuaRE standards domain included the quality models, descriptions and specifications needed for a quality-oriented method. We believe that our model can provide sustainable improvements while meeting the requirements of different types of people engaged in a SR project. A case study is planned in the future to see how this model can be applied to real-life situations. The study plan will naturally include a software product with defects in terms of quality and address how to improve the product quality through the proposed model. The implementation details and the results will be discussed in the next paper.

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IMPROVING RADIOLOGY OUT-PATIENT REGISTRATION PROCESS USING SIX SIGMA METHODOLOGY

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ABSTRACT:

The purpose of this paper is to understand the registration process and methods that are currently applied at hospital "A's" radiology department. This paper will dissect the current registration process from the time a patient calls to make an appointment to the completion of the test. The objectives of this paper are to an analysis outpatient waiting time, patient satisfaction and recommendation towards minimizing long wait time. The application of Six Sigma will be utilized in this paper to pinpoint the delays and suggest alternative methods to improve management capabilities.

INTRODUCTION

A question we often ask ourselves is, "why is it as important to us as customers to receive good service?" Well its simple, we want to be recognized for the human factor and the values it holds. As a customer we experience this on a daily basis, there are numerous transactions that are made by millions of people whether it's materialistic or humanistic. In the health care business people are dealt with the notion of sensitivity that is what we want to believe is happening and being practiced, but is it? [5]

The critical issue that hospital "A" faces is the waiting time in the registration process before a consultation is done with a Technologist/Nurse/and a Radiologist. The registration time starts from the moment patient arrives for his/her appointment. The process of getting all the financial clearance and retaining records is all part of registration from a patient's point of view and having delays in this process increases the chances of patient frustration, loss of referrals from private offices, and bottom line losing business for the hospital [5].

Currently, there are significant delays that range from 20 minutes to an hour when simply registering outpatients for their scheduled tests. A patient getting delayed by an internal process causes a domino effect which leads to additional delays in the procedure preparation area, causes a bottleneck which involves all modalities of the radiology department especially if the patient is having more than one exam done. This results in to an overload of tests that are pending and increases wait time for outpatients and inpatients.

Consumers today look for values in every dollar they spend; customer service is one of the areas where they demand value. The health care industry is no different; consumers have a lot of choices and will spend their dollars at a facility where they feel a sense of value.[5]
The scope of this paper is to understand what was happening at the Radiology department at Hospital "A". Numerous complaints have been made about the registration process, so we decided to use the Six Sigma DMAIC Model on the current registration process in place. DMAIC Model will be applied as a tool to explore the chronological phases for this process.

The complaints that were coming in part were due to significant delays in the registration process. Those delays led to a domino effect of additional delays in other area, resulting in agitated patients and staff members along with increased waiting times. To do our analysis we created our project charter:

Transformation of Hospital "A" Radiology Registration Out-Patient Area

Overview
Our project will focus on the as is process and recommend a new process based on the defects we uncover via the Value stream mapping process.

Team
- Champion: Hospital "A" Radiology Managers
- Black Belt: Professor Marose
- Green Belt: Vandana Khan
- Green Belt: Pat Knecht

Customers
- Senior leadership
- Patients
- Doctors
- Technologists

Goals
- To reduce complaints of waiting times.
- To limit patients complaints
- To speed up results for our Doctors
- To reduce stress levels of Technologists by reducing bottleneck

Background and issue at Hospital "A" Radiology Department:
Hospital "A" is a midsized institution with capacity of 700+ beds, located in a large metropolitan area. The hospital is a not for profit as well as learning institution, it is comprised of multi-functional, inter-related departments such as: Emergency, Radiology, Hematology , Surgical unit and etc,   For the purpose of this paper we will focus on the Radiology department's outpatient registration process.   Using the DMAIC model, our first phase is the Define Phase. In this phase we define the current process.

Current Radiology Process:

The Radiology department consists of multiple modalities, where various procedures are performed. Some of these procedures consist of Biopsies, Ultrasound, Cat-Scans, MRI, Nuclear Mammography, Etc. We took that in consideration when defining the current process.

<u>Patient Registration Process consisted of these steps</u>:

1st Step
- Patient arrives at the Radiology front desk.
- One of the registrar's will check the patient in Outlook (radiology's personal departmental system for keeping track of appointments and prescriptions and insurance authorizations) to check patient in.
- The Patient's name is hand written in the Log –in Book.
- The Patient is given paperwork to fill out and is seated in the Front Desk waiting area.
- When patient has completed filling out the required paperwork, the paperwork's is put together by the registrar and is then placed in the box on the door by the financial counselors.

2nd. Step

- The Financial Counselor will take the paperwork to begin the initial registration process the patient to have their test done. The patient's name is called and is taken to the back to get registered in the HIS (hospital information system), RIS (radiology information system) and Rombus (financial registration system).

3rd. Step

- The Financial Counselor will sit with the patient and go over all the demographic information, insurance information, and update the patient's records if needed. Then he/she will generate an Accession (procedure number) number and a Medical record number. After all the information is in the systems then the financial Counselor will escort the patient and the completed paperwork back to the front desk area.
- An ID bracelet is processed and is fastened to the patient's wrist, patients labels are picked up, and the paperwork is placed in black slots or is hand delivered in the procedure area depending on type of exam.

    Type of exam's placed in Front Desk Black Slots:
        (a) CT Oral Contrast
        (b) IR Procedure
    ii) Type of exam's placed in Back Holding Area Black Slots:
        (a) Ultra-Sound
    iii) Type of exams Hand Delivered to each modality section:
        (a) Mammography
        (b) Mammographic Biopsy
        (c) MRI

iv) Type of exams patient is escorted in the department:
  (a) X-ray
  (b) Nuclear Medicine

Our next phase in the DMAIC model is the Measurement phase.

       We prepared a baseline survey (Appendix A) to define the critical areas and validate the measurement via a scatter diagram and the regression analysis. The output of our survey showed that the critical issue is the waiting time a patient has to deal with from the time of registration until the time of consultation with a Technologist/Nurse/and a Radiologist. The process is cumbersome, from the point of gathering the financial data for clearance to retaining records. They defects in this process increases frustration, loss of referrals from private offices, and top line revenue losses for the department.

       It is noted from the visual assessment in the registration area has high noise levels, and there seems to be a pattern of lack of courteousness towards patients, confusion amongst the check in staff and financial counselors on paperwork hand off.

Our next phase in the DMAIC model is the Analyze phase; we saw that our key processes had a direct effect on our output. Through brainstorming and limited value stream mapping of the process we were able to ascertain that we could reduce defects immediately.

1. Relocation of Front Desk Black Slot as there is limited functionality and causes confusion amongst Techs and clerical staff. Our suggestion is to locate the slots on the left hand side by the door. All Black Slots should be at the Front desk and Technical staff must come out to the front for paperwork pick up and to escort patient to procedure room.
   - *This reduces the defect of misplace paperwork and patients.*

2. New improved method of informing Technical/Clinical Staff in the back:

   1st. Call should be made to the back Control area once Pt. arrives to notify staff of pt's arrival. 2nd. Call should be made to back Control area once Pt. is fully registered, ask the RN/Technologist how long the wait is until pt. will be taken. Patients must be kept informed of their wait time and offer an alternative appointment to the patient if wait time is too long due to uncontrollable circumstances ex. Equipment failure, emergency procedure patients were bumped.

   - *This reduces the defect of frustration; the patient will be fully informed and able to make their own choices.*

   Staffing issues needed to be addressed, as there are times inadequate staff and/or unusually high demand will cause the delay. Currently when an individual does not show for work there is no back filling for the staff.
   - Increasing the number of headcount, could eliminate this issue, however a feasibility study would need to be done later in the process
   - We can also rearrange the set up we currently have.
     1. Pre-register patients

2. Add 1 more computer to the front desk for additional financial counselors. (Having patient walk to the back and then go to the front to wait causes inconvenience for the patients; especially the elderly ones.)
3. When a patient arrives have them sign a "Sign – In" sheet with time of appointment and time of arrival. If a patient doesn't have their forms filled out, give them the required forms and write down on top of the form the next sequential number.
4. This will give the patent some time to fill out the paper work and gives them peace of mind that they are next in line to be called.
5. Each financial Counselor will call out the next number in the correct sequence to complete the registration process with the pt.
6. It is very important that the front desk communicates with patients: Inform them of anticipated waiting time, if there are any delays; what is the cause of the delay and how is it going to be resolved.

In the DMAIC Improvement phase we saw with our scatter diagram that there was a relationship between Y (Overall satisfaction) and X3 (Waiting times). After reviewing the process with the registrations senior leadership, we were able to map the entire pre-register process from the beginning to the end.

Pre-registrar Process:
When a patient calls to schedule an appointment, the "Scheduler" will book the next available appointment and start the "Quick Registration Process". He or she will get the basic information from patient, such as: Patient demographic, Type of Insurance, Contact information and Name of Referring physician. Upon completion of this process a Medical Record number and an Account number is generated for new patients. Patients who are already in the system get a new account number to process the exam. All of this information is then linked to an On-Trac registration system.

The On-Trac system will automatically distribute patients according to their last name in two separate sections (A-N and N-Z). The two categories are assigned to two specific registrars who will then make attempts to reach the patients to complete the pre-registration process. They will make sure that the patient has a script, get authorization from Insurance for the procedure and fill in any areas that were not completed during Quick Registration. This step is done 3 – 5 days prior to the patient's appointment.

Patients who were reached prior to their appointments:
Radiology Financial Counselors prints out the schedule for the following day from Outlook for each modality. If all of the information is in the system along with insurance authorization, the Financial Counselor will print out the Requisition, wrist band, and any other required questionnaire forms, put them together and file them in the specific modality folder. When the patients arrive to Radiology, the Financial Counselor will verify the information with patient and retrieve the paper work that was printed out the night before.

The next phase in DMAIC is the Control phase. This phase monitors all improvements and assigns accountability for each process. By doing that we would see sustained improvements.

Businesses can no longer afford to ignore complaints, process variations and defects need to be identified and eliminated to maintain a satisfied customer base.

Long Term Goal toward Efficiency:
Suggestion on a long-term goal is to have a patient portal system through the hospital web-site. The hospital web-site will allow patents to log-in and update their demographic, insurance, contact information. The portal ideally should link with the current RUMBA system. The average time it takes for processing each patient for registration at their time of arrival is estimated 15 min. per financial counselor.   That's a too much time wasted, if we are able to steam line this process we could see more value add in the actual procedure area. Creating a hospital website that has a patient portal to access their test results and register before coming for their appointments would be the way ideal way.

A case could be made to add the long term goals as a black belt project within the hospitals six sigma professionals. Six-Sigma a quality innovative tool to improve the current situation and most of all have a root cause analysis so improvements can be implemented. Six Sigma a quality initiative tool was pioneered at Motorola Corporation in the 1980's, and is based on rigorous statistical process control, it a systematic problem solving. It targets the root cause of the variations and then redefines the process for long term results. Six Sigma's methodology has been applied in the business world from all variations and types of business which includes the health industry. It has helped the health care organizations in developing higher standards by improving their defects in efficiency [3].

Ethical Issues:
Ethical issues is a very important topic in the healthcare management and the healthcare industry takes many precautionary steps in protecting the patients information which can be personal and private when it's on the web [1]. There was a time when patient's information was given out to anyone who claimed that they either knew the patient or acted as the patient and no questions were asked. As time has changed and technology is a major part of our daily lives we are able to share information in many ways in a split of a second, which can be very beneficial at times and also can be a negative factor as well.

Now a day's majority of the hospitals is all HIPPA compliant and has secure patient portals for allowing patients to see their results, make appointment, and update their demographics and insurance information. We need to keep in mind that while it's important for hospitals to market their services it is very important to keep the patient's personal information secure at all times [2]. This can be done when hospitals and marketers make sure that the information's that is being provided by the patient is accurate and personal information stays secure.

As we head towards to future and technology is the number one factor that is going to be the main center of all attraction. We as healthcare providers need to continuously strive to improve on the patient portal access sites to provide firewalls and security systems that enable other who are not authorized to gain access to the individual's personal information [2].

Conclusion:
        In conclusion, it is our belief that a hospital that moves forward and implements a methodical process such as Six Sigma tends to deliver consistently better results to its customers.

More importantly, a carefully executed process improvement can deliver real cost savings to the bottom line. The improved productivity leads to less errors and a happier staff. The belief that hospitals can use the trial and error principle can be costly. If as patients are inconvenienced or unhappy they can very easily move onto another location without any personal costs. It is our opinion that that a disciplined process such as six sigma is essential to optimize the relationship between the patient and the hospital.

Hospital "A" would greatly benefit from continuous improvement (Kaizan) and should monitor its progress on a weekly basis utilizing upper and lower control limits. If a Jidoka occurs, the process can be looked at immediately to see if there is a breakdown of the process or an anomaly occurred.[4] If it is a true process break, the hospital will have early involvement to limit any further defects. This process, Poke Yoke, is also known for squeezing out defects of the process and correcting them as they occur [4].

Appendix A

Radiology Patient Registration Survey

X1	The registrar was professional and courteous………………… 5 4 3 2 1
x2	The financial counselor informed you about our policies and procedures…………5 4 3 2 1
x3	The registration process was efficient and timely………………5 4 3 2 1
Y	How would you rate your overall registration experience…………………5 4 3 2 1

Surveys	Y	X1	X2	X3
1	4	5	5	3
2	4	5	4	3
3	5	5	5	4
4	4	5	5	2
5	4	5	5	3
6	4	5	4	3
7	5	5	5	4
8	5	5	4	4
9	5	4	5	4
10	5	5	5	4
11	4	5	5	2
12	4	5	5	2
13	5	4	5	4
14	5	4	4	4
15	5	5	5	5
16	3	5	5	3
17	4	5	4	3
18	4	5	4	4
19	3	3	4	2
20	5	5	5	3

x1	Professionalism & Courtesy
x2	Informative
x3	Timeliness & Efficiency
Y	Over all experience

Scale		
	5	Very good
	4	Good
	3	Satisfactory
	2	Poor
	1	Very poor

Based on the scatter diagram, the area of concern looks to be X3
The overall satisfaction is being driven downward due to x3
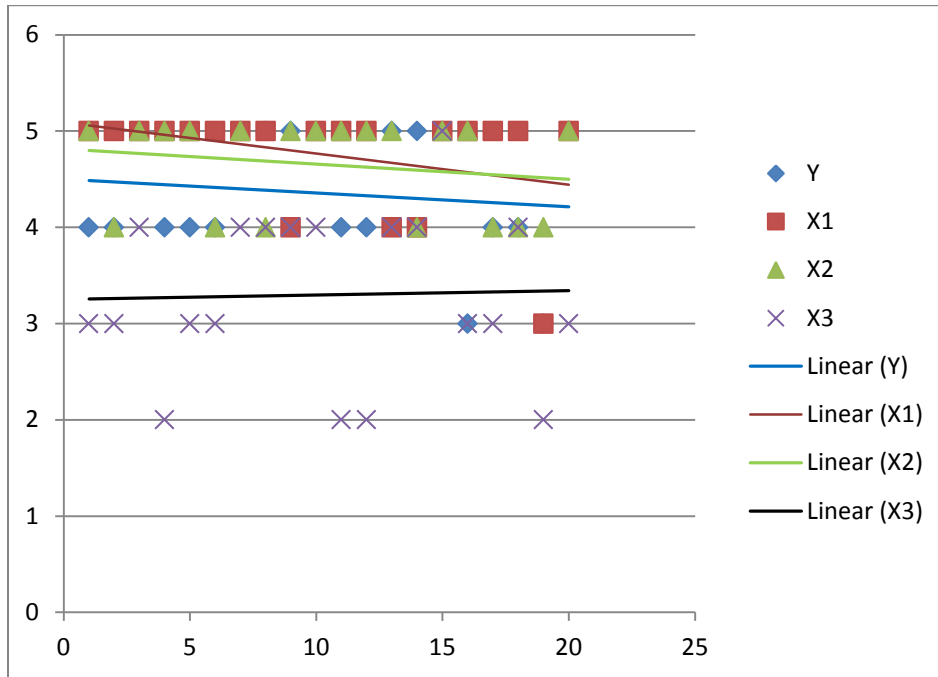
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.106965637
R Square	0.011441648
Adjusted R Square	-0.043478261
Standard Error	0.685248289
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.097826087	0.097826087	0.208333333	0.653536368
Residual	18	8.452173913	0.469565217		
Total	19	8.55			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	3.730434783	1.366020257	2.730878085	0.013720374	0.860532722	6.600336843	0.860532722
X1	0.130434783	0.285768291	0.456435465	0.653536368	-0.469942117	0.730811682	-0.469942117

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.232476601
R Square	0.05404537
Adjusted R Square	0.001492335
Standard Error	0.670319662
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.462087912	0.462087912	1.028396739	0.323973833
Residual	18	8.087912088	0.449328449		
Total	19	8.55			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	2.868131868	1.468932977	1.952527387	0.066605925	-0.217981795	5.954245531	-0.217981795
X2	0.318681319	0.314250705	1.014098979	0.323973833	-0.341534912	0.978897549	-0.341534912

Multiple R	0.716968147
R Square	0.514043324
Adjusted R Square	0.487045731
Standard Error	0.480447105
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	1	4.395070423	4.395070423	19.04033898	0.000374503
Residual	18	4.154929577	0.230829421		
Total	19	8.55			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%
Intercept	2.514084507	0.434240577	5.789612113	1.73893E-05	1.601778909	3.426390106	1.601778909
X3	0.556338028	0.127497424	4.363523689	0.000374503	0.288475881	0.824200175	0.288475881

Appendix B Value Stream Map current process:

Map of the Current Radiology Registration Process
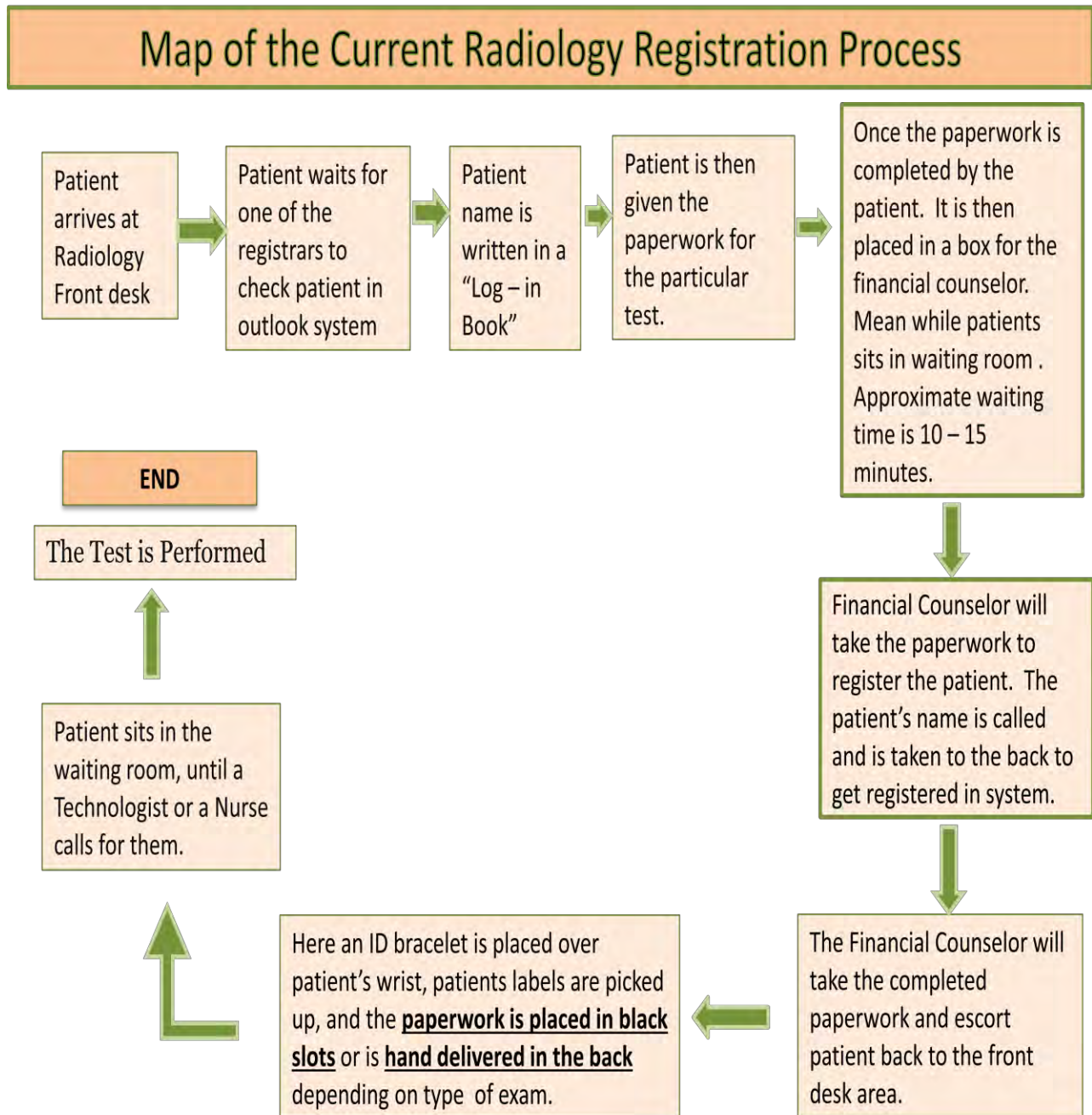
Appendix C Value stream map improvements:

Map of the New Proposed Radiology Registration Process

START

- Have a sign in sheet for patients. To keep track of their appointment.
- A week prior to Patients exam, Pre-registration process is initiated by calling the patient at home to collect the necessary information for registration process and is told to go on the hospitals patient portal site.
- Patient fills out the necessary paper work for the exam from patient portal site.

- Registrar checks patient in the system.
- Registrar starts the registration process if patient is not pre-registered (2 min. process of updating patients information)
- Hands patient the necessary paperwork for the exam if paperwork is not completed prior.

- Registrars informs the Technologist in the Control area about patients registration ready status.

- Registrar escorts patient to changing room and has patient wait in side the control area waiting area.

END

- Technologist or Nurse will greet patient from the control waiting area and will escort them to the procedure room.

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**2013 Annual Meeting of the Northeast Region Decision Sciences Institute.
April 5-7, 2013. Brooklyn, NY. Call for Papers Paper Proposal. (NEDSI 2013 --
www.nedsi.org/conf/conf.htm)**
**Track: Services and Health Care Management. Offering streamlined care in a
single location. Focusing in on outpatient care taking the inside track.**

Sole Author and Presenter: David M Chapinski

The idea of offering streamlined care in a single location has helped shape the
system's health park concept, an effort that has been under way for the past five
years. Today, in Georgia, WellStar Health System, a five-hospital health system, is
opening the first of a series of planned health parks or assembly of many different
types of health services into a single setting. Medical laboratory testing is but one of
the clinical services contained within these health parks. But with the financial
incentives lining up for health systems to focus on total population management
rather than just acute care, the shift has been accelerating. Until the early 1990s,
outpatient care accounted for only 0% to 15% of hospital revenue. Today that
figure is closer to 60%.[i] Health parks are one response to the steady increase in the
demand for outpatient care that is not tied to a hospital. It's also a shift that's been
happening across the board sweeping along academic medical centers, community
hospitals, for-profit chains and not-for-profit providers alike. And it's showing no
sign of slowing. We must remember that while healthcare reform can't account for
the whole story behind the recent acceleration, we can still wish it were more
introspective in accountable care organizations, because that would make the story
more benevolent in a way.

I believe that it is a very profitable move to switch to outpatient. The market for
outpatient services has gotten bigger- and hospitals, which used to control about
90% of it, now have just 50% of a much larger pie. The other element I will argue is
that it's something patients value. That is another impetus. At some locations, the
system doesn't just want to be a place where people come when they're facing an
illness, but where they seek information about staying healthy. Many of these

people will not be patients; they're not sick and they will not be treated. You're trying to create a business relationship before a need for treatment occurs.

I will make the case that outpatient zones of care, which are either dedicated areas in an existing facility, a separate location within the community or even art of its Advocate at Work program, which brings healthcare services into office buildings are important to a strengthening of services. We learn how the more care we can take and get closer to the patent the better. We can attribute the growth in outpatient services to new technology that allows patents t be treated less invasively, with less in-hospital monitoring, as well as new payment models that encourage earlier care as a way to prevent costlier illnesses and complications later on. We are seeing an opportunity to be reimbursed in a way that emphasizes both the quality and the total care of the patient. There's an issue indeed, too, in that the economics of outpatient activity are better than inpatient. Outpatient care also becomes more strategic for hospitals, as it is not only revenue but also income that is increasing from outpatient services. I do think this is one of those overarching trends. This is something that's on the agenda at every health system.

Finally, I believe that we can attribute the performance to a strong showing in outpatient care, which helps counteract weak inpatient volume. Not only is outpatient care more cost effective to deliver, but it also attracts more patients with commercial health plans at a time when Medicare and Medicaid reimbursement is being squeezed. Considering about 60% to 70%[ii] of all surgeries are now done on an outpatient basis, the rising cost of inpatient care has led to the expansion of outpatient care. Outpatient services are key to hospital's success.

As a result of rising healthcare costs, there is an increasing interest on the part of healthcare payers and providers to develop statistical models that can accurately predict future healthcare expenditures. With that being said we need to follow four techniques which are greater reliance on standards and guidelines, routine and systemic interval measures of patient function and well-being, with disease-specific clinical outcomes, pooled clinical and outcome data, and appropriate results from the data base analyzed and disseminated o meet the concerns of each decision

maker. Competency is arguably the most prevalent buzzword in medical education today. The concept of competency is incapable of assaying those qualities that should be the most important to us in medical education. We still cannot lose sight of the fact that almost the entire drop in mental health or substance abuse costs has been attributable to a decline in the number of inpatient hospital days for children and adolescents. Parity mandates, for example, do not lead to cost increase. Still, flexible spending accounts (FSAs) for health care are one way to lessen the impact of cost sharing on individuals and families. Streamlined care will also be affected by U.S. health care spending which is expected to increase for the next decade reaching $4 trillion in 2015, or 20 percent of GDP in 2005, employer health insurance premiums increased by 9.2 percent, nearly three times the rate of inflation.[iii] The diffusion of new medical innovation is assumed to continue to drive spending upward. We should expect that this factor will be spirited by continuing attempts to increase efficiency in the application of new technologies and to target them more appropriately to the populations most likely to benefit, as information is gathered and applied more quickly.

But, the need to account for cost and quality requires systems to have greater control over the entire spectrum of care, from promoting wellness and prevention to offering post-acute and home health services. I believe that it is a drive to deliver more accountable care. We are now necessarily and willingly and enthusiastically thinking about the patient when they're not a patient. This competitive dynamic is an interesting one in the face of both the public and private sectors since the value chain does not change considerably over the same ecosystem.

Although long-range projections to streamlined care offerings are by nature difficult and carry a larger degree of uncertainty, governmental proof the Congressional Budget Office (CBO) makes projections of total healthcare expenditures over the next 75 years. Extrapolating areas like the historical rate of health care spending growth relative to GDP growth into the future, however, produces projections that are implausible: by growing 2 percent faster than GDP over 75 years, spending on health care would consume virtually the entirety of our national income.[iv]

Because the assumed rate of health spending growth is higher than GDP growth, there is projected direction in National Health Expenditures (NHE) which is that it will grow to consume 38 percent of GDP by 2075. Accordingly, at a growth rate of GDP+1 (i.e., 2.6 percent), NHE will consume 48 percent of GDP by 2078, more than 80 percent by 2130, and more than 100 percent of the economy's resources by 2154.[v] While in reality NHE will never plausibly exceed GDP, we find emphasis that these projections are not predictions; rather, the purpose of projections is to show us, for example, that the magnitude of the Medicare financing problem in the absence of any reforms. So how do we protect those who serve? What is the answer to a question that poses such conscious effort to even answer?

There are 4 pitfalls to clinical integration. From an antitrust perspective, the FTC and DOJ have defined clinical integration as an active and ongoing program to evaluate and modify practice patterns by the network's physician participants and create a high degree of interdependence and cooperation among physicians to control costs and ensure quality[vi] However, with the government's repeated attempts to offer incentives for EHR adoption, it is easy to draw the conclusion that the FTC and DOJ do in fact require clinically integrated providers to use an EHR to track, monitor, and report upon provider performance. However, in reality, the FTC and DOJ have been hesitant to tell providers what specific steps they should take to achieve meaningful clinical integration. These agencies have looked favorably upon EHR adoption as part of a clinical integration effort because the adoption of this technology shows an investment of time, effort, and capital by the network's providers and signifies that the network has a long-term commitment to the model. However, no specific threshold for EHR adoption appears within the decade of FTC and DOJ guidance on establishing meaningful clinical integration.

From a practical perspective, EHRs can be powerful tools that enable providers to appropriately manage patients at the point of care, but having such a tool is only part of the clinical integration equation. Clinical integration also requires providers to audit their performance and proactively manage populations of patients. It

requires data aggregation across various providers and IT platforms as well as sophisticated data mining, analysis, and reporting capabilities that the cur- rent generation of EHRs tends to lack. As a result, many successful clinical integration programs The extent to which participating physicians and administrative support staff understand the impact of clinical integration on their day-to-day activities is a strong predictor of the long-term success of the program. I believe that we have downplayed their focus on implementing EHRs in favor of deploying comprehensive clinical registries to fulfill their business intelligence gaps. Rather, promoting EHR adoption should be a part of any clinical integration program's long-term strategy because it will increase the ease and accuracy of data collection for providers and their office staff. That said, providers with low levels of EHR adoption should not delay the start of their clinical integration efforts simply because they have not yet achieved meaningful use of an EHR. Clinical registries can serve as a bridge to a fully integrated EHR and enable providers to begin their clinical integration efforts well before achieving meaningful use.

When it comes to ambulatory support of clinical integration, another common pitfall is the erroneous decision to delay development of ambulatory services that support clinical integration. This ineptness hurts streamlined care due to the fact that hospital and health system executives often are making this mistake on their own; seemingly from typically two factors that influence their decision to support and dedicate resources to clinical integration programs, motivating them to focus initially on inpatient services.

We must recognize that because much of the inpatient value equation, namely physician behavior and decision making, lies outside of the control of hospital and health system leaders, the impending implementation and expansion of value-based purchasing programs by both governmental and commercial payers presents a growing liability to many organizations' balance sheets. This situation applies particularly to healthcare organizations that depend on independent providers. Clinical integration do provide healthcare administrators with a means to effect

change through influence or, more accurately, incentives in lieu of direct authority but we can do more.

Many hospitals and health systems self- fund their employees' healthcare benefits. Just like any other self-funded employer, these organizations are seeking innovative ways to curb escalating health benefit costs. Many hospitals and health systems have become early adopters of the clinical integration model as a means to manage their own employees' healthcare needs efficiently. Because hospitals and health systems have a vested interest in the success of their clinical integration programs, it should not be surprising that many programs' initial efforts are skewed toward optimizing inpatient care. The inpatient setting presents significant opportunities for reducing waste, so it can seem quite reasonable to begin the clinical integration effort by embarking on a three- to five-year strategy focused on this area.

A hospital or health system's inpatient information systems can provide data and resources to enable the emerging clinical integration program to achieve early wins in its first few years of operations, thereby helping the program prove its business case, attract payers and employers as long-term sponsors, and decrease its reliance on hospital or health system funding overtime. The problem is that hospitals and health systems are not the sole stakeholders in clinical integration programs. Despite the important role these organizations will always play, the long-term "sponsors"[vii] of such programs should he payers and employers. Once these second-generation stakeholders become engaged, outpatient and ambulatory care will become increasingly important value drivers for clinical integration. Payers and employers will realize their full value from a clinical integration program when the program effectively decreases incidence of acute illness or injury, prevents or slows the progression of dis- ease, optimizes the clinical resources utilized across the continuum of care, and ensures that transitions in care are smooth and safe.

Providing more services does not necessarily lead to better outcomes as we pursue streamlined care. Populations of patients with progressive chronic conditions in high-spending regions do not have higher survival rates or better quality of life.

Although the quantity of care may be greater, the quality of care is not better. In fact, more care may actually be worse. Chronically ill patients are actually at greater risk of dying in higher-spending regions.[viii]

We need to examine the costs of organized practices such as the Mayo Clinic and Intermountain Healthcare and the quality of care they deliver since they estimate that if all providers could achieve the same level of efficiency for inpatient spending on supply-sensitive care, Medicare hospital spending could be reduced by as much as 28 percent to 43 percent while quality of care could be maintained or improved.[ix]

The second major source of variation in the cost of health is the amount of preference sensitive care delivered. Preference sensitive care involves treating conditions where there are several legitimate treatment options, and the decision over which treatment to use involves tradeoffs and can significantly either promote or hinder streamlined care. Today's health care manager occupies a challenging position: how to maintain a competitive edge in the health care market while leading an organization through constant change. Rapid change is occurring as health care organizations (HCOs) strive to adopt new technology such as the electronic health record (EHR), implement quality improvement initiatives, and institute pay-for-performance plans. To deal with this change and help employees' transition to new ways of doing things, managers need an edge. We need to follow change management and focus on how new ideas can be used to successfully implement a change management project. During any period of change, a manager must deal with feelings of complacency, anger, false pride, pessimism, arrogance, cynicism, panic, exhaustion, in- security, complacency, and anxiety among employees. These are all emotions that can undermine attempts at promoting change within a healthcare institution. We need tools for turning these negative feelings into positive proactive feelings such as faith, trust, optimism, urgency, reality- based pride, passion, excitement, hope, and enthusiasm, emotions that promote change. A second major idea centers on the mindset that a health care manager must adopt before setting out on a change initiative. We need a 'think-

change' mindset as a traditional method used by managers to initiate change. At this level, the focus is on cognition and rational thought, by presenting individuals with information in the form of reports, PowerPoint presentations, and Excel spreadsheets, which form the basis of analysis. This leads individuals to change their thinking and, ultimately, their behavior. For some, this mindset rarely uncovers the 'big truths'[x] about why change is necessary. Employees do not need 200-page reports to show them why paper patient documentation hinders physician decision-making and generates increased risk of medical errors. Moreover, analytical tools work best when parameters are known, assumptions are mini- mal, and the future is not as fuzzy. Finally, according to some, analysis rarely changes how people think, and it does not send people running out the door to act in significantly new ways? To drive home this point home, when employees are motivated, it is something that they feel in their hearts and not in their heads that impel them into action.

To address policy issues to offering streamlined care in a single location, a Congressional plan for health care reform will almost certainly focus on universal health care coverage, preventive health care, and some form of centralized decision making to improve efficiency and quality in the system. As hospitals look at their distribution models, many will recall the spending for specific products in the distribution channel. However, simply relying too heavily on this data source can and will prove misleading and hospitals should not evaluate their distribution channel usage without first analyzing additional factors. The spending for manufacturer-directed items will clearly outweigh related 'spend' for med-surg items but we must remember that this is due to the fact that PPI plays a major role in direct purchases and is therefore where the majority of direct-manufacturer purchase dollars are spent.

Many healthcare institutions need both a recruiting management and a new onboarding solution to set them on the hunt for the best vendor options. An organization that chooses to bring a list of needs it has developed at a must haves crossroad must also have a well thought up list with other vendors. After
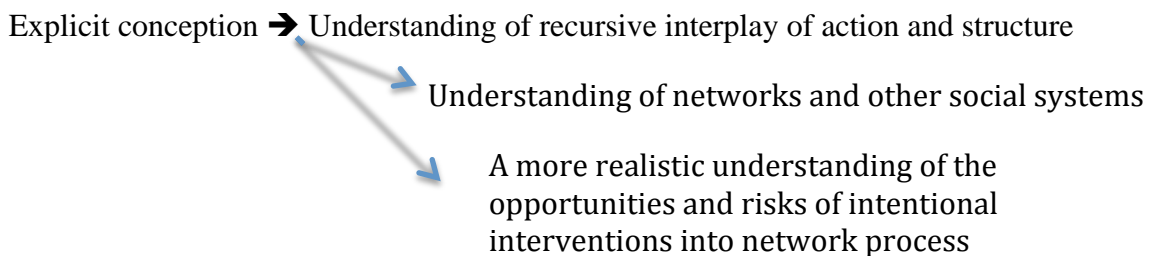
comparing offerings to their list of tastes, these are the companies that can better identify possible choices for their healthcare management. For example, the configurability can enable an agency to go in and out of the job code templates and change different things that they need to change, helping to get jobs posted in real-time and immediately.

We must remember that to make a whole system work better, you have to change how the system works not just the people in the system. To understand how to make the system work better, we have to understand how it works now. We have to understand how we gave ended up paying people vastly more than any other society and getting mediocre results. The core of the inside track focus to healthcare argument is still a monetary one based about healthcare as an economic system. Just like when the price has nothing to do with the value of what we are offering in a business, the irresistible incentive is to offer the least value for the price. For example, when we look at other countries with major, advanced healthcare systems this is what you see: whether you measure it by percentage of the economy (GDP) or in dollars per person devoted to healthcare, a few countries spend about two-thirds of what the United States does; the rest spend half or less. And they apparently get more for their money too. Opportunity costs and social costs are not only lucidly important to the economics behind new healthcare management, the rationale is a willing one but also the arithmetic to getting us there is weak. Since every dollar amount that is paid in healthcare is influenced by something other than a pure, free-market price, when you add them up, no one knows what the aggregate number really means. Basically somehow muddling the fact even more is that the aggregate number means what it says it means: when you add up the actual amount of cash that one pays for healthcare, it is really large.

There are a number of ways[xi] of estimating the waste in the U.S. healthcare system. Some of us may look at variation and conclude that if you are paying more and not getting more, then that is waste. Health professionals themselves indicate that the problem of attaining shared agendas for enacting services is an apparent thing

within their sector as well as beyond it. For example, ICT- based care is more than just a technological intervention; it includes a way of thinking about how to deliver health care with the aid of ICT. However, the most important modalities of ICT-based care are teleconsultation and videoconferencing. Teleconsultation is a kind of telemonitoring including patient-caregiver communication or monitoring and delivering feedback via email, phone, automated messaging systems, other equipment without face-to-face contact or image and voice via videoconferencing equipment like television, digital camera, videophone to connect caregivers and one or more patients simultaneously, usually for instruction. Reflexive monitoring is important to the pattern of collective action and their outcomes, which are continuously evaluated by participants in implementation processes, and the formality and intensity of this monitoring indicates the nature of cognitive participation and collective action.

Network management, a reflexive structuration, contributes to the development of the network, intentionally or unintentionally has led me to developing a model in which network agents will consider the particular stage of network development they are in more than before. We will move past the developmental stage that the network has taken us so far.

Explicit conception ➔ Understanding of recursive interplay of action and structure

Understanding of networks and other social systems

A more realistic understanding of the opportunities and risks of intentional interventions into network process

Network evaluation must be understood here as a process of interaction in which managers by reflexivity monitor the contextual embedded activities and their effects and try to control the outcome and eventually the process of organizing with respect to particular criteria. I dedicate my first theory of more streamlined care in healthcare management through: H_0: $a \geq b \rightarrow c$ where a represents the criteria for making healthcare more streamlined, b represents the indicators and time horizon

of evaluating a telehealthcare program, and c represents occasion and the subject of tele-health evaluation.

So what are the endogenous factors that affect implementing professional and other tele-health technologies? Among the main drawbacks of some outpatient care I find is its analytical dimensions in which human and machine agencies are treated as one in the same. I would argue that the complexity and number of networks increase as the number of telehealth services crosses paths with political realisms and the social and cultural avenues have thus been ignored. Yes, there are unintended consequences shape the outcomes of introducing technology in a network that might not always be desired and expected, but that unintention through ways of technology use actually increases when users and designers are spatially absent or distanced. F we diffuse innovation from a systems perspective, technology will be conceptualized differently both by the consumer and the agency.

H_0: $a \geq b \rightarrow c + d$ (relative advantage of loss of identity)

Sometimes a loss of identity is a good thing if we are trying to offer streamlined care. Particularly in the degree to which an innovation is perceived as better than the idea that it supersedes. Healthcare, we must remember, is a high touch and time-sensitive service. Patients and providers may need immediate access to treatment rooms, prescription medications and personal health information (PHI). So what if the patient has a medication condition or allergy not noted in the most recent treatment documents tele-health technology is supposed to service and associate care received with. To me, it is much like saying those who stole or borrowed our identity in the hospital will continue stealing from us outside as well. Business processes and the decisions that surround and support the technology play an important role in PIM and streamlined care. While business process should identify the workflow, policies and procedures to ensure PI Integrity need to be less self reliant on a singular-holder group that is simply go after involvement and support at the most basic levels of operability.

There needs to also be a certain level of triability or the degree to which a tele-

health innovation may be experimented with on a limited basis. There is a consonance and a dissonance if you will, which argues that an individual 's behavior is attributed to their constant effort towards eliminating or reducing the uncomforting feeling due to change. I believe that conceptualization of tele-health technology will benefit the healthcare community as a whole since its understanding of being the particular area of transformation under investigation apart from new technology is often viewed from the perspective of organizational front. In other words, these areas of transformation can also include change in organizational culture and work force.

We need to recognize that electronic health or e-health is much broader than telemedicine or tele-health. E-health, to me, is the prelude to medical devices and the managing the mismatch barriers to innovation in the field of medical devices. We must remember that medical innovation can be a highly contested area of decision-making, where clinical evidence; technical attributes of he technology and data on cost-effectiveness only partially influence implementation. For example, the failure to diffuse widely based on the strengths of evidence alone is the use of the computer support systems for treatment of diabetes in primary care. To this day, many practitioners are still not convinced that the evidence supports their own patients in primary care, and similarly feel that even the most guaranteed standards are not appropriate mainly for acute cases of diabetes.

How ironic is it that the need to increase access to health services to underserved populations occurs as these populations are adversely affected by misdistribution of financial resources and health professionals. In developing e-Health services to increase access to health care for these populations, we are providing services through controversial or unproven mechanisms and/or when there is no alternative. Certain companies like AT&T are at the forefront in helping healthcare providers to qualify for stimulus funding by achieving the meaningful use of technologies outcomes required by the American Reinvestment and Recovery Act or improving service quality, safety and efficiency and reducing health disparities

engaging patients and families, improving health care coordination; improving public health and ensuring adequate privacy and security protections for personal health information. Companies like AT&T that have developed a modular and incremental approach to adopting health information technology gives physicians and other providers access to best-of-breed applications, including ePrescribing, telemedicine, PACS images, lab results, radiology reports, and others. Herein lies successes through streamlined care, not to mention, having a multi-vendor approach lets healthcare providers share information more easily and securely to meet stringent HIPAA requirements.

I believe that the future of adoption and expansion of tele-health likely rests with future payment practices among private insurers and healthcare providers. However, what is the motivation or reason for e-Health services to be funded in places like private payers? We must continue to answer questions like are systems of care that are dependent upon public funding and reimbursement equivalent to systems of care that are dependent upon private funding? As health information and health services become available through the Internet, many new questions continue to emerge. For example, will e-Health services be included as part of a defined set of basic services that all Americans should have access to? Should access to electronic health information be considered central to accessing the full array of health services in the future? Is our reasoning and subsequent decision-making fully explicit when we define policy that endorses or compensates e-Health services?

Streamlining care does not come by way of simply 'Cloned' documentation producing cutting and pasting of information from previous patient visits. These types of shortcuts continue to be a significant problem that duly creates unnecessary redundancy and at times inaccurate information. The information technology industry generally will agree that computerized medical records can lead to higher costs. But we should instead argue that the software we do pursue will makes it easier for doctors and hospitals to more efficiently document all of the work that they do, which in turn rid the failures to do so by hand and on paper.

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Emerging Strategic Opportunities Surrounding the Evolution of Telemedicine

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Abstract

This paper presents a model and two scenarios that have been developed to assist decision makers in planning for the impact of telemedicine in both developed, and developing nations. A vision of ubiquitous access to health-monitoring and healthcare is explored and emerging approaches described, however there remain many formidable obstacles to the realization of telemedicine; some are technological, others relate to the development of international standards for medical record systems, and other challenges are related to human acceptance, as well as the development of appropriate and compelling business value chains.

Emerging Strategic Opportunities Surrounding the Evolution of Telemedicine

Introduction
Across the globe telemedicine is being adopted in response to escalating demand for healthcare services from a population that has passed the point of 7 billion. Telemedicine refers to the delivery of healthcare services via the Internet - a Radiologist located in California can provide a diagnosis for a patient living in Nepal. Telemedicine has been adopted by the armed services to deliver a diagnosis on the battlefield, and a course of psychological counseling sessions can be delivered using Skype. These services can be delivered via smart phones, medical devices, apps and cloud computing. The growth of telemedicine has implications for a range of industries and stakeholders. This paper presents a model and two scenarios that have been developed to assist decision makers in planning for the impact of telemedicine in developed, and developing nations, as well as to provoke further discussion.

Literature Review
The literature pertaining to this field has grown rapidly and reflects a number of important characteristics. Firstly, the field of telemedicine is broad and spans medical practice, telecommunications, operations strategy and marketing. Secondly, as the field has evolved, the terminology used to define it has become specialized and fragmented to encompass e-Health, m-Health, ihealth, digital health, and telemedicine. For example, e-Health is now more commonly used to refer to electronic health records, m-health – mobile health using smart phones and healthcare related "apps". The American Telemedicine Association formally defines telemedicine as:

> ...the use of medical information exchanged from one site to another via electronic communications to improve a patient's clinical health status. Telemedicine includes a growing variety of applications and services using two-way video, email, smart phones, wireless tools and other forms of telecommunications technology. (American Telemedicine Association, 2013)

Wilson (2008) provided a synthesis of the e-Health field and indicated a revolutionary change in the delivery of healthcare from a physician-centered approach to a patient-centered approach. Wilson observed that patients are increasingly empowered, as a consequence of a critical convergence of healthcare providers, technology and marketing. Increased collaboration between medical practitioners and technology providers is seen as a requirement to advance the m-Health pilots being trialed across the globe (Ascari and Bakshi, 2010; Sandhu, 2011). Falchuk, Falmolari, Fischer, Loeb and Panagos (2010) have provided a description of the technology required to deliver patient-centered mobile health. The pervasiveness of the Internet though the use of sensors has been described by Chui, Loffler, and Roberts (2010), in the Internet of things.

The common themes that emerge are the need for collaboration and the important shift to a patient-centric approach. The current paper builds on earlier work that explored the

relationship between technology and brand management in the evolving e-Landscape (Helman, de Chernatony & Addeo, 2010) and an examination of ubiquity and integration in m-Health and the implications for brand management (Helman, Addeo & Walters, 2011). Perspectives on the forces shaping the adoption of telemedicine and the development of a model to reflect this evolutionary process, were proposed by Santoso, Addeo, Helman and Santoso (2011). The purpose of the current paper is to explore the wide spread adoption of cloud based healthcare services and the implications for decision makers.

Integrative Models

The e-Landscape model (Helman *et al*. 2010), presented as Figure 1 integrates emerging technologies and focuses on the implications of the intersections of technology and brand management. *Market Pull (P1, P2, P3)* spans one or more application planes. For example, P1 depicts consumers of networked home appliances (e-Home), Intelligent Transportation Systems (ITS), and networked healthcare appliances (e-Health). P2 depicts consumers who have adopted e-Home and ITS applications, while P3 depicts consumers of only e-Home applications. Ubiquity and integration are critical characteristics and engines for growth in the e-Landscape. P1 may represent a diabetic patient who from his car is able to access information on insulin supply levels in his refrigerator at home and organize refills to be collected from his local chemist/pharmacy. The e-landscape model attempts to capture the critical relationships between an interactive consumer, digital devices and networks in the range of electronic landscapes that the consumer may navigate in the course of their everyday life. The brand manager should consider how the brand fits in these e-landscapes, particularly in relation to the need for collaboration to provide product-service combinations and in maintaining a coherent brand identity.
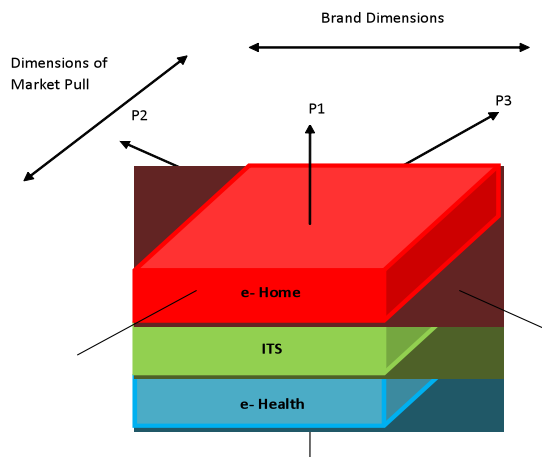

Figure.1. Dimensions of Market Pull and Brand Management in the e-Landscape
Source: Helman, D.A, de Chernatony, L. & Addeo, E.J., (2010)

The emergence of increasingly sophisticated Internet-based technologies and services is driving the evolution of Internet-mediated delivery of medical services to an expanding patient-base of Internet citizens. Patient record and clinical administration systems, digital imaging and archiving systems, e-booking, e-practice and e-prescribing applications and services are being deployed to improve efficiency and lower costs for medical practitioners. Furthermore sensor, communication and intelligent decision-making technologies may offer substitutes for experts in many medical specialties such as general practice, radiology, and pathology. Concurrently, as mentioned above, a new era of market pull is emerging from an increasing population of interactive customers who are creating new demands for networked home appliances, advanced intelligent transportation systems, and networked health care appliances. Santoso *et al.* (2011) explores the various driving forces that are emerging in relation to telemedicine and argues that once resistances are overcome, a broad-scale evolution will take place. The model in Figure 2, develops the e-Landscape model, and offers a more detailed illustration of the e-Health layer and the forces shaping that layer. The various forces working in conjunction and against each other affecting the evolution of the healthcare system may reconfigure the landscape and a more sustainable state may emerge.
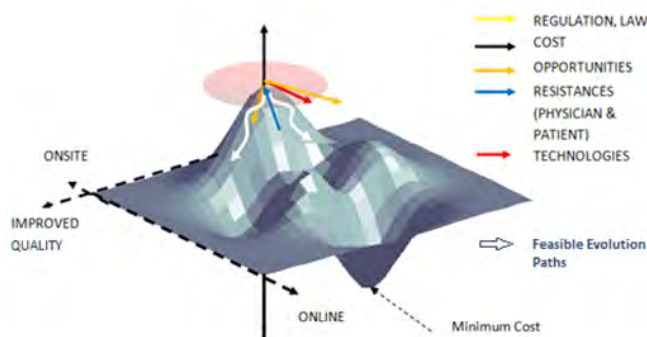
Fig. 2. The Landscape of Healthcare Delivery and the Driving Forces.
Source: Santos, N.I, Helman, D. Addeo., E.J., and Santoso, D.S. (2011)

The driving forces considered in this model include cost-reduction, quality-improvement, physician resistance/readiness, patient resistance/readiness, enabling technologies and opportunities, regulation, law and politics (e.g. malpractice law, tort reform, etc.). The combined forces can be defined as a resultant (or composite) vector and will serve as the prime-mover in the evolution of the current healthcare system (within the boundaries of current regulations/law) towards a new equilibrium state. Several new equilibriums, as illustrated in Figure.2, may emerge as solutions. Each of them will offer different benefits, challenges and opportunities to the healthcare industry.

The model has been developed to explore adoption of telemedicine across the globe – currently technology problems relating to interoperability, security concerns, the regulatory environment and physician resistance (Ascari and Bakshi, 2010) have inhibited growth. The model suggests that in environments where there is less resistance telemedicine is likely to be more readily adopted – indeed in developing nations with high patient doctor ratios and cost constraints telemedicine solutions are evident.

Interesting scenarios may develop where advances in healthcare may originate in developing nations and migrate to developed nations – as the process of reverse innovation identified by Immelt, Govindarajan, & Trimble (2009) suggests. Developing nations with ubiquitous access to cloud computing may be able to leapfrog the aging infrastructures of the developed nations. On the other hand, the emergence of the iConsumer (Ludwig, 2011) may create a global healthcare consumer willing to access better value propositions wherever they are available. In the US, a partnership between Walgreens and Cisco is responding to these opportunities.

Physicians, may be willing to implement various aspects of telemedicine, however, at the same time, they are reluctant to change believing that online interactions may depersonalize the patient-physician relationship. Furthermore, the absence of information obtained during clinical evaluation will deprive the physician of some important decision-making inputs used in diagnostic process, thus reducing the quality. Patients looking forward to more cost efficient healthcare may have similar concerns about quality. Future research will be directed towards determining sets of estimated values based upon their importance and relative power, the model will offer a useful evolutionary scenario and planning tool for decision makers.

Additionally; a cogent and useful model which yields accuracy and integrity in predicting global penetration of telemedicine applications and services will need to incorporate the realistic "resistances" associated with the very slow adoption of security protocols for telemedicine.

The problem of secure communications in a telemedicine service environment is compounded by the very high complexity of these protocols which can by their inherent nature stimulate or cause security critical mistakes. The challenge then is to send secure messages in a platform-independent manner that allows visibility (opening of private networks to the Internet thereby greatly increasing visibility to other entities, potential service providers and patients) and reusability that enables the interchange of Web services - independent of computing environment, operating system, and programming language. In other words, these end-to-end security mechanisms will need to enable sending messages between applications in a platform-independent manner. This will allow systems written in different languages, running on different operation systems in different locations to interoperate with perimeter security and end-to-end message security. Hence, previously closed functions would become broadly available to be called anytime, anywhere, by anyone with valid access (authentication) credentials.

Access control techniques have been developed in a variety of ways in which the access control procedure may be carried out. However, these authentication mechanisms typically use a biometric authenticator (fingerprint or retina scan) in conjunction with a time-dependent PIN generated by a smart card. These mechanisms have high integrity, but are not particularly well matched to ease of usability of patients and service providers. Providing graceful access to telemedicine applications and services remains a significant challenge and this likely

is a "significant component of "resistance" in the near term.   However, solutions will emerge. Two possible scenarios suggested by the model are presented here:
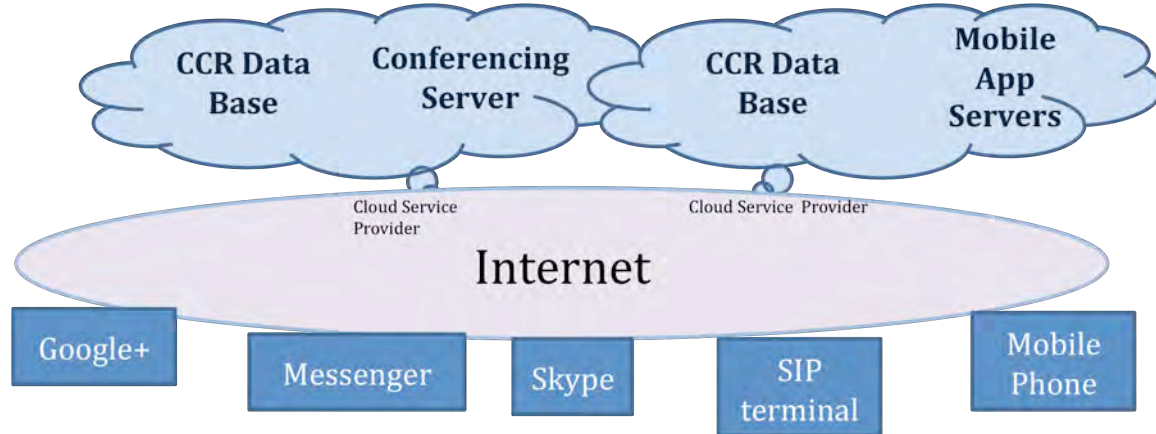
Scenario One:

Enabling-technology are fully developed, patients' and physicians' resistances are minimal, and regulations are established to facilitate cost reduction, the healthcare system will most likely evolve towards to the minimum cost point.
All appropriate online resources are utilized. Sharing information may be established through ASTM's continuity of care record (CCR) - a core data set of administrative, demographic, and clinical information facts about a patient's healthcare, covering healthcare encounters, could provide a means for one healthcare practitioner, system, or setting to aggregate all of the pertinent data about a patient and forward it to another practitioner, system, or setting to support the continuity of care. The CCR could provide a snapshot in time containing the pertinent clinical, demographic, and administrative data for a specific patient. In turn, global access to the CCR could be accessed through a "Cloud Computing" information-networked infrastructure. This approach could enable medical practitioners and patients to agilely access and update information from any end--user Internet appliance and even leverage off "Cloud– based" speech-to-speech language translation, with security and independent of location and time. Concurrently, synergistic advances in all areas of technology from low power electronics and sensor technologies to the development of novel wired and wireless communication appliances and services are emerging. These advances have already led to the development of new small-sized wireless medical and environmental sensors that are capable of monitoring the human body as well at its environment in a more efficient way. These advances in sensing and communication technologies along with advances in software engineering make it possible to synthesize new solutions for wearable healthcare systems and enable the development of ubiquitous healthcare smart homes. With these systems, elderly people and those with pre-existing health conditions can remain in their own home, while healthcare providers can remotely monitor and advise them on how to improve their well being and provide them with quality healthcare – from anywhere in the world. Telemedicine can also be a proactive process. Indeed, medical practitioners have long recognized that modern society should change its dietary and exercise habits to reduce the rising incidence of diseases such as diabetes, heart attack, and stroke. As a result, gaming systems are emerging to motivate "healthy" adults and children to lead more healthy lives. The communications, storage, and application-aware biometric capabilities, of a powerful "Cloud Computing" information-networked infrastructure will likely be multiplied many times by the emergence of synergistic technologies including: Low power wireless sensor nodes that enable ubiquitous biomedical signal monitoring, wireless and wearable ECG sensors, and body-area nanonetworks with molecular communications in nanomedicine.

Information Networked Architecture for Telemedicine

Attributes:
- Interworking of Different End-User Appliances
- Native security, networking, and redundancy
- Virtual and/or physical server capacity on demand
- Integration of applications from mobile phone users
- Ubiquitous Access

Scenario 2:

Devices and networks are available but not ubiquitous and are not well integrated. Uncertainty exists in the marketplace for industry participants. Problems with technological literacy and willingness to change and collaborate remain. Problems managing information exist for doctors and patients.

Technologies are available, selective interest is indicated by patients and doctors - this translates into a varied pattern of adoption and non-adoption. Manufacturers remain cautious to make large investments in Telemedicine related NPD. Consumer electronics retailers increasing expansion in telemedicine related appliances for home use, further decisions are required in relation to future range dimension development. Telemedicine products are moving slowly through the regulatory pipeline. Insurance company mHealth services are being launched. Success for companies participating in radiology (Telemedicine Inc, Nighthawk). Competition from retail based healthcare providers increases (CVS Minute Clinic) providing less expensive healthcare options.

Widespread use of mobile devices for communication by patients with doctors (making appointments) and use of apps focused on wellness (workout regime).

Increase in use of telemedicine for monitoring top disease targets: diabetes, hypertension, congestive heart failure, obesity and "target" markets: 18-24 year old patients, geriatric patients, caregivers. Individual practitioners constrained by costs and lack of confidence in decision-making capabilities given rapid changes in technology and are cautious about commitment to new technologies and uneven experience of eHealth (HIT management systems). Doctors envisage problems with patient involvement and have concerns relating to increase in costs to manage each patient due to technology.

Implications for Strategic Decision Makers
The model presented here and the scenarios developed from it will provide insights for managers considering the impacts of changes in the healthcare sector across the globe.

Several important inferences should be apparent: The healthcare industry provides huge opportunities given changing consumer demographics and lifestyle, technology and medicine. However, this sector is immensely complicated by legal and regulatory constraints; value propositions become more complex and costs are likely to increase in the near term with the need for greater personalization; value chain complexity increases with the provision of globally accessible product-service combinations and reconfiguration to encompass new partners; the management of brand identity becomes more complex with product-service combinations; costs associated with technical support and customer service are likely to increase; the need for the management of stakeholder relationships will become more critical, and of course the relationships between doctors and their patients is fundamentally and rapidly changing.

Conclusions
While this vision of ubiquitous access to health-monitoring and healthcare is being enthusiastically pursued there remain many formidable obstacles to the realization of these solutions; some are technological, others include development of international standards for medical record systems, and yet other challenges are related to human acceptance in terms of comfort, as well as development of an appropriate and compelling business value chain. This paper presents scenarios generated from a model of the forces driving the evolution of the healthcare landscape. These scenarios are designed to provoke discussion and aid strategic decision makers and managers involved in policy formulation.

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AN INVESTIGATION ON IMPLEMENTATION OF CENTRAL HOSPITAL APPOINTMENT SYSTEM (CHAS) IN TURKEY

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ABSTRACT

Health Transformation Program (HTP) is searching for a solution to overall concerns and structural insufficiencies such as public health insurance, accession to health care services and the service quality of Turkish Health System. One of the works and studies carried out in this context is the implementation of Central Hospital Appointment System (CHAS) enacted in February, 2010. This study aimed to assess one-year pilot studies in CHAS implemented in the scope of HTP and to reveal its development in the first year. Within the scope of CHAS implementation, 11 provinces and 104 hospitals have been included to the system in one-year pilot implementation period.

Key words: **Central hospital appointment system, call center, medical health records, hospital communication systems**

Introduction

Appointment systems for hospitals both help the health staff and patients arrange their time management and increase service quality and patient satisfaction. That's why, they have an important place in modern health service. However, when we look at the applications of appointment systems, we can see various kinds of examples where many technological opportunities are used such as telephone, Internet, SMS and kiosk. It is not difficult to come across similar applications in recent years where technology and information get in health organizations and hospitals.

In healthcare, with greater emphasis on preventive medical practices, productivity improvement in outpatient department is become a central concern in worldwide. For example, long wait times by patients seeking consultation has been a long term complaint in Turkey and other countries. Today's customers seek quality service for the price they pay while fierce competition has intensified the industry further. Enhancing productivity while maintaining a high level of quality has become a challenge for healthcare managers. The major factor for patients in terms of quality concerns waiting time which has become a significant portion of determining the service quality. Researchers have identified that the

root of the problem in long waiting time for outpatients as being the result of an improper appointment system (AS) in place at a hospital. Over the last fifty-six years numerous researchers, from the works of Bailey (1952) to Cayirli et al. (2008) [1,2] have investigated this issue extensively [3].

Appointment scheduling systems lie at the intersection of efficiency and timely access to health services. Timely access is important for realizing good medical outcomes. It is also an important determinant of patient satisfaction. The ability to provide timely access is determined by a variety of factors that include fundamental questions about how many and which types of physical assets and equipment a health system should invest in, how should it allocate resources among multiple sites, how should it staff each clinic or hospital site, what rules best determine which providers and patients receive higher priority access to resources, and how appointments are scheduled [4,5].

It has long been recognized that application of the appointment system to patient scheduling has provided advantages for both patients and physicians in heaalth care organizations [6]. Scheduled patient encounters include primary and specialty care visits, as well as elective surgeries. In each of these environments, the process of scheduling appointments (assigning a specific time when the patient is scheduled to start receiving care) is different, which we will describe shortly. In addition, there are unscheduled encounters that include walk-ins and urgent or emergency cases. The former, occurring mostly in primary care clinics, can be directed to an alternate facility if the clinic in question is heavily booked. However, urgent specialty care and surgical patients often need to be treated as soon as possible. The goal of a well-designed appointment system is to deliver timely and convenient access to health services for all patients. Appointment systems also smooth work flow, reduce crowding in waiting rooms and allow health systems to honor patient and provider preferences while matching supply and demand.

Each of primary care, specialty care and hospital services and organizations have certain unique features that give rise to different challenges for managing and planning appointments. In the primary care setting and institution, the vast majority of patients require services that can be performed within a fixed time length. So, primary care clinics tend to divide available provider time into equal-length time slots such that, by and large, patients' needs can be accommodated in a standard appointment slot. For certain types of visits that require more time, clinics may assign multiple appointment slots. The appointment scheduling problem then reduces to that of finding a suitable match among the available time slots of providers in the clinic, provider prescribed restrictions on how available slots may be filled and patients' preferences for day/time of week as well as for a particular service provider. (An example of provider restrictions on the use of available slots is the limit that many providers place on the number of physical exams or new patients that can be scheduled in any given session.) Still, the problem of matching supply and demand is not easy because different patients have different perceptions of the urgency of their need and different day-of-week and time-of-day preference patterns [3,7-9].

Keeping a health service appointment can be defined as attending a prescheduled appointment at a health care facility for a health service that is administered directly at the visit. Failure to attend appointments is a common occurrence in outpatient medical health settings [10,11].

Appointment systems can be a source of dissatisfaction, both for the patients and for the

providers. Patients are impacted by the lack of availability of timely and convenient appointment slots, especially when their need is urgent. Clinicians are impacted by the uncertainty in the number of patient appointments from day to day, and the mix of appointments on any given day. These factors can affect clinicians' earnings as well as their job satisfaction levels. In many instances, clinicians can handle high-priority demand, and variations in case mix, only by stretching their schedules to absorb demand variation--i.e., by shrinking lunch time, pushing back dinner and double booking (working faster). (The soft nature of provider capacity is one of the factors that differentiates health care delivery systems from manufacturing, transportation and logistics systems.) Even with such strategies in place, it is sometimes necessary to reschedule certain booked appointments for non-urgent services in order to take care of urgent demand. Moreover, significant direct waiting time is not uncommon in environments that deal with life-threatening urgent cases. Frequent involuntary changes in appointments and long direct waits can cause dissatisfaction among patients who book in advance [3,7,8,9].

Studies have documented that up to 30% of patients do not keep an initial outpatient appointment and 20% to 40% of follow-up appointments are missed in medical health clinics [12-14]. The patient failing to keep an appointment disrupts the health system at various points. By missing appointments, individuals deprive themselves of receiving necessary care, impairing clinician-patient relationship, reduce the opportunity for other patients to receive timely care, have adverse effect on learning and research in ambulatory care settings and indirectly contribute to rising health care costs [11, 15-17].

Central Hospital Appointment System (CHAS) in Turkey

As the basic level of fundamental rights and freedoms, ensuring right of life and maintaining physical and mental healthy life by Government to an individual is under our Constitution. In order to fulfill this duty by Government properly, it is required that necessary arrangements shall be done to provide health care services more effectively and to allow citizens to benefit from health services in the maximum way by improving access to health care services. The Ministry of Health providing a service in accordance with the scope of this constitutional right, has carried out Health Transformation Program (HTP) so as to provide (human) patient-centered health care services since 2003 [18].

Health Transformation Program (HTP) is searching for a solution to overall concerns and structural unqualifications such as public health insurance, accession to health care services and the service quality, improving information management, and hospital information systems of Turkish Health System [18, 19]. A information management priority for Turkey has been the creation and establishment of the major health information systems of the Ministry of Health, Turkey, namely, the Saglik-Net (Turkish for "Health-Net"), the National Health Information System (NHIS), the Family Medicine Information System (FMIS), *the Centralized Hospital Appointment System (CHAS)* and the Core Resources Management System (CRMS) [20].

Developments are currently occurring in terms of accessibility of healthcare for citizens. An important national project in Turkey is the Centralized Hospital Appointment System (CHAS) that is currently being piloted in some provinces (Erzurum, Kayseri). CHAS is an implementation where citizens can call the 182 CHAS Call Centre for Mouth and Dental Health Centres and secondary and tertiary Hospitals affiliated to the Ministry of Health and can get an appointment from the hospital and physician they choose through the operators.

CHAS was put into practice firstly in Erzurum and Kayseri provinces as a pilot. Throughout the pilot implementation, observations were made and then the process was initiated to roll-out it to entire Turkey. Within this scope, as of July 2010, CHAS implementation was initiated in Yalova, Eskişehir, Bilecik, Çanakkale, Edirne, Kırklareli, Sakarya and Tekirdağ provinces. It is aimed that CHAS is to be implemented throughout Turkey within a year [19].

One of the works and studies carried out in this context is the implementation of Central Hospital Appointment System (CHAS) enacted in February, 2010. CHAS enables the citizens to make appointments in any public secondary and tertiary healthcare provider together with Mouth and Teeth Health Centres by calling the CHAS Call Centre phone number "182". The citizens are assisted by online operators during phone calls. All the healthcare professionals from public secondary and tertiary healthcare providers share their calendars of at least 15 days with the MoH through CHAS Web Services to enable operators to make appointments according to these calendars. One of the ambitious targets of Ministry of Health (MoH) is the piloting of CHAS in all 81 provinces by the end of 2010. [20].

Objectives

The main objective of "Central Hospital Appointment System" is to improve health service accessibility. "Central Hospital Appointment System" (CHAS) is an implementation providing opportunity for citizens to make an appointment for a clinic or doctor in any hospital in the country through live operators by calling CHAS Call Center. All hospitals under the Ministry of Health (except primary health care facilities) and Oral-Dental Health Centers are in the scope of "Central Hospital Appointment System" (CHAS). CHAS project which improves patient access to health services in hospitals and improves health service accessibility and also has a direct effect on improving the service quality (facilitating examination process, giving the patients chance to choose their doctors or hospital etc.) is described as one of the important step of "Health Transformation Project" by the Ministry authorities. This implementation aims to provide more effective health care service delivery to a patient and ensuring patient satisfaction. The other advantages of the implementation are as follows [19,20]:
- Increasing productivity by providing hospital resource use in optimal way.
- Preventing long waiting process to make an appointment before examination.
- Providing more quiet and peaceful environment in hospitals.
- Facilitating to examination process.
- Increasing patient satisfaction by giving the patients a chance to choose their doctors or hospital.
- It is foreseen that data obtained in the result of this implementation will provide an important input to senior level decision makers on strategic issues such as demand forecasting, measuring market share and competitiveness of hospitals and doctors, planning and allocating of workforce and other important sources.
- To provide assistance to development of health policies through CHAS data.

It is planned to extend this implementation throughout the country by 2011. During one year period of implementation, 11 provinces and 104 hospitals has gradually carried into practice. CHAS implementation has provided a service to 6 million citizens totally by the end of January 2011. One of the works and studies carried out in the HTP is the implementation of Central Hospital Appointment System (CHAS) enacted in February, 2010. In this study, it is aimed to assess one-year pilot studies in CHAS implemented in the scope of HTP and to reveal its development in the first year. It is primarily intended in this study that the definition

and scope of CHAS will be addressed and findings obtained in the end of pilot implementation process will be assessed. As a next stage, operational indicators of call center in one-year pilot implementation in the scope of CHAS will be evaluated.

Currently, only the responsible operators working in the Call Centre can make appointments. By the end of year 2012, family physicians will be provided with a Web interface to the CHAS in order to make online referral of their patients immediately to secondary or tertiary healthcare providers. Hence, when leaving his GP, the patient will already know whom to visit and when to visit in case of a referral. Citizens are also able to make an appointment with any public secondary and tertiary provider via CHAS call centre in the piloting sites of CHAS. Soon, CHAS will be available in the whole country and GPs will have their dedicated CHAS interfaces for making online referrals [20].

Definition of Call Centers and Advantages

Central Hospital Appointment System (CHAS) will be a system that all the public hospitals (Ministry of Health's Hospitals) are dependent on. The hospitals will inform the the working timetables of the doctors regularly to a central system(resources), and the citizens (users using those resources), who phone call center, will take appointments according to that timetable for the empty hours. With that system, 75% of the working periods of the hospitals will be open to appointments. The remainin 25% of period will be spared for the control examinations and study results evaluations. That rates will be able to be changed when necessary observing the process of the system.Working timetables will not be same for every hospital, but will not completely be left to hospitals decision. It is aimed at protecting the density of polyclinic procedures not to scatter homogeneously during the day.

The access to the appointment system of the citizens will be processed over call centers, that is, operators at first. Call Centers was reached with a three-digit fixed line of the Ministry. Operators were chosen from especially medical vocational high school and given a special training. It is believed that even if it is not possible that they cannot offer medical instructions service, they will contribute in reducing the rates of citizens' visiting wrong polyclinics. Access channels such as SMS, Internet and kiosk will be opened to use due to the anxiety of exploitation of the system within 2 years. Still, with the electronic ID card whose pilot scheme will begin in 2012, the citizens will be able to get online appointments via Internet by themselves.

Call centers established as a result of great developments in the information and communication technologies can be defined as a "system" allowing all the connected groups (costumers, suppliers, distributor etc.) to use communication channels such as telephone, internet, fax and mail, referring received calls to one center and coordinating several highly skilled personnel [21-23]. Each call center has following features [21-22]:
- A call center is a dedicated operation with employees focused entirely on the customer service function.
- Those employees are using telephones and computers simultaneously.
- The calls are processed and controlled by an automatic distribution system.

Financial sector is the first sector using call centers due to high cost of face to face interaction with a customer [24]. These call centers are used in many sectors operating in different fields nowadays, enabling bank customers to make banking transactions from their homes after hours in the first years they established. Some of these are travel agencies, airports, hospitals,

marketing of cosmetic products, after-sales customer services, computer support services [25].

As a first implementation, call centers were used to reduce personnel costs and ensure work efficiency in the companies. However, these centers have changed into the centers in which all kinds of communication shall be provided with a customer [26]. Hence, the most important advantage of call centers is providing communication between customers and companies. The other advantages of call centers are additional sales, higher service quality, increasing the quality of customer relationship management and customer satisfaction.

For service organizations, these new technologies should facilitate greater effectiveness and efficiency. More customers can be serviced at any one point in time, and, with customers taking at least part of the responsibility for the streaming of calls (by selecting a preference from a predetermined menu using the telephone keypad), fewer staff are necessary. Fewer service centers with less space for customers should be needed leading to a concomitant reduction in management staff and further cost reduction [27].

The studies carried out for call centers can be divided into two groups. The studies in the first group have analyzed call centers through companies. Lam and Lau emphasized the advantages of restructuring call centers via technical support [28]. (Lam & Lau, 2004). Brown and Maxwell (2002) searched the effects of management approach to the efficiency in call centers in England [26]. Tuten and Neidermeyer have studied the effect of employees to companies who are working under stress in call centers [23]. Malhotra and Mukherjee (2004) explored similar studies as well. They searched the effect of job satisfaction of employees working in call centers to the operational efficiency in the banks [25].

Studies in the second group have addressed call centers in the terms of customers. Bennington et al. tried to determine satisfaction levels of customers using call centers [27]. Feinberg et al. emphasized the call satisfaction and explained "first call" and "call abandonment" operations as the important parameters that affecting customer satisfaction [29]. Dean has tried to determine the level of customer satisfaction of a call center by using SERVQUAL instrument to measure desired or ideal expectations [21]. Dean has also explored consumer expectations from call centers. Dean (2004) implied that consumers' expectations can be met by call centers of the present however expectations are increasing day by day and in parallel to this, the number of unsatisfied consumer increases [22].

Methodology

In this study, descriptive retrospective analyses are made. In this context, comparisons are made between 11 provinces using call center. In addition, comparative analyses are presented among hospitals and specialties in 55 specialties and 104 hospitals. In conclusion, various operational indicators of a call center are examined according to months. The data that was used for this study obtained from Turkish Statistical Institute and The Ministry of Health (CHAS Call Center Database 2011). Some descriptive analyses were made using SPSS (Version 15.0) and Excel softwares. This study was planned and conducted to pre-evalutaion of CHAS in Turkey. This study is first research about central hospital appointment system in Turkish health systems.

Evaluation of Implementation and Scope

Figure 1 shows the increases of the number of outpatients since 2003 in which year HTP began to carry out. Therefore, it is possible to address that HTP has an important success in the imrovement of accessibility of health care services. The total number of outpatients nearly 130 million in 2003 is now approximately 295 million by the increase of 130 percent as a result of amendments in favor of patients in the payment system and efficient policies in man power and sources (including public and private institutions).
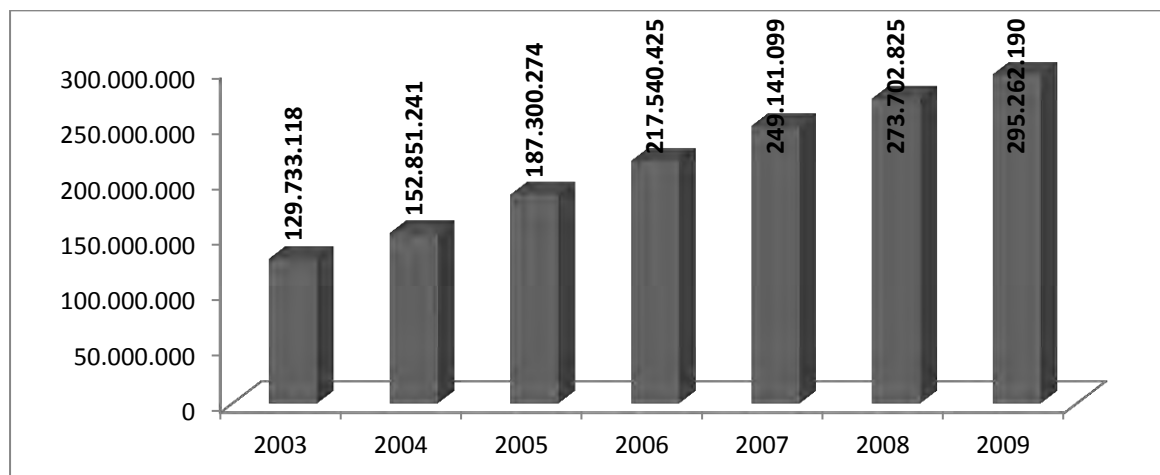
Figure 1: The number of outpatients by years (including public hospitals and all of the private hospitals). Source: The Ministry of Health, Annual of Inpatient Treatment Statistics of General Directorate of Treatment Services, 2009.

Annual frequency of admission to a physician was on the level of 1.75 in 2003 and it increases to the level of 4 by 2010. It is foreseen that this parameter will increase above this level as a result of CHAS implementation across the country. Yalova in June 2010; Eskisehir, Bilecik, Canakkale, Edirne, Kırklareli, Tekirdağ in July 2010; Burdur and Düzce in January 2011 have included in CHAS project which received its first call in Erzurum and Kayseri in 23rd February. In June 2011, CHAS implementation will be a country wide implementation by including all of the provinces in Turkey to the project. The number of population and outpatient in the provinces included to the project by 2010 is shown in Table 1.

Table 1: The number of Population and Outpatient in the provinces under CHAS implementation (2010)

Pilot Implementation Provinces	Population	Number of Outpatient
ERZURUM	769,085	3,286,258
KAYSERI	1,234,651	5,754,551
YALOVA	203,741	940,285
ESKISEHİR	764,584	3,014,262
BILECIK	225,381	657,586
CANAKKALE	490,397	2,185,848
EDIRNE	390,428	2,375,859
KIRKLARELI	332,791	1,586,526
TEKIRDAG	798,109	3,088,313
BURDUR	258,868	1,315,912
DUZCE	338,188	1,036,274
CHAS Total	*5,806,223*	*25,241,674*
TURKEY Total	73,722,988	295,262,190

Source: The Ministry of Health, Annual of Inpatient Treatment Statistics of General Directorate of Treatment Services, 2009.

11 provinces have been included in one-year pilot implementation period (February 2010-January 2011). Total number of population of provinces is approximately 8 % of country population and total number of outpatients in provinces is approximately 9 % of the total number of outpatients in Turkey.

The number of appointments and hospitals in 11 provinces implementing CHAS is shown in Table 2. In total 1,025,323 appointments are made through call centers in one-year pilot implementation period. In addition, 104 hospitals are included to CHAS project in one-year pilot implementation.

Table 2: The number of appointments in CHAS pilot implementation provinces and the number of hospitals and its rates under implementation (2010)

Province	Number of Appointments	Number of Hospitals	%
ESKISEHIR	178,491	13	12.50
BILECIK	171,815	9	8.65
TEKIRDAG	152,177	10	9.62
CANAKKALE	129,990	10	9.62
KIRKLARELI	123,936	6	5.77
EDIRNE	77,530	7	6.73
ERZURUM	73,569	23	22.12
KAYSERI	51,340	14	13.46
YALOVA	51,145	3	2.88
DUZCE	8,989	3	2.88
BURDUR	6,341	6	5.77
Total/Ratio	1,025,323	104	100

Source: The Ministry of Health (CHAS Call Center Database 2011).

When the number of hospitals are compared; Erzurum is in the first place with 23 hospitals (22.12 %) and Yalova and Düzce are the second ones with 3 hospitals (2.88 %). Although Eskisehir has 12.50% of the hospitals, it is in the first place with 178,491 appointments in the scope of CHAS implementation. One more point of attention is; although the number of outpatients in Eskisehir and Erzurum is so close and also the number of outpatients in the scope of CHAS in Erzurum is more than the others (Erzurum: 23; Eskisehir: 13), the difference in the number of patients using CHAS is approximately 100,000.

The distribution of patients making appointments according to provinces is shown in Figure 2. According to Figure 2, 17.41% of total appointment number in Eskisehir is in the first place, 0.62% percent of total number has been performed in Burdur is the last one.
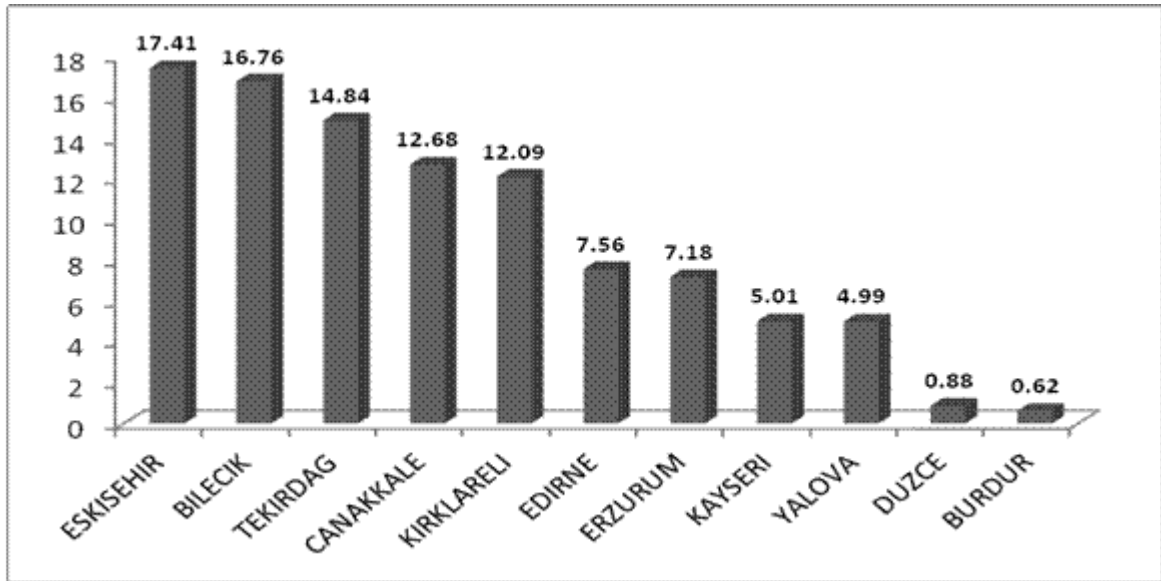
Figure 2: Distribution of appointments in CHAS pilot implementation provinces (%).
Source: The Ministry of Health (CHAS Call Center Database 2011).

The distribution of hospitals preferred by patients made appointment is shown in Figure 3; 81.55% of total appointment is given in 16 hospitals. According to this, 10.23 % of total number of appointments is made in Canakkale Public Hospital.
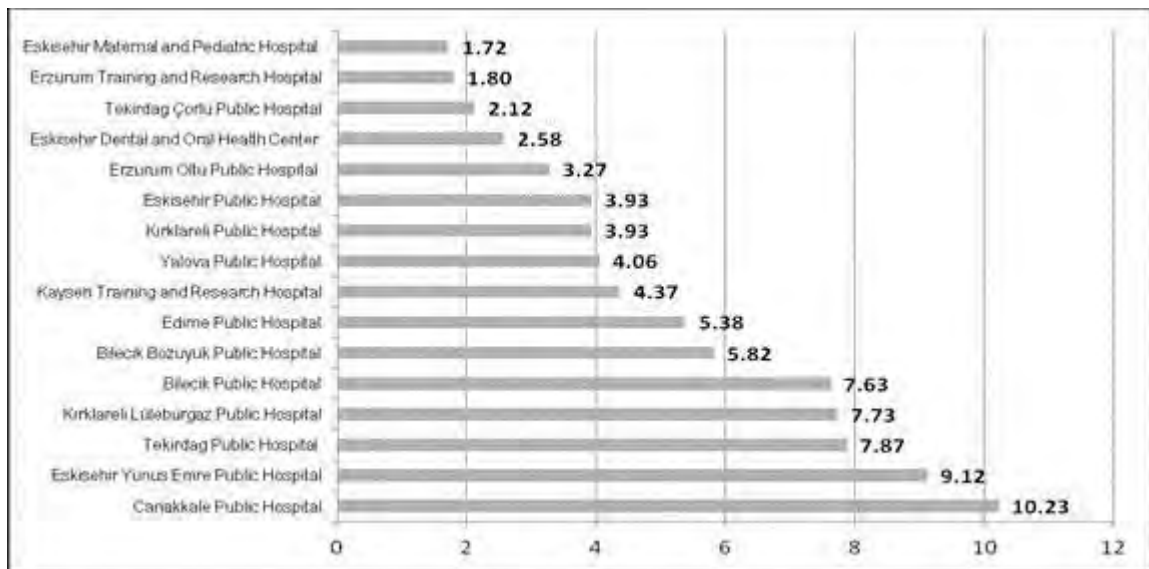
Figure 3: Hospitals intensified total number of appointments (%)
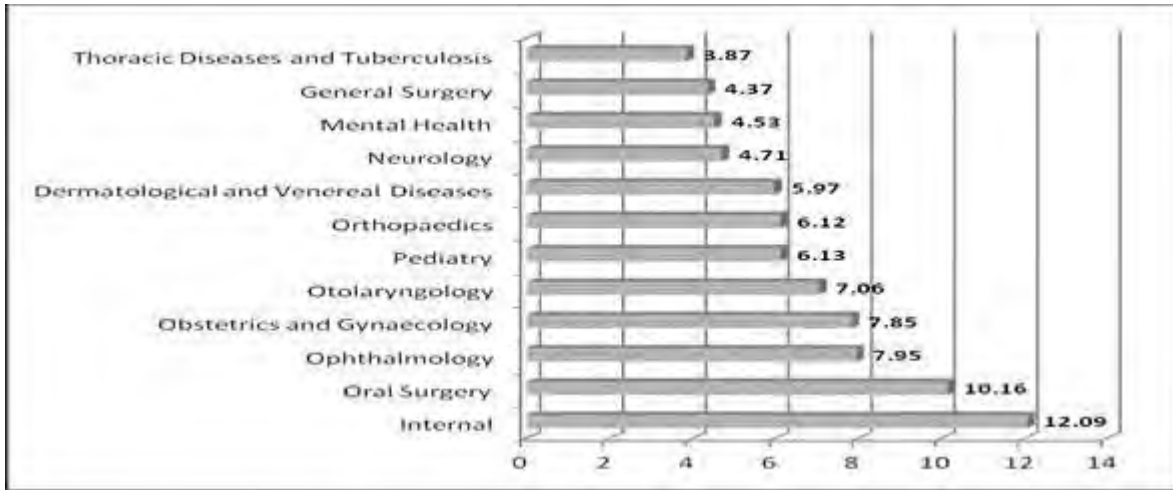
Figure 4: Specialties intensified total number of appointments (%)

Figure 4 shows in what areas of specialties are applied intensively by patients to make appointments. There are 55 appointments in different areas in the scope of CHAS. The distribution of 12 areas of specialties, 80.82% the total number of appointments is shown in Figure 4. Appointments made in maximum number are for internal medicine clinic with the proportion of 12.09 % in the end of pilot implementation.

Table 3: Distribution of the number of appointments and cancellations in CHAS

Months	Number of Appointments (Monthly)	%	Number of Cancelled Appointments (Monthly)	%
February	154	0.01	34	0.06
March	4,104	0.40	353	0.66
April	6,273	0.61	456	0.86
May	7,939	0.77	564	1.06
June	11,431	1.11	1,204	2.26
July	38,823	3.79	1,559	2.93
August	135,306	13.20	4,266	8.02
September	123,323	12.03	4,385	8.25
October	165,188	16.11	6,178	11.62
November	138,522	13.51	7,369	13.86
December	179,955	17.55	11,344	21.33
January	214,305	20.90	15,470	29.09
Total	**1,025,323**	**100**	**53,182**	**100**

Source: The Ministry of Health (CHAS Call Center Database 2011).

Table 3 shows monthly distribution of total number of appointments in 11 provinces in CHAS pilot implementation and cancelled appointments. Accordingly, 20.90 % of total numbers of appointments were made in January 2011. 29.09% of total number of cancelled appointments were made in January 2011. It is observed that the number of appointments has increasing through CHAS implementation across the country.

Operational Indicators of the Call Center

In this part of study, the operational indicators for CHAS call center will be analyzed. Monthly distribution of operational indicators is shown in Table 4. Operational indicators can be defines as [6, 9];

- *Offered Calls/Received/Incoming:* Total of incoming calls to queue of customer representative through dialing result after entry point.
- *Handled Calls / ACD Calls/Answered Calls:* Total of answered calls by customer representatives which are incoming to queue of customer representative through dialing result after entry point.
- *Abandoned Calls:* Total of unanswered calls by customer representatives which are incoming to queue of customer representative through dialing result after entry point.
- *Average Speed of Answer:* Average waiting time of answered calls on the queue. It can be figured out by the ratio of total waiting time to unanswered call number.
- *Answer Rate:* The ratio of the number of answered calls by customer representatives to total number of incoming calls.
- *Average Call Handling Time:* The average value of customer representatives service period for answered calls per an answered call (second)

Table 4: Operational Indicators of CHAS Call Center

Month	Offered Calls	Handled Calls	Abandoned Calls	Average Speed of Answer	Answer Rate (%)	Average Call Handling Time (second)
February	3,787	3,548	239	1	92	47
March	13,699	13,202	497	1	96	106
April	16,502	15,676	826	2	95	122
May	18,386	17,767	619	2	97	124
June	26,175	25,331	844	2	97	132
July	74,765	71,597	3,168	3	96	158
August	186,242	181,542	4,700	2	97	147
September	180,387	178,865	1,522	1	99	129
October	185,029	183,207	1,822	1	99	154
November	190,068	187,298	2,770	2	98	151
December	248,053	245,425	2,628	2	99	146
January	260,570	257,585	2,985	2	99	134
Total/Average	*1,403,663*	*1,381,043*	*22,620*	*1.75*	*97*	*129.17*

Source: The Ministry of Health (CHAS Call Center Database 2011).

Table 4 shows some of the operational indicators of call center. According to Table 4, call center has received 1,403,663 calls at the end of one-year pilot implementation period. 1,381,043 of incoming calls were answered, 22,620 of them were unanswered. The average response time is 1.75 second. The year-end average of call answering rate is on the level of 97 %. Average response time is in 129.17 seconds for each call.

CONCLUSIONS AND RECOMMENDATIONS

Health care practices and organizations are increasingly competing not only on cost, but also on quality and patient satisfaction. In this environment, timely access to care has become a more important issue for hospitals. As a result, physician practices and hospitals are eager to embrace new approaches to patient appointment scheduling to reduce backlogs, increase productivity, and improve patient satisfaction in health systems [30]. Health Transformation Program (HTP) is searching for a solution to overall concerns and structural unqualifications such as public health insurance, accession to health care services and the service quality of Turkish Health System [18].

As stated earlier, one of the works and studies carried out in this context is the implementation of Central Hospital Appointment System (CHAS) enacted in February, 2010. Within the scope of CHAS implementation, 11 provinces and 104 hospitals have been included to the system in one-year pilot implementation period. In a total 1,025,323 appointments were given at the end of this period. Eskisehir is a lead province which is using the system in the most effective way with a proportion of 17.41% and 178,491 appointments. 10.29 % of total appointments were given in Canakkale Public Hospital and 81.55% of total number of appointments were given in 16 hospitals. In the range of branches, internal medicine can be distinguished from other specialties with a proportion of 12.09 %. 80.82% of appointments intensified on 12 medical specialties. The average of call handling time is 129.17 seconds and 1,403,663 calls are received by call center in the pilot application period.

In addition, CHAS which is implemented in the scope of Health Transformation Program is also the first example of the systems established in this field as being extended throughout the country. The improvements provided by one-year pilot implementation in the health system are as follows;
- Disordered patient traffic in the clinics decreased significantly,
- Patients spent less time in hospitals.

These improvements are provided through the willingness of interoperability and clarifications of the roles and responsibilities, minimizing culture clash, Building strong communication, Planning far ahead and being ready for crises, Searching for beter But actually the most important ones are commitment, passion and teamwork.

It is foreseen that findings obtained as a result of CHAS implementation will provide an important input to high-level decision makers in strategic issues such as demand forecasting, measuring market share and competiveness of physicians and hospitals (due to system allows patient to choose their physicians and hospitals), planning and allocating work power and the other important sources. After all Ministry gets accurate feedback on planning. In addition, one of the significant result of the study is CHAS implementation has an important role in improving the accessibility to health care service. In the next studies, it is suggested to evaluate the cost effectiveness of implementation.

One of the appointment channels must be family physicians for the citizens. Family physicians must be able to take appointments for the patients they transferred to secondary health institutions from the central system which the operators reach in call center. Moreover, they will not only be able to take appointments but also send the referral information to the Electronical Health Record database(EHR) of the Ministry over Sağlık-NET (Health-NET) system. That way, the hospitals must be able to see both appointment information and referral information of the family physician for the appointments taken by family physicians. As the family practise gets more common and the rate of visits directly to the primary health institutions increases, it is expected that the majority of the appointments will be taken by the family physicians. Thus, It is targeted that the steps towards Change in Health Program will function in an integrated way and start to support each other. Thus, it will make chain of referral more attractive that health data is shared between family physician and the hospital thanks to the ease of appointment and appointment taking from family physician. On the other hand, we should not forget that that application will lead up the patients to go to the secondary health institution with no more trouble [31]. In future CHAS must be implemented in all hospitals (public and private hospitals) and familiy health practices. The call center

personnel must be educated and improved for increasing effectinevess of CHAS.

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TRANSFORMATIONAL LEADERSHIP, JOB SATISFACTION, ORGANIZATIONAL COMMITMENT, ORGANIZATIONAL TRUST IN TURKISH PUBLIC HOSPITALS: PUBLIC SERVANTS VERSUS PRIVATE EMPLOYEES

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ABSTRACT

The purpose of this study were to gain a better understanding of the predictability of organizational commitment based on job satisfaction, transformational leadership and organizational trust in for public servants and private firms' employees (outsourcing) two Turkish hospitals. 549 public servants versus 345 private employees responded to all questions in the study measurement tools. The measurement instruments of survey are the Job Satisfaction Survey, the Organizational Commitment Questionnaire and Organizational Trust Inventory and Transformational Leadership Inventory. The mean scores for Providing an Appropriate Model, Providing Individualized Support, Overall Transformational Leadership, and Communication significantly vary in terms of public servants and private employees in hospitals (employment status).

Key Words: **Transformational Leadership, Organizational Commitment, Human Resource Management, Job satisfaction**

INTRODUCTION

Hospital managers should give importance on the basic issues of administration and organization such as transformational leadership, job satisfaction, organizational commitment and organizational trust of health human resources for increasing the performance of human resources. By analyzing transformational leadership of the hospital administrators, the levels of job satisfaction, organizational commitment, and organizational trust of hospital employees, the effects of such factors on employee productivity, effectiveness, quality of patient care and hospital performance can be assessed [11] [4]. A significant positive relationship is discussed between job satisfaction of hospital employee and the quality of patient care [2]. High levels of organizational commitment, organizational trust, job satisfaction, and hospital managers' transformational leadership can have a positive effect on work outcomes; conversely, low levels can lead to poor organizational performance [7]. As a result, healthcare organizations should attempt to foster work environments that enhance perceptions of transformational leadership, organizational commitment, organizational trust,

and job satisfaction to generate positive effects such as creativity, motivation, and cooperation among organizational members and, thus, increase organizational effectiveness.

In the process of examining healthcare employees' perceptions of transformational leadership, organizational commitment, organizational trust, and job satisfaction, we must consider a multitude of factors and issues that come into play such as organizational culture, Quality Management and Human Resources practices, organizational policies. Pertinent literature revealed extensive material relating to leadership type, transformational leadership behavior, trust, commitment, satisfaction, and voluntary performance of employees. However, the relationships among all these variables have received little attention. Moreover, there is also very little information regarding these concepts in Turkey. The intent of this study is to focus on the importance of transformational leadership, organizational commitment, organizational trust, and job satisfaction specific factors to provide a better understanding of their interrelatedness, as well as how they can be used as indicators of job satisfaction and then incorporated into the hospital strategic human resources planning effort in Turkey health system. Hence healthcare management and human resources managers in Turkey could be better prepared to react to future personnel performance. This study is first research about transformational leadership, organizational commitment, organizational trust, and job satisfaction of public servants and employees in hospitals in Turkey.

METHOD

Purposes and Hypotheses

The main purpose of this study is to investigate transformational leadership, organizational commitment, organizational trust and job satisfaction according to public servants and private firms' employees (outsourcing) in two Turkish public hospitals. The other purpose is to analysis relationships among transformational leadership, organizational commitment, organizational trust and job satisfaction in terms of public servants and employees of private firms in hospitals.

The findings of this study will further help healthcare administrators, managers, and Quality Management and Human Resources professionals in comprehending the relevant public servants and private employees focus issues and developing programs to increase employee levels of commitment, trust, and job satisfaction as a means of attracting and retaining their employees in an industry where high levels of employee turnover is the case. In summary, this nonexperimental correlational, quantitative study explored the relationships among transformational leadership, organizational commitment, organizational trust, and job satisfaction public servants versus private employees. Also this study could help hospital managers for planning and managing outsourcing services in their hospitals.To achieve this, the study tested the following hypotheses.

- **H1:** There are significant differences among transformational leadership, organizational commitment, organizational trust and job satisfaction levels as perceived by public servants and employees of private firms in hospitals.
- **H2:** There are significant relationships among transformational leadership, organizational commitment, organizational trust and job satisfaction levels as perceived by public servants and employees of private firms in hospitals.
- **H.3:** General Organizational commitment of public servants in hospitals is affected by transformational leadership, organizational trust, and job satisfaction.

• **H4.** General Organizational commitment of employees of private firms in hospitals is affected by transformational leadership, organizational trust, and job satisfaction.
• **H.5.** Organizational trust of public servants in hospitals is affected by transformational leadership, organizational commitment, and job satisfaction.
• **H.6.** Organizational trust of private employees in hospitals is affected by transformational leadership, organizational commitment, and job satisfaction.

Data Collection Procedures

This study was conducted in two healthcare organizations in Sivas and Balıkesir, Turkey. The health care organization in Sivas is a general hospital of Ministry of Health with 650 patient beds. The health care organization in Balıkesir is a general hospital of Ministry of Health with 450 patient beds. There were a total of 2108 employees who worked at these two healthcare organizations. All 2108 employees were send the surveys, and 804 (549 public servants versus 345 private employees) responded to the study (38.14 %). This study conducted and planned between June 1, 2009 and August, 10 2009. Table 1 illustrates the participant demographics of the study according to professions.

Table 1. Frequencies and respose rates of the participants by professions *

HOSPITALS	Frequency of Physicians	Frequency of Physicians Completed The Instruments	Percent of Physicians Completed The Instruments	Frequency of Nurses	Frequency of Nurses Completed The Instruments	Percent of Nurses Completed The Instruments	Frequency of Other Health Personnel	Frequency of Other Health Personnel Completed The Instruments	Percent of Other Health Personnel Completed The Instruments	Frequency of Administrative Personnel	Frequency of Administrative Personnel Completed The Instruments	Percent of Administrative Personnel Completed The Instruments	Private Firms Personnel (Outtsourcing)	Frequency of Private Firms Personnel	Percent of Private Firms Personnel Completed The Instruments
Public Hospital in Sivas	120	34	28.33	226	123	54.42	96	25	26.04	154	55	35.71	483	121	25.05
Public Hospital in Balıkesir	108	32	29.62	288	106	36.80	133	34	25.56	122	50	40.98	378	224	59.25
OVERALL TOTAL	228	66	28.94	514	229	44.55	229	59	25.76	276	105	38.04	861	345	40.06

*: Frequency of personnel (physicians, nurses, other health personnel, administrative personnel, and private firms personnel) was obtained from statistical units of the hospitals and legal web pages. (www.sivasnumune.gov.tr/; www.balikesirdevlethastanesi.gov.tr/)

Instruments and Measures

A quantitative methodology was used for this exploratory study. Employee attitudes on transformational leadership, organizational commitment, organizational trust, and job satisfaction were assessed through the Transformational Leadership Inventory (TLI), Organizational Commitment Scale (OCS), Organizational Trust Inventory (OTI), and Job Satisfaction Survey (JSS).

Transformational Leadership Inventory (TLI)

Podsakoff, MacKenzie, Moorman, and Fetter's [22] transformational leadership behavior inventory was used to assess the transformational and transactional leader- ship behaviors in this study. This scale is designed to measure six key dimensions of transformational leadership identified in the research literature, as well as one dimension for transactional leadership scale. The six transformational leadership dimensions are: 1) Articulating a Vision; (e.g., "my supervisor paints an interesting picture of the future for our practice area"), 2) Providing an Appropriate Model (e.g., " my supervisor provides a good model for

follow"), 3) Fostering the Acceptance of Group Goals (e.g., "my supervisor fosters collaboration among work groups"), 4) High Performance Expectations (e.g., "my supervisor shows us that he/she expects a lot from us"), 5) Providing Individualized Support (e.g., "my supervisor shows respect from my personal feelings"), and 6) Intellectual Stimulation (e.g., "my supervisor has provided me with new ways of looking at problems which used to puzzle me"). One example of transactional leadership is "my supervisor personally compliments me when I do outstanding work."

The TLI contains 29 quantitative items in statement form (7 items for Articulating a Vision, 5 items for Providing an Appropriate Model, 5 items for Fostering the Acceptance of Group Goals, 4 items for High Performance Expectations, 3 items for Intellectual Stimulation, 4 items for Providing Individualized Support). Survey items were completed on 5-point frequency scales ranging from 1 (strongly disagree) to 5 (strongly agree).

The Organizational Commitment Scale

The Organizational Commitment Scale (OCS) is comprised of three types of commitment, described as normative, affective, and continuance commitment [1]. The normative commitment scale measures the sense of obligation employees experience relative to their jobs within the organization. The affective commitment scale assesses the emotional dedication of employees to the organization when they are pleased with their association. The continuance commitment scale measures employees' perceptions of the costs and benefits of remaining with the organization. Within the OCS developed by Meyer and Allen, there are 3 dimensions, termed affective, continuance and normative commitment. The OCS contains 24 quantitative items in statement form (8 items for each organizational commitment dimension). Responses are scored via a 5 point Likert scale. Responses are scored using a 5 point Likert scale, termed "1-Strongly disagree", "5- Strongly agree". Responses close to 7 indicate higher levels of organizational commitment; responses closer to 1 indicate lower levels of organizational commitment. An organizational commitment score is calculated for each respondent, by adding the scores given to the 24 statements and dividing them by 24. Additionally, a reverse scoring transaction is made for negatively loaded statements among the 24 statements. Personnel dimensions of organizational commitment scores were computed.

The Organizational Trust Inventory (OTI)

The Organizational Trust Inventory (OTI) consists of 12 items, 8 of which measure employees' trust in their supervisors, while the remaining 4 focus on trust in the entire organization [8]. The OTI contains 12 quantitative items in statement form. The instrument consists of 12 closed-ended questions which participants rank on a seven-point scale from "strongly disagree" to "strongly agree." Responses use a 5 point Likert Scale, scored as: "1-Strongly disagree", "5- Strongly agree". As a result, scores with a value close to 5 indicate higher levels of job satisfaction, and scores with a value closer to 1 indicate lower levels of job satisfaction. In the research the individual organizational trust score is derived by adding the scores given to the 12 statements and dividing to the total by 12.

The Job Satisfaction Survey (JSS)

The Job Satisfaction Survey (JSS) measures employee job satisfaction and was designed for application in both public and private service-type organizations [24]. In 1985, Spector

developed the Job Satisfaction Survey (JSS) to measure employee's job satisfaction. This scale originally consisted of 36 items with nine subscales: pay, promotion, supervisor, benefits, contingent rewards (performance based rewards), operating procedures (required rules and procedures), coworkers, nature of work, and communication. Each of them contains four items, with a total satisfaction score computed by combining all of them. The higher the overall score is the greater the indication of job satisfaction [24] [25]. A significant benefit of the JSS is that it produces an overall satisfaction score for each participant and also measures other important aspects of job satisfaction specific to each individual. Responses use a 5 point Likert Scale, scored as: "1-Strongly disagree", "5-Strongly agree". As a result, scores with a value close to 5 indicate higher levels of job satisfaction, and scores with a value closer to 1 indicate lower levels of job satisfaction. Therefore, the individual job satisfaction score is derived by adding the scores given to the 36 statements and dividing to the total by 36. The wording of 18 of the questions was reversed.

Table 2. Definitions of JSS Characteristics

Scale	Description
Pay	Pay and remuneration
Promotion	Promotion opportunities
Supervision	Immediate supervisor
Fringe Benefits	Monetary and non-monetary fringe benefits
Contingent Rewards	Appreciation, recognition, and rewards for good work
Operating Procedures	Operating policies and procedures
Coworkers	People you work with
Nature of Work	Job tasks themselves
Communication	Communication within the organization

Cronbach's alpha was calculated to measure the internal consistency reliability of the transformational leadership, organizational commitment, organizational trust, and job satisfaction scores. Specifically, for the TLI reliability, alpha values for 6 scales ranged from .87 to .96 (articulating a vision scale is .89; providing an appropriate model scale is .92; fostering the acceptance scale is .94; high performance expectations scale is .88; providing individualized support scale is .96; intellectual stimulation scale is .87). Cronbach's coefficient alpha value for TLI was .91. For the OCS reliability, alpha values for 24 scales ranged from .79 to .84 (affective commitment scale is .79; continuance commitment scale is .82; normative commitment scale is .84). Cronbach's coefficient alpha value for OCS was .81. Cronbachs coefficient alpha value for OTI, on the other hand, was .88. Finally, among the three variables of the study, JSS has the highest Cronbach's coefficient alpha value for .87. As a result, the internal consistency reliability was above .70 for all of scales. Thus, the scales in this study had acceptable reliability [10].

Data Analysis

Descriptive statistics were used to identify participant characteristics and the distribution of subscale scores. Data analysis was conducted and planned using SPSS 15.0. Evaluation of internal consistency and intercorrelations were based on Cronbach's Alpha and bivariate correlations, respectively. Mean, standard deviation, range, minimum and maximum scores for transformational leadership, job satisfaction, organizational commitment and

organizational trust were computed. Pearson correlations between job transformational leadership, satisfaction, organizational commitment, and organizational trust data were performed for the total participant group to determine the degree of the relationships among the variables. The transformational leadership, organizational commitment, organizational trust, and job satisfaction scores were calculated and then reliability, correlation, multiple regression analyses were used for purposes of this study.

RESULTS

This section has the fundemantals of results in terms of tables and explanations.

Table3. Summary of Respondents' Characteristics

Characteristics	Frequecy	%
Gender		
Male	290	36.0
Female	514	64.0
Job Title		
Physicians (Public Servant)	66	8.2
Nurses (Public Servant)	229	28.4
Other Health Personnel (Public Servant)	59	7.3
Administrative Personnel (Public Servant)	105	13.0
Personnel of Private Firms (Outsourcing)	345	43.1
Level of Education		
Less than High School Degree	151	18.7
High School (College) Degree	293	36.4
Pre- Bachelor (2 years) Degree	254	31.5
Bachelor and Above (Master / Ph.D.) Degree	106	13.8
Mean Age (Years)	36.64	(sd.= 10.04)
Average Organizational Tenure (Years)	5.24	(s.d.=10.22)
Average Job Tenure (Years)	9.83	(sd.= 8.20)
Average Tenure with Supervisor (Years)	3.20	(s.d.= 4.32)

Table 3 shows some characteristics of the respondents in frequency and percentage. The majority of the respondents (64.0 %) were female. 55.5 % of the subjects were from the health organization in Baalıkesir. 8.2 % of the respondents are physicians, 28.4 % of the respondents were nurses. 36.4% of the subjects possessed a college (high school) degree. % 13.8 had got a bachelor or (Master / Ph.D.) degree. Average age mean of the respondents was 36.64 years. 345 participants were employees of private firms in hospitals.

Table 4. Descriptive statistics of transformational leadership, organizational commitment, organizational trust and job satisfaction of public servants in hospitals

	Mean	Std. Deviation	Range	Minimum	Maximum
Transformational Leadership Dimensions					
a) Articulating a Vision	3.42	.89	4.00	1.00	5.00
b) Providing an Appropriate Model	3.24	.90	4.00	1.00	5.00
c) High Performance Expectations	3.26	.89	4.00	1.00	5.00
d) Providing Individualized Support	3.26	.88	4.00	1.00	5.00
e) Intellectual Stimulation	3.29	.96	4.00	1.00	5.00
f) Fostering the Acceptance	3.29	.90	4.00	1.00	5.00
Overall Transformational Leadership	3.31	.85	4.00	1.00	5.00
Organizational Commitment Dimensions					
a) Normative Commitment	2.95	.54	4.00	1.00	5.00
b) Affective Commitment	2.93	.49	3.75	1.00	4.75
c) Continuance Commitment	2.85	.53	3.75	1.00	4.75
Overall Organizational Commitment	2.91	.38	3.29	1.29	4.58
Overall Organizational Trust	3.15	.47	3.58	1.33	4.92
Job Satisfaction Dimensions					
a) Pay	3.02	.73	3.00	1.00	4.00
b) Promotion	3.12	.68	4.00	1.00	5.00
c) Supervision	3.37	.59	3.50	1.50	5.00
d) Frienge Benefits	2.80	.58	4.00	1.00	5.00
e) Contingent Rewards	2.99	.64	4.00	1.00	5.00
f) Operating Procedurs	3.12	.53	3.25	1.50	4.75
g) Coworkers	3.48	.60	4.00	1.00	5.00
h) Nature of Work	3.36	.60	4.00	1.00	5.00
i) Communication	3.56	.72	4.00	1.00	5.00
Overall Overall Job Satisfaction	3.19	.34	3.14	1.50	4.64

Table 4 shows descriptive statistics of all subscales for 459 public servants . Descriptive statistics were calculated for all continuous scaled variables. The JSS mean score was 3.19 (SD = .34) and the range was 1.50 to 4.64. The highest mean score in subscales of JSS was coworkers (3.48±.60). The OTI mean score was 3.15 (SD = .47) and the range was 1.33 to 4.92. The OCS had a mean score for Affective, Continuance, and Normative commitment, respectively, of 2.95; 2.93; and 2.85 (SD = .54; .49; .53). Finally the TL mean score for Articulating a Vision, Providing an Appropriate Model, High Performance Expectations, Providing Individualized Support, Intellectual Stimulation, and Fostering the Acceptance, respectively, of 3.42; 3.24; 3.26; 3.26; 3.29; 3.29. In dimensions of job satisfaction "Operating Procedures" has the highest mean score, "Supervision" has the lowest mean score. Mean scores for Transformational Leadership Dimensions are higher than mean scores of JSS, OTI and OCS.

Table 5. Descriptive statistics of transformational leadership, organizational commitment, organizational trust and job satisfaction of employess of private firms in hospitals

	Mean	Std. Deviation	Range	Minimum	Maximum
Transformational Leadership Dimensions					
a) Articulating a Vision	3.84	.80	4.00	1.00	5.00
b) Providing an Appropriate Model	3.70	.89	4.00	1.00	5.00
c) High Performance Expectations	3.62	.83	4.00	1.00	5.00
d) Providing Individualized Support	3.66	.79	4.00	1.00	5.00
e) Intellectual Stimulation	3.64	.90	4.00	1.00	5.00
f) Fostering the Acceptance	3.64	.90	4.00	1.00	5.00
Overall Transformational Leadership	3.70	.78	4.24	1.14	5.38
Organizational Commitment Dimensions					
a) Normative Commitment	3.19	.58	3.38	1.13	4.50
b) Affective Commitment	2.96	.57	4.00	1.00	5.00
c) Continuance Commitment	3.03	.62	3.75	1.13	4.88
Overall Organizational Commitment	3.06	.44	3.21	1.33	4.54
Overall Organizational Trust	3.19	.58	3.38	1.13	4.50
Job Satisfaction Dimensions	3.31	.51	3.58	1.00	4.58
a) Pay	3.32	.76	4.00	1.00	5.00
b) Promotion	3.22	.62	4.00	1.00	5.00
c) Supervision	2.88	.65	4.00	1.00	5.00
d) Frienge Benefits	3.05	.82	3.75	1.00	4.75
e)Contingent Rewards	3.00	.65	4.00	1.00	5.00
f) Operating Procedurs	3.49	.74	3.25	1.00	4.25
g) Coworkers	3.37	.64	4.00	1.00	5.00
h) Nature of Work	3.19	.67	4.00	1.00	5.00
i) Communication	3.01	.62	4.00	1.00	5.00
Overal Overall Job Satisfaction	3.17	.38	3.22	1.28	4.50

Table 5 shows descriptive statistics of all subscales for 345 employees of private firms in hospitals. The JSS mean score was 3.17 (*SD* = .38) and the range was 1.28 to 4.50. The highest mean score in subscales of JSS was operating procedures (3.49±.74). The OTI mean score was 3.19 (*SD* = .51) and the range was 1.00 to 4.58. The OCS had a mean score for Affective, Continuance, and Normative commitment, respectively, of 3.19; 2.96; and 3.03 (SD = .58; .57; .62). Finally the TL mean score for Articulating a Vision, Providing an Appropriate Model, High Performance Expectations, Providing Individualized Support, Intellectual Stimulation, and Fostering the Acceptance, respectively, of 3.84; 3.70; 3.62; 3.66; 3.64; 3.64. In dimensions of job satisfaction "Operating Procedures" has the highest mean score, "Supervision" has the lowest mean score. Mean scores for Transformational Leadership Dimensions are higher than mean scores of JSS, OTI and OCS.

Table 6. Transformational leadership, organizational commitment, job satisfaction and organizational trust according to public servants and private employees in hospitals

Organizational Dimensions	Public Servants in Hospitals (n= 459)		Private Employees in Hospitals (n= 345)		t	p
	Mean	Std. Deviation	Mean	Std. Deviation		
Affective Commitment	2.93	.49	2.96	.57	-.724	.469
Continuance Commitment	2.85	.53	3.03	.62	1.251	.212
Normative Commitment	2.95	.54	3.19	.58	1.273	.204
Overall Oeganizational Commitment	2.91	.38	3.06	.44	.823	.411
Transformational Leadership Dimensions						
a) Articulating a Vision	3.42	.89	3.84	.80	1.543	.124
b) Providing an Appropriate Model	3.24	.90	3.70	.89	2.366	**.018***
c) High Performance Expectations	3.26	.89	3.62	.83	1.906	.057
d) Providing Individualized Support	3.26	.88	3.66	.79	2.148	**.032***
e) Intellectual Stimulation	3.29	.96	3.64	.90	1.873	.062
f) Fostering the Acceptance	3.29	.90	3.64	.90	1.416	.157
Overall Transformational Leadership	3.31	.85	3.70	.78	2.104	**.036***
Job Satisfaction Dimensions						
a) Pay	3.12	.68	3.32	.76	2.126	**.034***
b) Promotion	3.37	.59	3.22	.62	-.345	.730
c) Supervision	2.80	.58	2.88	.65	1.355	.176
d) Frienge Benefits	2.99	.64	3.05	.82	1.488	.137
e)Contingent Rewards	3.12	.53	3.00	.65	-1.271	.205
f) Operating Procedurs	3.48	.60	3.49	.74	.926	.355
g) Coworkers	3.36	.60	3.37	.64	-.022	.983
h) Nature of Work	3.56	.72	3.19	.67	.752	.453
i) Communication	2.92	.59	3.01	.62	1.994	**.047***
Overall Job Satisfaction	3.19	.34	3.17	.38	1.482	.139
Organizational Trust	3.15	.47	3.31	.51	-.106	.915

Table 6 shows significant differences among subscales and overall mean scores for Transformational leadership, organizational commitment, job satisfaction and organizational trust by employment status (public servants versus private employees in hospitals). The mean scores for Providing an Appropriate Model, Providing Individualized Support, Overall Transformational Leadership, and Communication significantly vary in terms of public servants and private employees in hospitals (employment status) ($p<.05$). In general the mean scores of private employees were higher than public servants' mean scores. Consequently, **H1** was accepted ony for Providing an Appropriate Model, Providing Individualized Support Overall Transformational Leadership, and Communication.

Table 7. Intercorrelations among transformational leadership, organizational commitment, organizational trust and job satisfaction organizational trust and job satisfaction

		Public Servants in Hospitals				Private Employees in Hospitals			
		1. OT	2. JS	3. OC	4.TL	1. OT	2. JS	3. OC	4.TL
1. Organizational Trust	r	1				1			
2. Overall Job Satisfaction	r	,377**	1			,369**	1		
3. Overall Organizational Commitment	r	,400**	,333**	1		,421**	,440**	1	
4. Overall Transformational Leadership	r	,396**	,204**	,292**	1	,412**	,278**	,228**	1

** Correlation is significant at the .01 level (two- tailed)

Table 7 indicates that the correlations among transformational leadership, organizational commitment, organizational trust, and job satisfaction according to public servants and private employees in hospitals. Correlations were tested using a two-tailed Pearson's correlation to determine whether a relationship existed among the categories of transformational leadership, organizational commitment, organizational trust, and job satisfaction. Table 7 indicates that there are significant relationships among the scores of transformational leadership, organizational commitment, organizational trust and job satisfaction. The highest correlation for public servants are between organizational commitment and organizational trust (r=.400; p<.01). The highest correlation for private employees are between organizational commitment and job satisfaction (r=.440; p<.01). It was concluded that there are statistically significant strong positive correlations (interrelations) transformational leadership, among organizational commitment, organizational trust and job satisfaction scores of public servants and private employees in hospitals. Consequently, **H2** was accepted.

Table 8 was presented for regression analysis to determine predictors of overall organizational commitment of public servants and private employees in hospitals. Table 8 shows that 26.4 % (Adjusted R square = .25, F= 8.020, p = .00001) of the variance in the dependent variable (Organizational Commitment of public servants) was explained by the 16 independent variables (Articulating a Vision, Providing an Appropriate Model, High Performance Expectations, Providing Individualized Support, Intellectual Stimulation, Fostering the Acceptance, Pay, Promotion, Supervision, Frienge Benefits, Contingent Rewards, Operating Procedurs, Coworkers, Nature of Work, Communication). Multiple regression analysis revealed that Operating Procedurs (st. ß= -.153; t= -2.788; p< .05), Communication (st. ß= .120; t= 2.339; p< .05) and organizational trust (st. ß= .284; t= 5.105; p< .05), have a significant effect on the dependent variable (organizational commitment of public servants). On the other hand Table 8 shows that 32.5 % (Adjusted R square = .31, F= 12.388, p= .00001) of the variance in the dependent variable (Organizational Commitment of private employees) was explained by the 16 independent variables. Multiple regression analysis revealed that Providing Individualized Support (st. ß= .457; t= 2.404; p< .05), Fostering the Acceptance (st. ß= -.297; t= -2.404; p< .05), Promotion (st. ß= .121; t= -2.639; p < .05), Contingent Rewards (st. ß= .222; t= 4.856; p< .05), Organizational Trust (st. ß= .291; t= 5.993; p< .05) have a significant effect on the dependent variable (organizational commitment of private employees). The most significant predictor of organizational commitment of public servants is organizatational trust. However the most

significant predictor of organizatinal commitment of private employees is Fostering the Acceptance. Consequently, **H3** was accepted for operating procedurs, communication and organizational trust. Whereas **H4** was accepted for providing individualized support, fostering the acceptance, promotion, contingent rewards and organizational trust.

Table 8. Dimensions of transformational leadership and job satisfaction, organizational trust on overall organizational commitment

	PUBLIC SEVANTS IN HOSPITALS				PRIVATE EMPLOYEES IN HOSPITALS			
	Unstandardized Coefficients		Standardized Coefficients	t	Sig. (p)	Unstandardized Coefficients		Standardized Coefficients	t	Sig. (p)
	Beta (ß)	Std. Error	Beta (ß)			Beta (ß)	Std. Error	Beta (ß)		
(Constant)	1.336	.181		7.375	**.000**	.769	.176		4.365	**.000**
Transformational Leadership										
a) Articulating a Vision	.051	.039	.119	1.310	.191	-.024	.042	-.043	-.566	.572
b) Providing an Appropriate Model	-.088	.051	-.209	-1.707	.089	.001	.051	.001	.010	.992
c) High Performance Expectations	-.060	.126	-.141	-.476	.634	.000	.112	.000	-.002	.999
d) Providing Individualized Support	.059	.112	.136	.523	.602	.256	.107	.457	2.404	**.017**
e) Intellectual Stimulation	.043	.088	.107	.482	.630	-.051	.078	-.105	-.658	.511
f) Fostering the Acceptance	.065	.071	.154	.915	.361	-.146	.061	-.297	-2.404	**.017**
Job Satisfaction										
a) Pay	.027	.029	.048	.929	.353	-.015	.028	-.025	-.537	.592
b) Promotion	.031	.033	.049	.958	.339	.087	.033	.121	2.639	**.009**
c) Supervision	-.001	.034	-.002	-.030	.976	.013	.032	.020	.427	.670
d) Frienge Benefits	.040	.031	.068	1.288	.199	.028	.025	.053	1.134	.257
e) Contingent Rewards	.060	.035	.084	1.710	.088	.151	.031	.222	4.856	**.000**
f) Operating Procedurs	-.096	.034	-.153	-2.788	**.006**	.003	.028	.005	.106	.915
g) Coworkers	.069	.038	.109	1.819	.070	.063	.032	.091	1.926	.055
h) Nature of Work	.003	.028	.005	.098	.922	.058	.031	.088	1.864	.063
i) Communication	.077	.033	.120	2.339	**.020**	.033	.032	.047	1.030	.304
Organizational Trust	.226	.044	.284	5.105	**.000**	.254	.042	.291	5.993	**.000**
Model Summary	R= .514; R²= .264; F= 8.020; p= .0000; Durbin – Watson (DW) = 1.847					R= .570; R²= .325; F= 12.388; p= .0000; Durbin – Watson (DW) = 1.731				

- Dependant variable: Overall Organizational Commitment

Table 9 was presented for regression analysis to determine predictors of overall organizational trust of public servants and private employees in hospitals. Table 9 shows that 38.8 % (Adjusted R square = .37, F= 12.516, p = .00001) of the variance in the dependent variable (Organizational Trust of public servants) was explained by the 19 independent variables (Affective Commitment, Continuance Commitment, Normative Commitment, Articulating a Vision, Providing an Appropriate Model, High Performance Expectations, Providing Individualized Support, Intellectual Stimulation, Fostering the Acceptance, Pay, Promotion, Supervision, Frienge Benefits, Contingent Rewards, Operating Procedurs, Coworkers, Nature of Work, Communication). Multiple regression analysis revealed that Affective Commitment (st. ß= .127; t= 2.669; p< .05), Normative Commitment (st. ß= .165; t= 3.487; p< .05), Articulating a Vision (st. ß= .276; t= 3.350; p< .05), Pay (st. ß= .209; t= 4.492; p< .05), Supervision (st. ß= .181; t= 3.901; p< .05), Operating Procedurs

(st. ß= .182; t= 3.633; p< .05) have a significant effect on the dependent variable (organizational trust of public servants). On the other hand Table 9 shows that 36.9 % (Adjusted R square = .35, F= 13.314, p= .00001) of the variance in the dependent variable (Organizational Trust of private employees) was explained by the 19 independent variables. Multiple regression analysis revealed that Affective Commitment (st. ß= .093; t= 2.062; p< .05), Normative Commitment (st. ß= .219; t= 4.738; p< .05), Articulating a Vision (st. ß= .208; t= 2.806; p< .05), Intellectual Stimulation (st. ß= .334; t= 2.175; p< .05), Fostering the Acceptance (st. ß= .262; t= 2.181; p< .05), Supervision (st. ß= .171; t= 3.873; p< .05) have a significant effect on the dependent variable (organizational trust of private employees). The most significant predictor of organizational trust of public servants is Articulating a Vision. However, the most significant predictor of organizatinal trust of private employees is Intellectual Stimulation. Consequently, **H5** was accepted for affective commitment, normative commitment, articulating a vision, pay, supervision, operating procedurs. Whereas **H6** was accepted for affective commitment, normative commitment, articulating a vision, ıntellectual stimulation, fostering the acceptance, supervision.

Table 9. Dimensions of transformational leadership and job satisfaction, organizational commitment on organizational trust

	PUBLIC SEVANTS IN HOSPITALS				PRIVATE EMPLOYEES IN HOSPITALS			
	Unstandardized Coefficients	Standardized Coefficients	t	Sig. (p)	Unstandardized Coefficients	Standardized Coefficients	t	Sig. (p)
	Beta (ß) / Std. Error	Beta (ß)			Beta (ß) / Std. Error	Beta (ß)		
(Constant)	.669 / .223		3.001	**.003**	.926 / .194		4.766	**.000**
Organizational Commitment								
a) Affective Commitment	.123 / .046	.127	2.669	**.008**	.082 / .040	.093	2.062	**.040**
b) Continuance Commitment	.034 / .042	.038	.814	.416	.048 / .037	.058	1.281	.201
c) Normative Commitment	.147 / .042	.165	3.487	**.001**	.191 / .040	.219	4.738	**.000**
Transformational Leadership								
a) Articulating a Vision	.148 / .044	.276	3.350	**.001**	.132 / .047	.208	2.806	**.005**
b) Providing an Appropriate Model	-.056 / .059	-.106	-.944	.346	-.043 / .057	-.075	-.752	.453
c) High Performance Expectations	-.142 / .145	-.265	-.975	.330	-.115 / .124	-.188	-.926	.355
d) Providing Individualized Support	.013 / .130	.025	.104	.917	-.125 / .119	-.196	-1.052	.294
e) Intellectual Stimulation	.129 / .101	.259	1.273	.204	.188 / .086	.334	2.175	**.030**
f) Fostering the Acceptance	.033 / .082	.063	.408	.683	.148 / .068	.262	2.181	**.030**
Job Satisfaction								
a) Pay	.145 / .032	.209	4.492	**.000**	.026 / .031	.039	.853	.394
b) Promotion	.001 / .038	.002	.040	.968	.003 / .037	.003	.076	.939
c) Supervision	.149 / .038	.181	3.901	**.000**	.134 / .035	.171	3.873	**.000**
d) Frienge Benefits	-.040 / .036	-.053	-1.100	.272	-.004 / .028	-.006	-.127	.899
e) Contingent Rewards	-.018 / .041	-.020	-.445	.657	-.002 / .035	-.003	-.068	.946
f) Operating Procedurs	.143 / .039	.182	3.633	**.000**	-.024 / .031	-.035	-.765	.445
g) Coworkers	-.058 / .044	-.074	-1.335	.183	.061 / .036	.077	1.699	.090
h) Nature of Work	.011 / .032	.017	.350	.726	.040 / .035	.053	1.140	.255
i) Communication	.035 / .038	.044	.923	.357	-.008 / .036	-.010	-.218	.827
Model Summary	R= .623; R²= .388; F= 12.516; p= .0000; Durbin – Watson (DW) = 1.995				R= .607; R²= .369; F= 13.314 ; p= .0000; Durbin – Watson (DW) = 1.807			

- Dependant variable: Organizational Trust

DISCUSSION

The current study explored the relationship between transformational leadership, organizational commitment, organizational trust, and job satisfaction according to public servants and private employees in two Turkish public hospitals. The mean scores for Providing an Appropriate Model, Providing Individualized Support, Overall Transformational Leadership, and Communication significantly vary in terms of public servants and private employees in hospitals (employment status). It was concluded that there are statistically significant strong positive correlations (interrelations) transformational leadership, among organizational commitment, organizational trust and job satisfaction scores of public servants and private employees in hospitals. Operating procedures, communication and organizational trust were the significant predictors of organizational commitment of public servants. Whereas individualized support, fostering the acceptance, promotion, contingent rewards and organizational trust were the significant regressors of organizational commitment of private employees.

The results of this study are consistent with a pervious exploratory study that examined the same relationships [28] [16] [32] [23] [20] [26] [1] [21] [27] [31] [19] [18] [13] [12]   [29] [17] [30] [3] [15]. Transformational leadership behavior enables the leaders to embrace strong emotional ties to their followers. This demonstrates that transformational leadership encouraged higher organizational commitment. Bycio, Hackett, & Allen [6] found that transformational leadership has strong correlations with the three dimensions of organizational commitment. To some extent, affective commitment can be regarded as the outcome of transformational leadership. Studies indicated that transformational leadership had higher correlations with the affective commitment than normative commitment [15]. Avolio, Zhu, Koh, and Puja [3], using a sample of staff nurses employed by a large public hospital in Singapore, found a positive association between transformational leadership and organizational commitment.

In the current study, organizational trust and some dimensions of job satisfaction were significant direct predictors of organizational commitment for public servants and private employees in hospitals. Consistent with this finding, levels of perceived job satisfaction and loyalty have been identified as significant predictors of organizational trust for business managers [28]. Support also exists in the human resource literature for the direct effect of trust on affective commitment [16]. Causal model findings further support the strong direct effect of job satisfaction on organizational commitment. This study further demonstrates the role and importance of QM practices in the healthcare industry in enhancing jobs as "enriched jobs are positively associated with both measures of well being, job satisfaction and anxiety" [32].

Leadership and job satisfaction are recognized as fundamental elements influencing the overall effectiveness of an organization [14]. Bryman et al., [5] and Fuller et al., [9] found that transformational leadership behaviors were positively related to the job satisfaction. Yusof [33] also presented that transformational leadership behaviors led to greater job satisfaction among employees of industrial and business organizations. Furthermore, Friedrich [34] found that transformational leadership positively affected job satisfaction within an organization.

Saygun et al. [23] examined the sub-factors affecting the job satisfactions of 139 doctors working in three hospitals in the province of Kirikkale, Turkey. The results indicated that job

satisfaction amongst doctors varied significantly in terms of ownership type of the employed hospital. Moreover, it was found that institutional loyalty and institutional confidence are among the most important factors which affect the job satisfaction of doctors [23]. Although studies investigating the interaction between organizational commitment, organizational trust, and job satisfaction in the Turkish healthcare settings have been conducted, such studies lack the QM approach [20] [26]. Thus, the findings of this study aim to fill that gap.

CONCLUSION

The study had some implications for practitioners and researchers in human resources management in Turkey. From a practical perspective, the results suggested the need for more transformational leaders in Turkish hospital sector. Organizational commitment and employees' job satisfaction has been especially shown to be positively related with transformational leadership for public servants and private employees.

The findings of this study are subject to several limitations. First, the samples of this study are only limited to the personnel in two organizations. The study was conducted in two public hospitals in Turkey. We don't know whether these results would generalize to other hospital settings or to other types of organizations. Generalizability of the present findings should therefore be examined in future research in other types of organizations, with more heterogeneous samples and large populations.

In sum, this is the first study to examine the relationships among transformational leadership, organizational commitment, organizational trust, and job satisfaction in Turkey context and Turkish public health care system for public servants and private employees. Other researchers are highly encouraged to extend this work to include other European countries and several other important organizational outcomes, such as organizational citizenship, adjustment, trust, job performance, absenteeism, empowerment, and turnover. The future research should include the transactional leadership as well because managers of hospitals and other health care organizations are normaly using both transformational and transactional leadership in tehir routine work and roles. For beter results the qualititative study may be recommended to define and analysi relationship among transformational leadership, organizational commitment, trust and job satisfaction. Longitudinal studies for future research would be conducive to our further understanding of the leadership dynamics in organizations. This study could also be deployed in other countries or regions for comparing and contrasting.

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THE VALUE OF HEALTH CARE SUSTAINABILITY

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ABSTRACT

The sustainability of the U.S. health care industry has been in question for decades. Industry analysts have focused on assigning blame among the various players: Federal and State governments, pharmaceutical companies, medical device manufacturers, direct care providers (hospitals, general physicians, outpatient facilities, etc.), and medical insurers. However, until recently, the conversation has been limited primarily to accounting. To be sustainable, the health care industry must possess five "abilities": availability; dependability; capability; affordability; and marketability. This paper presents a strategy for health care sustainability based on value, which is defined as the benefits of health care relative to its costs.
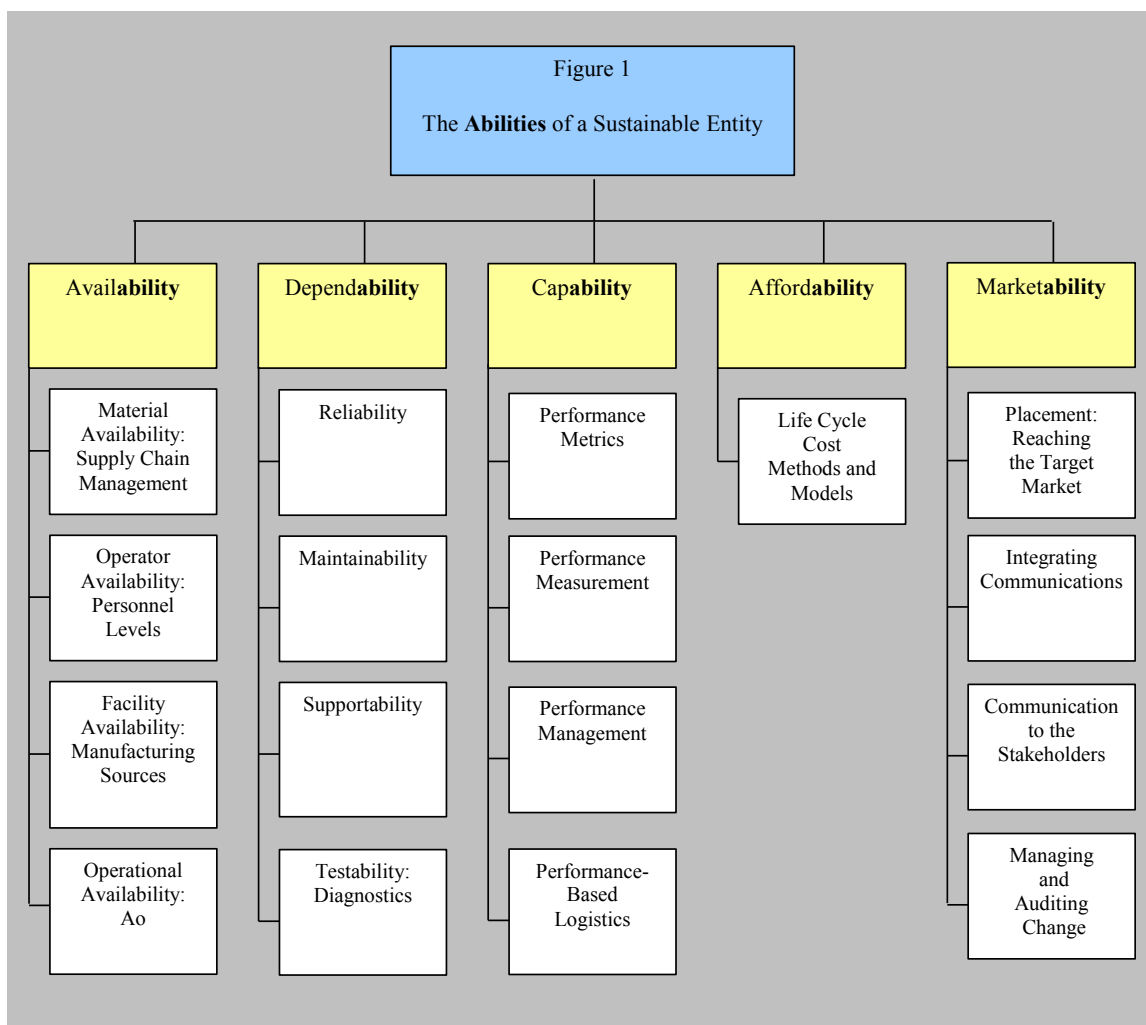
BRIEF BACKGROUND

The World Health Organization ranking of the world's health systems ranked the U.S. number 37 in 2000 [1]. Out of 7 industrialized countries (Australia, Canada, Germany, the Netherlands, New Zealand and the U.K.) the U.S. ranked last on quality, efficiency, access, equity, and ability for citizens to lead long, healthy lives [2] Health care in the U.S. is a bad value, where more is spent per person than in other countries, but patients are getting poorer results. Everyone is to blame for this poor value: Federal and State governments, pharmaceutical companies, hospitals and physicians, medical insurers, citizens. 34% of dollars are wasted in U.S. health care [3]. Some of the most common causes of waste are:

- Overtreatment of patients
- Errors and injuries in the hospital (up to a third of hospital patients may be harmed during their stays)
- Coordination failures, like sending patients home too early from hospitals
- Administrative complexities
- Failures of price competition
- Fraud

The Patient Protection and Affordable Care Act (PPACA) signed into law by President Obama on March 23, 2010 is meant to be a start for creating better value.

THE ABILITIES FOR SUSTAINABILITY IN HEALTH CARE

The abilities for health care sustainability are illustrated in Figure 1.

Figure 1

The **Abilities** of a Sustainable Entity

Avail**ability**	Depend**ability**	Cap**ability**	Afford**ability**	Market**ability**
Material Availability: Supply Chain Management	Reliability	Performance Metrics	Life Cycle Cost Methods and Models	Placement: Reaching the Target Market
Operator Availability: Personnel Levels	Maintainability	Performance Measurement		Integrating Communications
Facility Availability: Manufacturing Sources	Supportability	Performance Management		Communication to the Stakeholders
Operational Availability: Ao	Testability: Diagnostics	Performance-Based Logistics		Managing and Auditing Change

Effective sustainment strategies require time and patience to be developed and implemented. They might need to be altered during phases of the life cycle of the entity or enterprise with modifications and upgrades.

PROPOSED DISCUSSION AND PRELIMINARY CONCLUSIONS

Each of the five abilities will be discussed and related to health care using examples. Some of the examples will consider hospital and provider issues, billing errors, and fraud. Overall, the emphasis will focus on looking at patient outcomes versus procedures to

provide value and reduce costs. By applying these five abilities, the desire is to illustrate that increased quality of care does not necessarily have to result in added costs. But, the abilities must be refined throughout any entity's life cycle, particularly during its development, its modifications, its implementation, and its upgrades to create value.

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STUDENT ATTITUDES TOWARD USING FACEBOOK FOR EDUCATION: A SURVEY

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ABSTRACT

Although there is a growing literature base on the potential of social media to enhance student learning, there is little guidance on practical implementations of social media, or empirical evidence that these interventions produce expected results. In this study we surveyed undergraduate students with regard to their social media usage and attitudes toward social media in general, and Facebook in particular. We simultaneously conducted an experiment on the use of social media to encourage student engagement and participation in an introductory Operations Management course. While students report high comfort levels and usage of social media in their personal lives, we find that the willingness to use Facebook as an educational tool varies depending on the student's chosen field of study.

INTRODUCTION

Social media has taken the millennial generation by storm. In 2009, approximately 93% of young adults' ages 18-29 reported going online, with 72% them active on at least one social media site [14]. The most popular social media site is Facebook, where 71% of young adults online have posted a profile. Given its widespread distribution and its ability to facilitate communication, social media has been proposed as a way to increase student participation, collaboration, information sharing, and critical thinking [1][15][23]. However, there is scant empirical evidence of successful implementation of Facebook as an educational tool. In this study we investigate student attitudes towards social media, their use of Facebook, and the results of an experiment in delivering course enrichment through a Facebook page.

The paper is organized as follows: first we survey the literature to identify educational uses of Facebook. We then describe the results of a survey of undergraduate students regarding their knowledge and use of social media. Finally, we discuss the results of our experiment and a follow-up survey. We finish with suggestions for potential uses of this new forum and proposals for future studies.

LITERATURE REVIEW

Developments in information and communication technologies have changed pedagogical and technological applications and processes [17]. Beyond the traditional printed syllabus, class lecture sessions, and written assessments, electronic Course Management Systems (CMS)

provide an individualized online presence for students to access course materials, submit assignments, and communicate with instructors and each other. Electronic Learning Management Systems (LMS) can also be linked to the CMS, providing an instructor with a central electronic platform to monitor student performance. In the midst of this connectivity, it has been reported that students today demand more autonomy, connectivity, interaction, and socio-experiential learning opportunities [18]. Although the CMS and LMS allow students to interact with the instructor, the opportunities for students to interact with each other and create their personal "class space" are limited. On the other hand, the rise of social media has created a portfolio of opportunities for educators to branch out beyond traditional forms of communication and interaction.

Social network sites can be defined as "web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system. [2]" Social software or "Web 2.0" is used to describe a platform in which content is created, shared, remixed, and passed along [6]. In contrast to the passive posting and downloading of instructor-generated content, students participating in Web 2.0 exercises are active participants in creating, evaluating, and transmitting, and assimilating knowledge. Web 2.0 allows participants to create their own "on-line communities" [4][24]. It has been suggested that Web 2.0 technologies have the potential to support lifelong competence development [12]. Hence the potential benefits of using social media include enhancing student communication, collaboration, and engagement in the classroom and beyond.

By far the most popular social network used by college students and young adults is Facebook [14]. Facebook is a social network site at which members can share photographs and personal information as well as form and/or join in groups with other individuals of similar interests. In June of 2012, Facebook announced that it had over 950 million users worldwide [8]. Given its ubiquity in the lives of today's college students, Facebook would seem to be the perfect candidate to experiment with implementing a Web 2.0 component in the classroom. The ability to create, post, link, and comment on content in Facebook allows instructors and students to customize the course experience every term.

Several scholars have examined the successful use of Facebook in academic settings. Ractham, Kaewkitipong and Firpo (2012) describe the use of Facebook to enhance participation and foster a positive learning environment in an introductory management information systems course for Thai undergraduates. LaRue (2012) used Facebook as course management software in a graduate nursing course. Cheung and Vogel (2011) studied how Facebook can enhance communication between teachers and students. On the other hand, other researchers have concluded that students use Web 2.0 largely for social reasons, and are reluctant to share this "personal" space with instructors [25][9][10]. In short, the literature on educational use of Web 2.0 is still nascent, and questions remain as to when and how to implement these new technologies in order to reap the potential benefits, if they can indeed be achieved.

SURVEY DEVELOPMENT

Our purpose is to explore the attitudes of college students toward using social media in order to determine if and how this could be a fruitful educational intervention. A search through the literature on the educational use of social media did not identify a comprehensive instrument. Thus, we assembled a list of survey items intended to provide a comprehensive overview of students' perceptions of social media, including how much they use it, how they use it, and their likelihood of participating in class-related social media outlets. With the exception of the "Facebook Intensity" scale, which was adapted from Ellison et al (2007), the items included in the survey were developed for this research.

The general questions we seek to answer are:

- **Are our students a representative of the national sample?** [14]. The purpose of these items is to confirm that the respondents generally match the behaviors reported by the previous survey.
  - o I am comfortable using social media.
  - o Social media is easy to use.
  - o I use social media regularly.
  - o Social media lets me communicate quickly.
  - o Social media helps me stay in touch with things that are important to me.
  - o Social media wastes a lot of time.
  - o Social media is a productive use of my time.
  - o Social media is relevant to my life.
  - o I check at least one social media site every day.

- **What is the level of Facebook intensity for our sample?** The Facebook Intensity scale measures an individual's emotional connection to Facebook and the extent to which Facebook is integrated into daily activities [7]. We adapted the Facebook Intensity scale by removing two items that were not considered germane to this research.
  - o Facebook is part of my everyday activity
  - o I am proud to tell people I'm on Facebook
  - o Facebook has become part of my daily routine
  - o I feel out of touch when I haven't logged onto Facebook for a while
  - o I feel I am part of the Facebook community
  - o I would be sorry if Facebook shut down

- **Are students using social media for anything besides purely social reasons?** We hypothesize that students that are using the site for purely social reasons might be less inclined to participate in Facebook activities that relate to academic activity. On the other hand, those who have found social media to be useful in academic or professional tasks might be more inclined to participate in an academic application of Facebook.
  - o I use social media to interact with my friends.
  - o I use social media for my academic school work.
  - o I use social media to increase professional opportunities.
  - o I use social media to make new friends.
  - o I use social media for coordinating group projects in my classes.

- **Do students have privacy concerns about Facebook?** There have been conflicting assessments regarding the attitude of social media users towards the privacy of their online postings. Debatin et al (2009) argue that although they are aware of privacy issues, social media users value the social interaction enough that they will risk having their postings become public. On the other hand, Rosenblum (2007) suggests that users perceive their online presence as occurring within a protected (i.e.—private) environment and thus post their thoughts freely. In either case, and given highly publicized instances of students being disciplined for their online comments, the fact remains that the student/instructor dynamic creates a challenge when attempting to use social media tools to reach students.   The items used assess a student's level of comfort with the idea of faculty members having potential access to their Facebook profiles and postings.
  - I am Facebook "friends" with at least one of my professors.
  - I would not "friend" a professor. (reverse coded)
  - I monitor my privacy settings in Facebook.
  - I would be worried that if I visited or posted on a class Facebook page, my professor would see my private postings intended for my friends only.
  - I think Facebook is overused.

- **Are students interested in seeing Facebook used as an educational tool?** Even the best-planned interventions depend on the participation of the target subjects. The items used assess the willingness of the student respondents to engage with class material on a Facebook page.
  - I wish more professors used Facebook in their classes.
  - I think Facebook is a good way to disseminate information.
  - I would post to a Facebook page connected to a class.
  - I would visit a Facebook page set up by a professor.

Once we have preliminary answers, we will implement a Facebook page for the class, and monitor participation in it in the form of comments to postings, independent postings, and general activity level. When the intervention ends, we will follow up with a de-briefing survey.

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EXPLORING THE ROLE OF SOCIAL MEDIA ON SOCIAL BEHAVIOR

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ABSTRACT

Computers have changed many aspects of life, but none more than how we communicate. Computer-Mediated Communication (CMC) is largely responsible for a change in what is viewed today as normal social behavior. Interaction between one another has changed as a result of developing dependencies and comforts with new technologies and social media.

Social media has become a major form of communication for all ages across the world. As the world becomes continuously more interactive with advancements in communication technologies and globalization, social behavior is rapidly changing. Many of these changes have resulted as a dependency on CMC.

In an effort to analyze the effects that CMC has had on face-to-face communication and social behavior, the history of social media will be examined as well as many of the components of CMC. The areas of user generated content (UGC), social presence/anonymity; self-disclosure, uncertainty avoidance, and communication mediums will be examined with regards to their relationship with social behavior and face-to-face interaction. The virtual environment will be compared to the real world, and the online relationship will be compared to the traditional relationship process in order to identify key differences that are impacting the culture and norms present in 2012.

Research Question:

How does CMC affect the building of physical social relationships?

HISTORY OF SOCIAL MEDIA

 To better understand the broad definition of Social Media, its history must be explored. According to Andreas M. Kaplan and Michael Heinlein (2009), the era of Social Media as we understand it today started around 1959, when Bruce and Susan Abelson founded "Open Diary," an early social networking site that brought together a community of online diary writers. Around the same time, the term "weblog" was first used. It was later shortened to "blog". Twenty years later, Tom Truscott and Jim Ellis of Duke University had created the Usenet, a

worldwide discussion system that allowed Internet users to post public messages. Still the popularity of Social Media as we know it today came with the creation of sites such as MySpace (in 2003) and Facebook (in 2004). At this time the term "Social Media" was coined. Extending the concept of Social Media even further came applications known as "virtual worlds" where users participate in a simulated environment with three-dimensional avatars as themselves. The most popular of these programs is the virtual world created by Linden Lab's called Second Life.

With the combination of Web 2.0 and UGC, Kaplan and Haenlein (2009) have established the following definition, "Social Media is a group of internet-based applications that build on the ideological and technological foundations of Web 2.0, and allow the creation and exchange of User Generated Content" (p. 61). Because this is a broad definition, it presently applies most directly to web applications and Internet sites such as Wikipedia, Youtube, Facebook, and Second Life. With new sites being developed and launched almost daily, it is difficult to come up with a formal definition for upcoming applications.

The growing availability of high-speed networks and mobile Internet access has helped these social networks explode in popularity. According to Forrester Research (as cited in Kaplan & Haenlein, 2009), "75% of Internet surfers used 'Social Media' in the second quarter of 2008 by joining social networks, reading blogs, or contributing reviews to shopping sites; this represents a significant rise from 56% in 2007" (p. 59). This revolutionary trend of Social Media has grown substantially since 2008 and is not slowing down anytime soon; sharing anything from daily thoughts, feelings, observations, as well as photos and video on a daily basis has become the new norm amongst the social media generation.

Computer-mediated communication was once confined to technical users and was considered somewhat arcane (Kiesler, Siegel & McGuire, 1984). This no longer applies to our current society where CMC has become a part of everyday life and communication with text messaging, e-mail, and the use of social media applications.

USER GENERATED CONTENT

The introduction of the modern-day Smartphone has revolutionized the uploading and sharing capabilities of social media users and become one of the primary tools used for creating user generated content. User Generated Content (UGC) is the voluntary content that users input onto the World Wide Web to be viewed by all users. With Web 2.0 as the technical foundation, "UGC can be seen as the sum of all ways in which people make use of Social Media." (Kaplam & Haenlein, 2009, p. 61) UGC is broadly defined as the various ways end users upload or input all types of media content for public availability.

> "UGC needs to fulfill three basic requirements in order to be considered as such: first, it needs to be published either on a publicly accessible website or on a social networking site accessible to a selected group of people; second, it needs to show a certain amount of creative effort; and finally it needs to have been created outside of professional routines and practices." (Kaplam & Haenlein, 2009, p. 61)

UGC differs today in comparison to its initial use when Tom Truscott and Jim Ellis created Usenet largely because of the generations who are using UGC. Because of widespread use of

technology, younger age groups have substantial technical knowledge and are more willing to engage online, which makes UGC fundamentally very different.

MEDIA RICHNESS & UNCERTAINTY AVOIDANCE

Through the research of Richard L. Daft and Robert H. Lengel (1986), they have broken down the organizational informational requirements that make up the Media Richness Theory (MRT) that classifies different types of communications by their carrying capabilities as well as their effectiveness. In order to examine the effect that social media has on face-to-face behavior; social media must be classified in regards to its' media richness.

Media Richness Theory helps categorize different forms of CMC's effectiveness. Media Richness Theory is based on the assumption that the goal of any communication is the resolution of ambiguity and the reduction of uncertainty. (Daft & Lengel, 1986) This theory supports the idea that media differs in the degree of richness that it possesses which affects the amount of information that can be transmitted in a given time interval. According to Media Richness Theory some media are more effective than others in resolving ambiguity and uncertainty. When this theory is applied to Social Media, it is assumed that a first classification can be made based on the richness of the medium and the degree of social presence it allows (Kaplan & Haenlein, 2009). Social presence is influenced by the intimacy (interpersonal vs. mediated) and immediacy (asynchronous vs. synchronous) (Kaplan & Haenlein, 2009, p. 61).

Communication mediums vary in their capacity to process rich information. In order of decreasing richness Daft and Lengel ranked the media classifications in order of descending richness; (1) face-to-face, (2) telephone, (3) personal documents such as letters or memos, (4) impersonal written documents, and (5) numeric documents (Daft & Lenegel, 1986). Social Media was not present in 1986 at the time Daft and Lengel were conducting their research however, it is believed that Social Media falls somewhere between (1) face to face and (2) telephone communication due to the high variety of media content and capabilities of social media applications. The reasons for richness differences include the mediums capacity for immediate feedback, the number of cues and channels utilized, personalization, and language variety (Daft & Lengel, 1986).

The relationship between the richness of information on information processing behavior has a direct effect on equivocality and uncertainty avoidance. The key factor in equivocality reduction is the extent to which structural mechanisms facilitate the processing of rich information (Daft and Lengel, 1984). Daft and Lengel (1986) use the early work in psychology of Miller and Frick, Shannon and Weaver, and Garner to define uncertainty as the absence of information; as information increases, uncertainty decreases.

Weick, Daft and Macintosh (as cited in Daft and Lengel, 1986) stated that "equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation" (p. 556). Further defined, Daft and Lengel (1986), view equivocality as a problem, therefore, asking a yes or no question is not feasible. Daft and Lengel (1986) continue to use these factors of uncertainty and equivocality as a means to explain information processing behavior.

Social Media is viewed as a form form of CMC; one in which is very rich in self-presentation and self-disclosure, and medium in social presence and media richness according to Kaplan and Haenlein's (2009) classification system. Technically CMC has the adaptability of text, the speed and energy efficiency of face-to-face communication but lacks visual feedback. In traditional forms of communication, head nods, smiles, eye contact, distance, tone of voice, and nonverbal behavior give speakers and listeners information they can use to regulate, modify, and control exchanges (Kiesler et al., 1984). The absence of such nonverbal communication can weaken the influence of such messages.

SOCIAL PRESENCE & SELF DISCLOSURE

Social Media has been analyzed and categorized into the field of media richness in regards to two major components of social media, social presence and social processes (self-presentation, self disclosure) (Kaplan & Haenlein, 2009).

"Social Presence Theory states that all media differs in the degree of 'social presence' –defined as the acoustic, visual, and physical contact that can be achieved –they allow to emerge between two communication partners" (Kiesler et al., 1984) This theory analyzes the differences between forms of communications. Social presence is related to the intimacy of the form of communication. The intimacy levels of a face-to-face conversation are much higher than a phone conversation and so on, leaving one of the least intimate forms of communication as CMC. Social Presence Theory proves that "The higher the social presence, the larger the social influence that the communication partners have on each other's behavior." (Kaplan & Haenlein, 2009, p. 61)

The concept of self-presentation has been discovered to state that in any type of social interaction people have the desires to control the impressions other people form of them. This can be seen in numerous social situations, whether it is dressing nice to attempt to make a positive impression on future in-laws, or when walking into a prospective job interview. This desire to control impressions is reflected through a wish to portray an image that is consistent with one's belief of their personal identity. This is evident with the emphasis in profile pictures and online profiles in today's society. There is an increased concern with the image and appearance that someone has in their profile picture while the need to look presentable and neat in face-to-face interactions is decreasing.

Chistopherson (2006) suggests, "the key reason why people decide to create a personal webpage is, for example, the wish to present themselves in Cyberspace" (p. 344). This is done through self-disclosure; either conscious or unconscious revelation of personal information (e.g. thoughts, feelings, likes, dislikes) that are consistent with the image one *would like* to give. Previous to Social Media, self-disclosure was mainly a process revealed on a basis of trust in a close relationship. Today, individuals are more willing to disclose information freely to a social network page leaving very few secrets for face-to-face interactions.

PROPER MEDIUM SELECTION

The interconnectivity of the word in 2012 can be a beautiful thing as a result of CMC. It has brought together people in many ways that are positive, both inside the business world, as well as socially. These gains of a smaller and more connected world have nonetheless come at the expense of some formal behavior. Many individuals have a difficult time deciphering the proper mediums of communication as a result of the wide range of choices available to them. An example of this is when a "friend" experiences either a tragedy or a great accomplishment. In these situations it is most proper to send condolences or congratulations in a personal manner. Past precedence would say a phone call or card sent in mail would be appropriate depending on the level of the personal relationship.

It is now common for these condolences or congratulations to be expressed through a text message, over a Facebook "wall post" or a "tweet" on Twitter, which would formally be viewed as unacceptable behavior. CMC is becoming more of an acceptable interaction medium as societ becomes increasingly comfortable with its' use.

People who are directly connected and have strong ties often choose the proper medium to express their feelings as a result of the respect gained between one another in a close relationship. The problem of proper choice of communication mediums most often are encountered between individuals who have weak ties with one another or individuals who shy away from personal interaction.. When there are weak ties it is easier to make a half-hearted attempt at communicating using the most convenient medium.

When referring to loss of formality in the e-mail and social media generation, it is seen when comparing a formal letter vs. an important E-mail. Before CMC took over as the normal means of communication for businesses and individuals, a nice formal letter said a lot about a business or a person. A letter shares many characteristic traits that are, not as meaningful in electronic mail. In a physical letter/envelope, the type of paper, the letterhead, and the physical signature or even handwriting are noticed and appreciated. Certain parts of these characteristics cannot be replicated efficiently electronically. Currently if you were to receive an important e-mail pertaining to a job offer, it would be located in an inbox that is full of a variety of messages ranging from junk mail that bombards an inbox on a daily basis to important business decisions that must take place at a current job.

It is difficult deciphering the e-mails that are junk compared to messages that are of high value and importance. It can be observed that an active CMC user can receive more than twice the amount of e-mails per day in comparison to traditional mail. Because e-mail provides effortless forwarding capabilities the importance can be diluted, contributing to a less formal environment.

Society falls victim to using the most convenient possible form of communication at all times whether it be the most appropriate or not. This is evident in the business world today; it is common that a coworker will email a minor task to another coworker whose desk is right across the hall rather than take the effort to personally address the other individual. The business world is constantly striving for better efficiency and profitability, which in turn encourages this type of behavior and communication. This is not to say that there is never a proper time to email someone even if they are residing directly across the hall; in spite of this, it is important that we

become mindful of the choice of medium we use in this day of age to maintain healthy communication as well as relationship growth.

HOW SOCIETY IS AFFECTED

In 1984 Kiesler et al. asked, "How do people develop a technology in culture transition? Do they import norms from other technologies? Do they develop new norms?" (p. 1126). In 2012 have we now developed norms with electronic communication?

Due to the nature of CMC and its restrictions; people have adjusted the manner in which they receive and process information. Email, Twitter tweets, and other Internet-based communication channels have significantly improved communication efficiency. A standard text message or "tweet" is comprised of 140 characteristics which leaves limited space for one to express themselves and the point they are trying to get across to their communication partner but society has adapted and makes use of each one of those 140 characters daily.

It is believed this demand for concise and direct responses has rolled over into face-to-face communication as a result of individual's comfort with CMC. This behavior can often come off as rude and disrespectful. Many would argue that the art of conversation is being lost as a result of society's dependence on CMC.

In 1983 Edinger & Pattterson (as cited in Kiesler et al., 1984) hypothesized that the use of CMC will cause social influence among communications to become more equal due to so much hierarchical dominance and power information hidden in electronic text and information. They also hypothesized that "social standards will be less important and communication will be more impersonal and more free because of rapid exchange of text, the lack of social feedback, and the absence of norms governing the social interaction redirect attention away from others and towards the message itself" (p. 1126).

According to Kiesler et al. (1984), CMC is comprised of similar conditions that are essential to conditions involved with deindividuation and anonymity that both reduce self-regulation and self-awareness. The effect of these blurred status lines that are created as a result of CMC comes to benefit minorities while hurting the influence leaders or higher-ups.

Hoffman (as cited in Kiesler et al., 1984) suggests that, people who are high in status usually talk most and dominate decision-making. CMC deemphasizes the impact of status and also increases peoples consideration of minority views; "If minority opinions can enhance performance, then groups could be more effective when using computers to communicate" (p. 1126). It has been proven that electronic media does not efficiently communicate the nuances of communications such as; frame of mind, organizational loyalties, symbolic procedural variations, and the individuating details about people that might be embodied in their dress, location, demeanor, and expressiveness, this theory is supported by examples from Ekman, Friesen, O'sullivan, & Scherer 1980 and Mehrabian, in 1972 (Kiesler et al., 1984, p. 1126).

The use of computers as form of communication induces quicker responses that lower self-awareness fostering feelings of depersonalization. The weakening awareness of self occurs when CMC causes a person to feel less aware of themselves and more submerged into a group;

this situation of becoming less self aware in a group dynamic is referred to as deindividuation. CMC has been proven to greatly increase the levels of deindividuation.

Wellman, Salaff, Dimitrova, Garton, Gulia & Haythornthwaite (1996) state in their research that many studies have examined how the limited "social presence" of computer-mediated communication affects both interactions as well as decision-making. Verbal nuances are lost with the use of CMC for example voice tone or volume; nonverbal cues such as gaze or body language are lost, as well as the physical context of meeting places and observable characteristics of individuals. "These factors of anonymity contribute to increased participation in groups, more egalitarian participation, more ideas offered and less centralized leadership" (Wellman et al., 1996, p. 220). This limited social presence in CMC also encourages people to communicate more freely and creatively than they do in person.

Very similar Lott & Lott's (as mentioned in Postomes et al., 2001) "theories of social influence based on interpersonal attraction or interdependence of group members suggest that face-to-face interaction should strengthen the interpersonal bonds that transmit social influence, whereas isolation and anonymity should weaken them." (Postomes et al., 2001, p. 1244). This theory supports the general belief that anonymity explicitly or implicitly weakens social influence by and within groups, as well as leaves individuals unaware of the repercussions of their behavior.

Language used electronic communications often is a mixture of language appropriate for boardrooms mixed with language appropriate for ball fields. Normal conventions of privacy are often neglected by posting personal messages as bulletin board material; this is evident today with Facebook and Twitter where individuals often reveal more about themselves or others than intended through public posts. "Flaming" is another negative byproduct of this social presence scenario where individuals use extreme aggressive language in response to posts or messages. The near instant response time of this medium largely contributes to these irrational, emotional responses.

ONLINE RELATIONSHIPS

The research of Wellman et al. (1996) supports a viewpoint that states people support and willingly use CMC for more reasons than just the exchange of information. From the studies of this journal; despite the limited social presence of CMC, people find social support, companionship, and a sense of belonging through the normal course of computer-supported social networks (CSSNs) of work and community, even when they are composed of persons they hardly know (Wellman et al., 1996). Users take advantage of social networks to connect with people who are experiencing or have experienced similar situations or emotions that they are going through in order to feel a sense of community as well as comfort that they are not alone. Social networks provide this support and are a large factor of why individuals embrace social media and their online relationships.

"The structure of the internet encourages specialized relationships because it supports a market approach to finding social resources in virtual communities" (Wellman et al., 1996, p 221). This contributes to relationships based off of formulas. The market approach of finding relationships

and building networks is often based off of complex algorithms and formulas created by software developers for sites like Facebook , Linked In, Twitter etc.

Rheingold (as cited in Wellman et al., 1996) reveals that "in the absence of social and physical cues, people are able to get to know each other on the Internet on the basis of their communication and decide later to broaden the relationship or move it off-line" (p. 220). This approach to relationships creates a much different dynamic than the standard introduction and exchange of information leading to self-disclosure.   Under the process mentioned above from Rheingold (as cited in Wellman et al., 1996) individuals are allowed a preview to a friendship before they commit to any face-to-face interaction. Pending on an individuals disclosure in an online profile several trust building steps can be skipped previous to any face-to-face interaction. This social dynamic raises concern because it is possible that future generations will depend on analyzing an online profile previous to building a relationship in the face-to-face realm. Interactions and relationships are spontaneous in nature and are meant to be experienced through face-to-face encounters.

CMC and social media produce several more weak ties than face-to-face communication but lack in strong ties and relationships. Therefore as the use of social media and CMC increases with the advancements in communication, there is an increase of communication medium confusion and a loss of formal communication practices.   These communication tendencies that are developing as a result of extensive use of CMC and social media are forming new norms that will define what the relationship process will look like as we move into the future.

Friendship is on of the most common types of interpersonal relationship. It has been defined several different ways over time. Hartup (as mentioned in Chan & Cheng, 2004) defines friends as those 'who spontaneously seek the company of one another; furthermore, they seek the proximity in the absence of strong social pressures to do so' (p. 11)

Social media has created an environment in which we have an abundance of weak ties (friendships) with various networks of people yet have devalued some of the close tie relationship characteristics such as face-to-face interaction, quality time, as well as respect. Relationships are based and built on one large factor, respect, and more importantly mutual respect. Respect is built in a relationship as one reveals unknown facts about themselves and their history to another person with the confidence and comfort that that person will not use that information in any malicious way. Some would consider this the revealing and opening of their Johari Window to one another.

In the pre-social media era, relationships were initiated with an introduction and a handshake in almost every situation. This gives both sides an opportunity to look one another in the eye and make a physical connection. Tone of voice, eye contact, posture, physical appearance, as well as several other non-verbal communication indicators are continuously given off and received simultaneously during this small gesture. In comparison to the traditional formal introduction we have the social media generation Facebook friend request, often times previous to any physical encounter or shortly following a brief introduction. Upon the acceptance of this friend request it is normal and socially accepted to look into one another's profile and through their photo library to make your own judgments about someone based on their online profile and any public UGC available. In some cases this is an overload of self-disclosure pending on what content an individual displays on their own page. In traditional relationships it often takes time and trust for

an individual to disclose information to someone else. It is in a way a slow process of discovering who a person really is and the reward is the bond of a relationship.

Chan and Cheng (2004) conducted an experiment in 2004 at the Chinese University of Hong Kong comparing the different stages of online vs. offline friendship qualities at different stages of relationship development and came up with the following conclusion. Of the 162 internet users who were tested the majority rated the quality of offline friendships as higher than that of their online friendships. Higher degrees of breadth, depth, code change, understanding, interdependence, commitment, and network convergence were found in offline friendships than online friendships. They concluded that both social presence theory and the lack of social context clues suggest that the limitations of communication channels used in CMC make it more difficult to develop close relationships online.

Along with weaker relationship ties comes less accountability for actions and behavior. If there is mutual respect and accountability in a relationship the members owe each other a certain level of appropriate communication practices. This accountability and respect is less evident in online relationships and it is possible that the less proper tendencies and behavior developed in the online setting can roll over into face-to-face interaction.

PROPOSED EXPERIEMNT

To observe the affect of CMC on the building of physical social relationships an experiment can be set up to observe the interactions of individuals when CMC is introduced. This experiment will attempt to identify how much different socializing is when CMC/SM is present in a physical interaction.

In this proposed experiment, volunteers will be brought into a testing facility to take a mock survey. Previous to taking the survey the subjects would be required to wait for an extended period in the waiting room. The subjects will be told in advance the whereabouts to report to this waiting room and at a specific time. The waiting room is where the real experiment is being conducted. By filming the waiting room when the subject walks into the room their behavior can be examined. In all of the experiments there will be an individual present in the waiting room that has seemed to have been there for quite some time before the volunteer, this individual will be referred to as the confederate. After approximately 20 minutes of waiting/observing someone will come into the waiting room and retrieve both the subject as well as the confederate and will escort them to the room where they will be taking their "survey". The survey will have no direct relationship with this experiment other than the demographic characteristics filled in by the subject. Upon leaving the waiting room the experiment will conclude and the 20-minute waiting period will be analyzed qualitatively.

There are certain modifications and combinations to the given scenario explained throughout the chart below that will produce varied results and different dynamics of interaction. The waiting room will be of sufficient size with six chairs on one side of the room with a small coffee table. On the other side of the room there will be a kiosk with three computer terminals.

Assumption: It will be assumed that all subjects have possession and access to their own mobile cellular device with or without Internet connection capabilities.

The following situations are explained and can be combined for 18 combinations to test.

 (1) The computers will be turned on and the Facebook log in screen will be pulled up on all three terminals.

(2) The computers will be shut off and a pass code will deny access to the computers by the subject

(a) The confederate will be seated in a waiting room chair with phone located in pocket the entire time.

(b) The confederate will remain seated in the chair with phone in hand making use of texting/social media.

(C) The confederate will be seated at the computer "Facebooking"

(i) Confederate will not initiate any communication

(ii)Confederate will initiate conversation with one line such as "How are you doing?"

(iii)Confederate will initiate and continue with three scripted inquisitions

All 18 combinations will be tested

Ex: combination (1)(a)(ii) – The subject will enter the waiting room with the confederate seated in one of the waiting chairs with his phone in hand using CMC. The confederate will then ask the subject "How are you doing?" while keeping phone out entire time.

Subject	Confederate	Confederates Communication
(1) Access to Computer	(a)W/phone in chair	(i)Nothing
(2)No Access to Computer	(b)W/out phone in chair	(ii)1 Line
	(c)Seated at Computer	(iii)Conversational

The baseline (control) in which all experiments will be compared to will be combination Baseline = (2)(a)(1) No access to computer/Confederate with phone concealed and saying nothing

The behavior of the subject will be analyzed from the point they walk through the door until the moment they leave the room. Key indicators will be noted such as acknowledgment of the actor upon entering the room, the greeting of the subject to the confederate (if there is one), body language, eye contact, etc. Once seated in the waiting room the time it takes for interaction/conversation between the subject and the actor will be noted. How much the subject says as well as the content will quantitatively be analyzed. Each separate combination can be

compared against one another in order to discover the effect of the presence of CMC/Social media on physical social interaction.

Through this experiment, conclusions could be made to the impact CMC/Social Media is having on the building of physical social relationships and interaction dynamics. With CMC present in a physical interaction it allows for attention to be directed outside of the physical presence of others, which goes unseen and can be interoperated incorrectly. When the subject walks into the waiting room and is actively texting someone; the presence of the person that they are texting is also in the room but this goes unseen. This experiment's goal is to account for the distractions of CMC on physical interaction. Through collecting demographic variables the results of this experiment could be used to develop a future quantitative study.

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A PICTURE IS WORTH A THOUSAND WORDS, BUT ARE THEY THE WORDS THAT MATTER? – AN ANALYSIS OF THE INFLUENCE OF IMAGE COMMENTS ON SOCIAL NETWORKING SITES ON THE RECRUITERS' EVALUATION OF JOB CANDIDATES

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ABSTRACT

Social networking sites (SNS) have become a very popular way for people to share information about themselves and their lives. However, the type and amount of information shared on SNS can have an impact on an individual's desirability as an employee. This paper proposes a study to examine the effects that personal images posted to an individual's SNS and the comments associated with the image have on the interpretation of those images. It builds on prior studies done in this area by specifically examining SNS images and not an entire SNS profile. It is our hope that this will allow for a better understanding as to the impact of the images themselves and how the comments associated with the image impacts how the image is perceived.

Social Networking Sites, job candidates, images, comments, interpretation

INTRODUCTION

Over the past few years, advances in Information Technology have lead to many changes in the nature of communication and socialization. Currently, social networking sites (SNS) have become very popular as they allow users to both express their individuality and meet people with similar interests [8]. According to [5], a SNS is defined as a web-based service that allows individuals to construct a public or semi-public profile within a restricted system, articulate a list of other users with whom they share a connection, and view and navigate their list of connections within the system. In addition, social network sites form a community of a network of offline friends (whose friendship is extended to online), online acquaintances, or one or more interest groups (based on school attended, hobby, profession, cause, or ethnicity) [11]. Social network users can keep in touch with friends and family, especially with people they do not see on a regular basis, find old friends, contact friends of friends, and even contact people they have not met before [8]. Popular SNS, such as Facebook, allow users to explore other users with similar interests, share personal information with friends, and share photos [12].

Many SNS require the user to create a webpage that contains personal information about the social network user that he or she wants to share with others [7]. Some social network users utilize these pages as billboards about themselves while others use them as personal diary pages [7]. Facebook is the most popular SNS with over 800 million active users who collectively spend 700 billion minutes-per-month on the website [13]. Furthermore, the average user shares 90 pieces of content (e.g., photographs, status updates, and web links) on Facebook; equaling more

than 30 billion pieces of content shared each month [13]. Currently, Facebook is the third most visited website in the world and the most visited website in the United States, surpassing Google and Yahoo in terms of the time users spend on each website [13].

SNS are incorporating photo sharing features which allow users to very easily upload and post photos for their friends and families [2]. For instance, Facebook has become the largest photo sharing site on the Internet; it hosts over 100 billion images, with more than 6 billion new photos being added every month [16]. In addition, free photo-sharing programs such as Instagram and Pinterest enable users to take photographs and share them with other users connected to the social network as well as SNS such as Facebook. Both photo-sharing programs have been growing in the number of active users. For instance, Instagram has captured tens of millions of mobile users by making it easy to share photographs [16]. Furthermore, Pinterest lets users pin interesting photographs and then compose them into boards that can be shared and commented on [16].

Photo sharing within SNS provide the opportunity for users to tag other users, annotate, and link images to the identities of the people in them. Tagging is a process that allows social network users to identify and label individuals that are shown in the photograph [1]. Furthermore, the tagging process makes the photograph searchable by the contributing user and enables users to discover other users' photos [1]. According to [15], photo tagging first appeared in commercial applications such as Adobe Photoshop Album but is now widely used in online tools such as Facebook. This feature successfully increases the opportunities to share photos among people with established offline relationships. Specifically, [2] examine the privacy concerns and mechanisms surrounding these tagged images. Furthermore, the increased access to an individual's photos has led to these images being used for purposes that were not intended. [2] showed that the photos on Facebook profiles have been used by employers and law enforcement to investigate the behavior of individuals. The problem is that users are posting photos of other users and the outcome is that people have no control over their images and who is able to view them.

Compounding this problem are new features such as facial recognition that have been added to SNS. Specifically, the privacy of the social network user is at risk with the use of facial recognition that automatically identifies users in images and tags them [17]. With the use of facial recognition it is easier than ever before to locate individuals in photographs and link users between collections [2]. This makes tagging and sharing photographs even easier and further erodes the social network users' abilities to control the disclosure of their images as they could be automatically identified in many more photos [2].

An increasing number of recruiters are utilizing SNS to gather data on job applicants. However, the use of SNS can cause many privacy risks stemming from the disclosure of personal information, such as personal photographs which can influence recruiters' evaluation of job candidates. Therefore, the photo related habits of college-aged social network users can have immediate and/or long-term consequences that can affect various human resource decisions, including hiring, training, promotion, and termination. Specifically, images that include alcohol consumption, family orientation, or a professional orientation could have negative or positive

consequences for the job applicant. Furthermore, social network users post comments related to the photographs that could impact the employers' decision during the hiring process.

For example, job applicants that have alcohol-oriented photographs posted on their SNS are viewed as less desirable employees [4]. On the other hand, applicants that have professional-oriented and family-oriented photographs posted on their SNS are viewed as more desirable employees [4]. In the case that the photographs are consistent with the written comments associated with the images found on the SNS, it is expected that the information found would influence the recruiters' evaluation of the job candidate [4].

In the area of higher education, there are cases in which students have had to deal with the consequences of sharing or being tagged in photographs illustrating behaviors that are considered inappropriate by society, including drug use, alcohol consumption, and sexual promiscuity [13]. Therefore, such photographs shared through the Internet can have implications for college students, particularly as more employers are looking at SNS as part of the interviewing and hiring process [4]. Given the expanding percentage of employers using SNS to gather data on current or potential employees, it is reasonable to expect this practice to affect various human resource decisions, including hiring, training, promotion, and termination [6]. Therefore, the images and/or comments associated with the users' social network profile can have negative or positive consequences on the social network users' academic and professional lives.

PROBLEM STATEMENT

Though intensive research has been conducted on the topic of information sharing on SNS, there is a need to further investigate the different effects of image sharing in terms of image comments by the social network users and their network friends. A study conducted by [4] focused on the consistency of the photographs disclosed on the SNS with the comments made on the page and not the comments made on the specific image (although they did put a caption on one image). This is a critical distinction because the comments made on an image can, in part, provide the context of the image [4]. For example, imagine that you see several pictures on a job candidate's site of them holding several alcohol bottles. Without comments to help set the context, the image is open to whatever interpretation the person seeing it wants to make. However, the presence of comments associated with the image could serve to indicate whether the person in the image was drinking the alcohol or if they were simply helping to clean up after an event.

It is important to focus only on the images posted to a SNS and the comments associated with the images, whereas the study conducted by [4] focused on Facebook from the perspective of a user page with a mixture of textual comment postings and images. While this may be effective in determining the impact of these types of SNS on employee desirability, newer SNS that feature images only with image comments such as Pinterest and Instagram are becoming more and more popular as standalone SNS platforms. Therefore, it is important to study impact of images and their comments in isolation as the results may be generalizable beyond the Facebook-style SNS to these types of SNS as well.

For these reasons, this paper will present a conceptual model and a proposed study to examine the effect that image comments have on the interpretation of those images with respect to their

evaluation by job recruiters. The remainder of this paper is structured as follows. First there will be a brief review of the literature on the impacts of SNS. This will be followed by the presentation of a conceptual model to explain the impact that image comments have on the interpretation of the image and the desirability of the employee. Next, a proposed study will be discussed to help validate the conceptual model. This will be followed by some concluding remarks and areas for future research.

BRIEF REVIEW OF THE LITERATURE

Social Networking Sites (SNS)

A SNS is a platform that focuses on facilitating social relations among social network users who share similar interests, activities, backgrounds, or real-life connections. SNS such as Google+, MySpace, and Facebook are designed for users to locate friends and to interact with others online to discuss hobbies and similar interests [4]. By definition, SNS provide a new method of communicating, employing computers as a collaborative tool to accelerate group formation and influence [10] [14]. SNS allow users to create open or semi-open profiles within the system they are part of, to see list of other people in the group, and see the relations of users within different groups [3]. Furthermore, SNS is an online environment that allows individuals to share texts, photographs, and link other users of the portal by applications and groups provided on the Internet [5] [14]. Facebook is one of the most commonly used SNS today [3]. As of February 2012, Facebook had over 845 million social network users who spent more than 9.7 billion minutes per day on the website [19]. In addition, social network user share four billion pieces of content per day, including uploads of 250 million photographs, and Facebook is integrated with over seven million websites and applications [19]. Each Facebook user builds a profile that allows the user to post notes, photographs, links, and videos to be shared with friends; that is, other social network users who are connected to an individual's online social network [9]. Furthermore, one of the most significant pieces of self-disclosure is the profile photo, which is the default photograph by which Facebook users choose to identify themselves within the network [9].

Each Facebook profile includes a message board known as the wall, which serves as the primary messaging mechanism between social network users [18]. Social network users can upload photos and tag their friends in them [18]. In addition, comments can be left on the photographs. Specifically, the wall posts and photo comments are labeled with the name of the user who performed the action and the date and time of submission [18]. These elements of Facebook allow its social network users to construct an identity to communicate to the online community [9].

Hiring Managers Use of Social Networking Sites

An increasing number of hiring managers are utilizing SNS to aide in screening and selecting applicants [6]. Given the expanding percentage of employers using SNS to gather data on current or potential employees, it is reasonable to expect this practice to affect various human resource decisions, including hiring, training, promotion, and termination [6]. This type of screening procedure has several benefits to organizations. For example, SNS provide a readily available

public forum to evaluate potential job candidates while incurring minimal cost [6]. Furthermore, the information on SNS may provide further indication related to the accuracy of information presented on an applicant's resume [6]. Also, organizations may have access to detailed information about the applicant's character or personality, which may increase or decrease the likelihood that a candidate is considered for further review [6].

A study conducted in 2009 found that 35% of employers reported not hiring an applicant due to negative information found on a SNS [6]. Specifically, the reasons for not hiring an applicant ranged from posting inappropriate photographs or information, displaying poor communication skills, conveying information that falsifies qualifications listed in a resume, and posting content disparaging work associates [6]. On the other hand, the study also revealed that applicants' profiles may enhance their chances of being hired by providing supportive evidence of their listed qualifications, portraying a profile indicative of being a good fit for the organization, and displaying positive communication skills [6]. Despite the promising potential that reviewing SNS may have for employers, this screening method presents an invasion of the applicants' privacy and the applicants' shared information might be distorted by social desirability or high levels of self-monitoring. Therefore, employers must consider the role of context while evaluating potential employees.

Overall, the review of the literature reveals that social networking users are not careful enough with their personal information that they post online. Specifically, the images and/or comments associated with the users' social network profile can have negative or positive consequences on the social network users' academic and professional lives. Though intensive research has been conducted on the topic of information sharing on SNS, there is a need to further investigate the different affects of image sharing in terms of comments by the social network users and their network friends. This study provides an in depth understanding of the affects of such online behavior in terms of photographs and associated online comments. The study discovers the short and long term impact of SNS image commenting in regards to an individuals' professional development. As SNS continue to grow in popularity and the users add more and more information and photographs, meeting users' privacy needs is important to allow safe and comfortable participation on these online communities.

CONCEPTUAL MODEL

An increasing number of recruiters are utilizing SNS to gather data on job applicants. Therefore, the photo related habits of college-aged social network users can have immediate and/or long-term consequences that can affect various human resource decisions, including hiring, training, promotion, and termination. Specifically, images that include alcohol consumption, family orientation, or a professional orientation could have negative or positive consequences for the job applicant. Furthermore, social network users post comments related to the photographs that could impact the employers' decision during the hiring process.

FIGURE 1

Overview of the influence of personal photographs with comments posted on SNS on the job recruiters' evaluation of job candidates
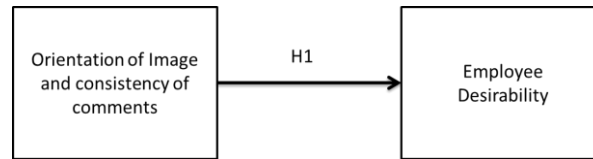

Figure 1 gives an overview of the influence of personal photographs with comments posted on SNS on the job recruiters' evaluation of job candidates. Specifically, the social network user posts the photographs and the comments are added on the specific image. Specifically, the comments made on an image can provide the context of the image. For example, imagine that you see several pictures on a job candidate's site of them holding several alcohol bottles. Without comments to help set the context, the image is open to whatever interpretation the person seeing it wants to make. However, the presence of comments associated with the image could serve to indicate whether the person in the image was drinking the alcohol or if they were simply helping to clean up after an event.

In this research study, the impact that the image comments have on the interpretation of the image is measured using employee desirability. For instance, job candidates that have alcohol-oriented photographs posted on their SNS are most likely viewed as less desirable and qualified employees. In contrast, job candidates that have professional-oriented and family-oriented photographs posted on their SNS are most likely viewed as more desirable and qualified employees [4]. Furthermore, in the case that the images are consistent with the written comments associated with the images found on the SNS, it is expected that the information found would strengthen the effect that the image has on recruiters' evaluation of the job candidate. In the case where the comments are inconsistent with the images that are posted, it is proposed that the comments could weaken the effects of the image on the recruiter's evaluation of the job candidate. In addition, a qualitative question would determine the factors that influenced the participant's decision. Based on the given information, the following is hypothesized.

H1: The presence of comments has a statistically significant effect on the interpretation of the image as measured by employee desirability.
H1a: Comments consistent with the actions depicted in the image will increase the effect of the orientation of the image on employee desirability when compared to the same image with no comments.
H1b: Comments inconsistent with the actions depicted in the image will decrease the effect of the orientation of the image on employee desirability when compared to the same image with no comments.

DISCUSSION OF PROPOSED STUDY

This paper presents a proposed study to help validate the conceptual model. Specifically, an experimental study would be based on the study conducted in [4] to determine the effect that

image comments have on the interpretation of those images with respect to their evaluation by job recruiters. The participants of the research study would include a number of current recruiters and hiring managers from various organizations, which is different from [4] that utilized students. We felt that by professionals instead of students, we may be able to get a more accurate assessment of the impact that the images have on employee desirability. However, the study participants will be will be given a questionnaire to assess their experiences with SNS similar to the one administered in [4].

For the experiment the participants will be presented with a hypothetical SNS user's profile that consists of a series of photographs that reflect one of the following: (a) an emphasis on drinking alcohol, (b) a family orientation, or (c) a professional orientation. Some of the images on the profiles will have no comments, while others will have comments that are consistent or inconsistent with the orientation depicted in the image.

For each profile, the hiring managers would rate the applicant's desirability similar to the method in [4] by having the rate their qualifications for the position, their likelihood to offer the person depicted in the SNS profile an interview, and their likelihood to hire the person depicted in the SNS profile on a 10-point Likert scale. The format of the questionnaire would consist of the following three statements used in [4]: "Is the applicant qualified for the position?" (1, not qualified at all, 10, very well qualified); "Would you interview this applicant for the position?" (1, not likely at all, 10, very likely); "Would you offer the job to this applicant?" (1, not likely at all, 10, very likely).

The data from the three groups in each orientation (no comments, consistent comments, and inconsistent comments) will be assessed using a quantitative methodology. The objective of the quantitative research is to collect specific data to determine if the image comments have an effect on the interpretation of those images. The quantitative methodology would be followed by a qualitative methodology that would examine what factors affected their interpretation of the images.

CONCLUSION

SNS use is a phenomenon that is changing the way that we live and work. Because of this, it is important to examine the impact that SNS use has not only on our desirability as employees, but in other facets of our lives as well. The study proposed in this is one effort to this end and we feel that it has the potential to make the following contributions:
1. By examining the image comments in addition to the image, it seeks to deepen our understanding of how image comments serve to set the context of the image and how this context affects our perception of the image.
2. It focuses on an aspect of SNS (images) that allows it the results to be generalizable outside of Facebook style SNS.
3. It serves to build upon the understanding of the impacts of SNS on employability by leveraging a prior study and thus serving to validate its results in a different survey population.

Contingent upon the results of this study, future studies might include a qualitative examination as to why the image comments changed the perceptions of the employability of the SNS user by the respondents. Additionally, the job that the SNS user is being considered for may also be included in the study as a factor that might influence the perceptions of the respondents. Regardless of the specific aspect of the SNS being studied, we feel that this is a very rich area for information systems researchers and we invite others to assist in developing our understanding of this phenomenon.

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THE USE OF SOCIAL MEDIA IN THE CONSTRUCTION INDUSTRY: ANALYSIS OF THE TOP 10

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In an international landscape, companies are in dire need to stay competitive. Social media tools provide a platform to create leads, build and manage customer relationships, and monitor feedback. Little is known about the use of social media when analyzing specific B2B industries, such as construction industry. This study identifies the top 10: national construction companies; international contractors; construction management at risk contractors; green contractors; and design build companies to uncover their use of social media via Twitter. Results indicate that the green contractors have the highest percentage of companies with a Twitter account. The least active group is the specialty contractors. Design build companies, while having a high number of followers, do not follow others, showing a lack of communication with others. Overall, the results show that while social media is emerging as a useful tool in most industries, construction industry has not fully grasped its advantages.

Keywords: Social media, construction industry, B2B

ADOPTION OF SOCIAL NETWORKING TECHNOLOGIES IN THE WORKPLACE

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ABSTRACT

This study empirically investigated the influence of technology acceptance model factors, social influence factors and demographic factors on the adoption of social networking technologies in the workplace. More than half of the surveyed respondents reported using instant messaging, Facebook or both at work for business-related or personal-related purposes. Results of a discriminant analysis suggest that perceived ease of use, perceived usefulness and subjective norm (collapsed into one construct), critical mass and gender are significant in distinguishing between adopters and non-adopters of social networking technologies. Compared to non-adopters, adopters perceived social networking to be more useful, easier to use and are more influenced by others.

KEYWORDS: **Critical Mass, Facebook, Instant Messaging, Subjective Norm, Technology Acceptance Model.**

INTRODUCTION

Social networking sites may be defined as web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system [9]. Social networking sites have significantly increased the potential for individuals to communicate with each other no matter where they may be located. It has also broadened the number of social relationships that an individual may carry on at any one time. Users visit their favorite web sites to keep up with news, entertainment, and to enhance their individual social life through sharing personal information with others. It is expected that people will conduct more and more of their online lives through social media.

Social networking use in the workplace has also gained in popularity over the last few years but is by no means universal. A recent survey of 1100 employees by SilkRoad [7] found that 43% of employees work in organizations in which social media access is completely open; 24% reported that access was monitored and only 16% of companies completely block their employees' access to social media at work. Gartner [2] has predicted that that by the year 2014 fewer than 30 percent of large organizations will block employee access to social media sites with those blocking access to all social media dropping by around 10 percent a year. SilkRoad [7] also found that regardless of the corporate policy towards social media, 75% of workers access social media on the job from their personal mobile devices at least once a day, and 60% access it multiple times for work and / or personal use.

Instant messaging (IM) and Facebook are two social networking technologies in particular that are making inroads into the enterprise. IM applications include functions such as history-keeping, file transfer, real time video and audio chatting, offline messaging, e-mails, offline appearance (invisible), notification (pop ups) and buddy lists [20]. One of the most appealing attributes of IM for businesses is the fact that unlike the delayed, asynchronous nature of e-mail, the current on line status or presence of the intended recipients is displayed and allows for immediate response. A study published by INT Media Research [6] reported that among corporations using IM, 81% said their employees are more productive, e-mail traffic was down by 30 – 40% and voice mail was down by as much as 10%.

A study by the Radicati Group [3] reported that IM accounts will rise from 1.8 billion dollars in 2008 to over 3.7 billion dollars by 2012. Approximately 45 to 50 percent of US firms currently permit their employees to use IM for business purposes [4]. Gartner [1] predicts that IM will be the de facto tool for voice, video and text chat with 95% of workers in leading global organizations using IM as their primary source for real time communication by 2013.

Facebook has quickly grown to become one of the most popular social networking sites worldwide. Facebook currently has over 800 million active users worldwide and approximately 72 percent of all US internet users have a Facebook account [5]. SilkRoad [7] found that 65 percent of the 1100 employees surveyed use Facebook during work hours for a combination of personal and work related purposes while only 19 percent reported using corporate intranets. An interesting finding was that when asked how they used Facebook and social media for work, 49% responded that they use it to connect with co-workers and 44% responded that they use it to communicate with customers.

The purpose of this study is to investigate factors that influence the adoption of social networking (IM and Facebook) in business organizations. Given the rapid growth of social networking in the workforce for company sanctioned activities, gaining a greater understanding of these factors may provide important insights into how this growth may be effectively managed. Two key constructs derived from the Technology Acceptance Model (TAM) are considered; perceived ease of use (PE) and perceived usefulness (PU). Several researchers have been critical of TAM for excluding social influence in the adoption and use of new technology [21]. The value of social networking is dependent on the degree to which the technology is used by the members of an individual's communication network. Consequently, social influence may be an important factor in the adoption of social networking. In this study two constructs are employed that consider social influence in the adoption of social networking in the workplace; subjective norm (SN) and perceived critical mass (PCM). Subjective norm refers to the belief regarding the degree to which important others believe s/he should use the system and perceived critical mass refers to the perceptions of whether an innovation has attracted a critical mass of users [34]. Several mediating factors have been considered with regard to the adoption of new technology. Two factors which have received a great deal of attention in the literature are gender and age. This study also investigates the influence of gender and age on social networking adoption in the workplace.

LITERATURE REVIEW

Factors Impacting Social Networking Adoption

The Technology Acceptance Model (TAM) was first proposed by Davis and has since become one of the most widely accepted models of technology adoption [10]. TAM is an adaptation of Fishbein and Ajzen's [12] theory of reasoned action (TRA), in which TRA's attitudinal determinants, derived separately for each behavior, are replaced with a set of two variables perceived ease of use and perceived usefulness [22]. TAM suggests that an individual's perceived ease of use and perceived usefulness of a particular technology determine the individual's behavioral intentions which in turn determine his or her acceptance and use of the technology. TAM posits that the impact of other external variables is fully mediated by the perceptions of ease of use and usefulness [11]. In a detailed review of the literature, Lee, Kozar and Larsen [15] found that the impacts of perceived usefulness and perceived ease of use on IT adoption and usage remain consistent and significant across different settings.

To date, only a few studies have considered the influence of ease of use and usefulness in the adoption of social networking. For example, Lee, Cheung and Chen [15] conducted an online survey of business students. They found that both perceived ease of use and perceived usefulness had a significant impact on behavioral intention to use IM with perceived ease of use having the stronger impact of the two. Strader, Ramaswami and Houle [32] conducted an online survey of undergraduate and graduate business students and found that perceived ease of use had a positive effect on intention to use IM; however the same was not true for perceived usefulness. Ilie et al., [13] and Van Slyke et al., [34] found that perceptions of relative advantage and ease of use had a positive influence on intention to use IM among business students.

In a review of TAM research, Lee, Kozar and Larsen [16] suggested that more research is needed to investigate the causal linkage between social influence and IT adoption. Legris et al., [17] point to the need for including additional variables related to human and social change processes. In this study two constructs were adopted that consider social influence on the adoption and use of social networking in the business world; subjective norm and critical mass.

Venkatesh and Davis [35] describe subjective norm as the person's perception that most people who are important to him think that he should or should not perform the behavior in question. The persons may be superiors or peers [33]. The influence of subjective norm on technology adoption is inconclusive [16]. Few studies have considered subjective norm in the adoption of social networking. Lin et al., [20] considered the adoption of two instant messaging technologies. They found that the effect of subjective norm on intention to use each technology were significant but differed in strength. They concluded that behavioral models can show different effects for competing products. Premkumar et al., [27] found that subjective norm was one of five variables that had a significant influence on intentions to use IM in a setting where most communications were of a social nature. Van Slyke et al., [34] found that subjective norm did not have a significant impact on intentions to use IM.

On the other hand, critical mass suggests that an individual's choice must be considered in the social context of their membership in communities, such as organizations [34]. The more people

in the community who adopt a communication technology such as IM or Facebook, the more the innovation is perceived as being beneficial to both previous and potential adopters. Van Slyke et al., [34] suggest that critical mass is the point at which the innovation is sufficiently diffused for its use to persist. They point out that those communication innovations that fail to achieve critical mass eventually fall into disuse. Premkumar et al., [27] found that perceived critical mass had the most significant influence on intentions to user IM, highlighting the importance of network externality in the diffusion of social networking technologies.

Gender and Social Networking Adoption

Many studies have suggested that compared to men, women are less likely to adopt new technology and if adopted they tend to use it to a lesser degree than men. For example, Shashaani and Khalili [31] found that females had low confidence in their own ability to work with computers even though they showed strong beliefs in equal gender ability and competence in the use of computers. Liaw [19] found that male students had more positive perceptions toward computers and web technologies than females. Wood and Li [36] found that males were more willing to adopt new technologies than females. Reinen and Plomp [30] found that female students knew less about information technology and enjoyed using it less than males. Allyn [8] found that men and women use the computer for different purposes at work. Michie and Nelson [23] indicated that women students are less likely to choose a career in information technology. Similarly, Li et al. [18] found that female students are less likely choose an information systems minor than male students.

On the other hand, some studies have found that gender gaps are lessening or disappearing [28]. Ray et al. [29] found that there is no significant gender difference toward computer anxiety. Morahan-Martin and Schumacher [24] found that attitudes towards new technology, but not gender, predicted Internet and computer competencies and experiences.

Few studies have considered gender differences in the perceptions and use of social networking. Ilie et al., [13] in a study of undergraduate business students perceptions and use of IM found women value perceptions of ease of use, and visibility more than men, while men value perceptions of relative advantage, result demonstrability and perceived critical mass more than women. Premkumar et al., [27] found that among undergraduate student perceptions of IM, females exhibited much higher hedonic and social outcome beliefs than men and less utilitarian outcome beliefs. They did not find any differences for a number of other factors including subjective norm and critical mass.

Age and IM Adoption

Morris and Venkatesh [25] point out that relatively little research has been reported on the influence of age on technology adoption decisions in an organizational context even though it appears that gaining a better theoretical understanding of age differences is important given that they relate to user acceptance and usage of new information technologies. In a study of 300 personnel in a medium size financial accounting firm, the authors found that older workers weighed the importance of subjective norm and perceived behavioral control more strongly than younger workers in determining usage of new technology in the short term. After three months

of use, age differences in emphasis of subjective norm disappeared. Pagani [26] found that in comparing subjects aged 18 to 24 with subjects 25 to 34, the older group considered usefulness more important in adopting mobile services and the younger group considered speed of use more important. Kolodinsky, Hogarth and Hilgert [14] in a survey of banking practices found that respondents over the age of 65 were least likely to adopt phone banking and PC banking and that respondents in their middle age were less likely to adopt PC banking than the youngest group of consumers aged 35 and below. In a study of the adoption of mobile commerce in China, Zhang [37] found that age positively predicts consumers' perceived usefulness but not their perceived ease of use.

Research Framework

Figure 1 presents the theoretical framework for this study. Drawing upon the literature on new technology adoption, the framework proposes that the adoption of social networking is impacted by three broad factors: technology acceptance model factors (perceived ease of use and perceived usefulness), social influence factors (subjective norm and critical mass), and demographic factors (gender and age). Other factors may impact the use of social networking and are not included in this study because of the limitation of the data.
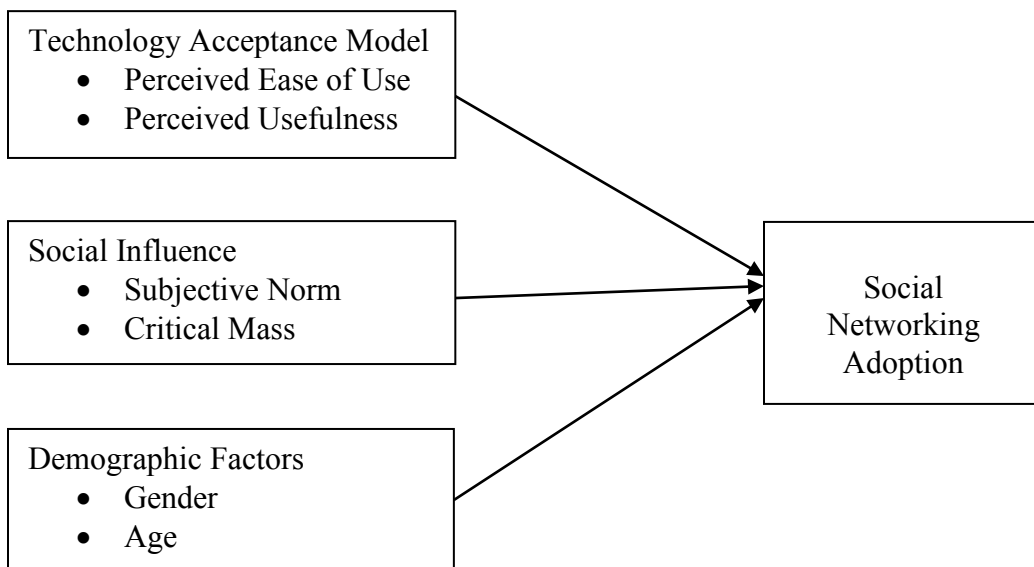
Figure 1: Research Framework

Research Questions

Based on the research framework, the following research questions will be empirically investigated in the study:
Research Question 1a: Does perceived ease of use impact the adoption of social networking (IM and Facebook)?
Research Question 1b: Does perceived usefulness impact the adoption of social networking (IM and Facebook)?

Research Question 2a: Does subjective norm impact the adoption of social networking (IM and Facebook)?

Research Question 2b: Does critical mass impact the adoption of social networking (IM and Facebook)?

Research Question 3a: Do gender differences exist in the adoption of social networking (IM and Facebook)?

Research Question 3b: Do age differences exist in the adoption of social networking (IM and Facebook)?

METHODOLOGY

Data Collection

A paper-based survey was distributed to MBA students who were working full time while enrolled in an MBA program at a private university in the Northeast United States. Students were asked to voluntarily participate in the survey. The survey instrument had been presented previously to a group of students and all questions were found to be clear and unambiguous. The survey instrument is included in the Appendix. Items for measuring perceived ease of use and perceived usefulness were adopted from previous studies [13,15,22,32,34]. Items for measuring subjective norm and critical mass were adopted from Van Slyke et al., [34]. Construct validity is discussed in a section to follow.

A total of 97 usable responses were received. The profile of the respondents is summarized in Table 1. Of the sample, 64% were male. About two-third of the respondents (67%) were between 20 and 29 years old with the rest at or over 30 years old.

TABLE 1. Demographic profile of the respondents

		Respondents	Percentage
Gender	Male	62	63.9%
	Female	35	36.1%
Age	20-29	65	67.0%
	At least 30	32	33.1%

Data Analysis and Results

Our results show that 42% of the surveyed organizations allow employees to use IM and about 16% of the organizational allow employees to use Facebook at work. Table 2 shows the status of employees' social networking use in the workplace. The results show that more than half of the respondents have used at least one type of social networking technology at work for either business-related or personal-related purposes. It can also be seen that about 11% of the respondents use both IM and Facebook at work for business related purpose, about one third of the respondents (36.1%) only use IM and less than ten percent (about 8%) only use Facebook at work for business related purpose. Less than half (44%) have not used either IM or Facebook for business related purpose. Regarding personal use of social networking at work, about one fourth

of the respondents (25%) use both IM and Facebook, about 14% use IM only and about 20% use Facebook only. The rest of the respondents (41%) have not used any of the technologies at work for personal purposes. The above results show that IM is a more popular technology for work-related purpose as about 47% of the respondents have used it while only 19% of the respondents use Facebook for business related purpose. However, Facebook is slightly more popular for personal purposes as about 45% of the respondents use Facebook for their own personal purposes. This number decreases to 39% for IM.

Table 2 also shows that the majority of respondents receive 20 or fewer social networking postings per day and spends less than 10% of their workday participating in social networking. The results suggest that social networking is not currently a dominant communication tool in the corporate world.

TABLE 2. Social Networking Technologies Use in the Workplace

		Number (%)
Use of social network technologies at work for business related purposes.	Both IM and Facebook	11 (11.3%)
	IM only	35 (36.1%)
	Facebook only	8 (8.2%)
	None	43 (44.2%)
Use of social network technologies at work for personal purposes.	Both IM and Facebook	24 (24.7%)
	IM only	14 (14.4%)
	Facebook only	19 (19.6%)
	None	40 (41.2%)
On average how many social networking postings (message) do you receive each day while at work?	0	39 (40.2%)
	Between 1 and 20	46 (47.4%)
	At least 21	12 (12.4%)
	Between 41 and 60	2 (2.1%)
Percentage of your day spent on reading, writing or dealing with social networking?	<10%	81 (83.6%)
	Between 10% and 20%	12 (12.3%)
	Between 21% and 30%	4 (4.1%)

Construct Validation

To test for construct validity of the factors influencing social networking technologies adoption (perceived ease of use, perceived usefulness, subjective norm and critical mass), a factor analysis was conducted using principal components as the means of extraction and the varimax method of rotation. Three factors emerged as shown in Table 3.

Results of the factor analysis indicate that perceived usefulness and subjective norm loaded on one factor. This unexpected result may be caused by small sample size. On the other hand, there may be a high correlation between these two constructs, suggesting that a person's perception of the usefulness of social networking is closely tied to social factors. For the purpose of analysis, perceived usefulness and subjective norm will be treated as one construct.

TABLE 3. Factor analysis for Factors Impacting Social Networking Adoption

Item	Perceived Usefulness and Subjective Norms	Critical Mass	Perceived Ease of Use	α
PU5	**.90**	.17	.19	
PU4	**.88**	.15	.19	
PU1	**.86**	.25	.18	
PU6	**.83**	.31	-.01	
PU3	**.83**	.04	.23	.96
PU2	**.82**	.22	.27	
SN1	**.76**	.47	.05	
SN2	**.76**	.47	.03	
SN3	**.67**	.41	-.02	
PCM2	.21	**.78**	.27	
PCM1	.24	**.73**	.19	.78
PCM3	.41	**.63**	.22	
PE1	.05	.06	**.88**	
PE2	.07	.43	**.71**	.76
PE3	.33	.17	**.71**	
Eigenvalue	8.41	1.82	1.02	
% of Variance	56.06	12.10	6.81	
Cumulative % of variance	56.06	68.16	74.96	

With respect to the three factors (perceived usefulness and subjective norm, perceived ease of use, and critical mass), all items loaded on their respective factors and there were no items with cross-loadings greater than .50. These results suggest that there is strong convergence and support the validity of the constructs. The last column of Table 3 shows that the Cronbach alpha coefficient for all the constructs is greater than .75, indicating good reliability of the constructs.

Discriminant Analysis for IM adoption

A discriminant analysis was used to identify the degree to which each of the individual variables (perceived ease of use, perceived usefulness and subjective norm, critical mass, gender, and age) may distinguish among non-adopters and adopters of social networking. Non-adopters include those respondents who have not received/sent any social networking postings/messages while at work. Adopters consist of those who have received/sent some social networking posting/message at work. Age and gender are nominal variables and were treated as dummy variables in the analysis. For purposes of this analysis, age was classified into two groups. One group includes the respondents between 20 and 29 years old and the other group consists of the respondents 30 years old and above.

Table 4 presents the results of the discriminant analysis. The table provides information on (1) standardized discriminant function coefficients and their significance, (2) the size of the group, and (3) the significance level of the discriminant function. The discriminant function developed

in this study has a chi-square value of 33.34 (5 degrees of freedom) which is significant at p<0.05 level. This provides strong support for the discriminate function's ability to discriminate group membership on the basis of the variables used. The results further show that perceived usefulness and subjective norm, perceived ease of use, critical mass, and gender are significant at the .05 level. Age did not enter into the discriminant function, suggesting that this factor did not have a significant impact on social networking adoption.

TABLE 4. Discriminant Analysis Results between Non-Adopters and Adopters

Variables	Standardized Coefficient	F Value	Significance
Perceived Ease of Use	0.48	14.09	**0.00**
Perceived Usefulness and Subjective Norm	0.54	21.49	**0.00**
Critical Mass	0.25	18.34	**0.00**
Age	-0.35	0.25	0.62
Gender	-0.45	7.23	**0.01**
	Discriminant function statistics Group1 = Non-Users (39 cases) Group2 = IM Users (58 cases) Wilks' Lambda: 0.70, Chi-square: 33.34, significance: 0.00		

The standardized discriminant coefficients provide useful information on the relative contribution of their associated variables to the overall discriminate function. The higher the absolute value of the standardized coefficient, the greater its contribution to the function. On this basis, perceived usefulness and subjective norm, and perceived ease of use emerged as the two most important variables in distinguishing between the non- users and users of social networking, followed by gender and critical mass.

Table 5 presents the IM adopter, non-adopter and overall means for each of the influencing variables. It can be seen that compared to the non-adopters, adopters perceive social networking to be more useful, easier to use and are more influenced by others.

TABLE 5. Group Means of Adopters and non-Adopters of Social Networking

Group Means	Adopters	Non-adopters	Overall
Perceived Ease of Use	5.64	4.74	5.28
Perceived Usefulness and Subjective Norms	3.83	2.51	3.30
Critical Mass	4.94	3.61	4.40

Since the results show that gender is significant in distinguishing between the adopter and now-adopter of social networking, Table 6 further shows the group means of male and female respondents in each influencing factor. Compared to the male respondents, females have a high

means on perceived ease of use, perceived usefulness and subjective norms, and critical mass. A further analysis also show that about 77% of female respondents (27/35) are adopters, while only half (31/62) of the males are the adopters of social networking.

TABLE 6. Group Means of Male and Female Respondents of Social Networking

Group Means	Male	Female	Overall
Perceived Ease of Use	5.22	5.38	5.28
Perceived Usefulness and Subjective Norms	3.19	3.49	3.30
Critical Mass	4.27	4.64	4.40

CONCLUSIONS AND IMPLICATIONS

This study empirically investigated the influence of technology acceptance model factors, social influence factors and demographic factors on the adoption of social networking technologies (instant messaging and Facebook) in the workplace. The results show that more than half of the surveyed respondents have used instant messaging, Facebook or both at work for business-related or personal purposes. Results of a discriminant analysis suggest that perceived ease of use, perceived usefulness and subjective norm (collapsed into one construct), critical mass and gender are significant in distinguishing between adopters and non-adopters of social networking technologies. Compared to non-adopters, adopters perceived social networking to be more useful, easier to use and are more influenced by others. In addition, female respondents were more likely to adopt social networking at work than males.

One contribution of this paper is that it is one of few that considers perceptions and use of social networking for business purposes by individuals in the workplace. Different factors may be at play in the personal use of social networking outside of the workplace and therefore perceptions of social networking may vary dramatically based on the context. For example, social networking may have already reached a critical mass from the perspective of an individual's social communication but may be relatively little used by business associates.

A second contribution relates to the support this paper provides for the body of research on the positive impact of social influences for the adoption and use of new communication technologies. It would suggest that models of new technology adoption such as TAM would benefit by including measures of social influence.

LIMITATIONS AND FUTURE RESEARCH

One of the limitations of this research is the small sample size and the fact that all the subjects were from the northeast and enrolled in an MBA program. This study also focuses on IM and Facebook. Research is required to consider whether these finding are generalizable to other groups and within other innovative technologies and contexts. Relatively few variables were

considered for this study. Future research may include additional perception variables and more demographic and task related information.

TAM suggests that an individual's perceived ease of use and perceived usefulness of a technology determine the individual's behavioral intentions which in turn determine his or her acceptance and use of the technology. This study did not include intention in the study because of the limitation of the data. This may be a direction for future study.

APPENDIX: PERCEPTIONS OF SOCIAL NETWORKING

Perceived Ease of Use
PE1: Learning to operate SN is easy for me
PE2: Overall I believe that SN is easy for me to use
PE3: I believe that it is easy to get SN to do what I want.
Perceived Usefulness
PU1: Using SN enhances my effectiveness when communicating for work
PU2: Overall, I find using SN for work gives me greater control over my communication
PU3: Using SN for work enables me to accomplish tasks more quickly
PU4: Using SN increases my productivity when communicating for work
P45: Using SN improves my performance when communicating for work
PU6: Overall, I find SN to be advantageous when I communicate for work
Subjective Norms
SN1: My coworkers think I should use SN for work
SN2: People who are important to me think I should use SN for work
SN3: People who influence me think I should use SN for work
Perceived Critical Mass
PCM1: Many people I communicate with at work use SN
PCM2: Of the people I communicate with regularly at work, many use SN
PCM3: The people I communicate with at work will continue to use SN in the future

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FORECASTING THE AMOUNT OF EFFLUENT FOR A LARGE MUNICIPAL WATER SUPPLIER

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ABSTRACT

The authors obtained effluent (clean water output) data from the Providence Water Supply Board (PWSB) as well as meteorological data for an 11 year period. It was our goal to create a forecasting model for the effluent or discharge for future periods. In addition, we discovered a strong relationship between maximum daily temperature and the amount of effluent, as might be expected. However, we also noted that the relationship was somewhat curvilinear. We further examined the data with a time series graph, an autocorrelation plot, and a partial autocorrelation plot. Ultimately, we wanted to compare linear regression and Autoregressive Integrated Moving Average (ARIMA) modeling as predictive models for effluent data. We also wanted to identify the best predictive periodicity that would fit the water data.

INTRODUCTION

Recently, the authors were involved with a project for the Providence Water Supply Board (PWSB) regarding water conservation by studying the overall flow rates of the PWSB. The details of this project can be found in the reference of Salzillo, et. al. [1] When that project was completed, we were given additional data from the PWSB in order to predict the amount of effluent (clean water output into the system) based on weather conditions. We were also given meteorological data for an 11 year period. Specifically, in addition to the effluent amounts, we were provided with the maximum daily temperature in degrees Fahrenheit, average daily dewpoint in degrees Fahrenheit, the average daily wind speed in miles/hour, the average sky cover (as a fraction), the average daily station or barometric pressure (in inches Hg), and the number of hours of data available for the day.

Although this region of the country is not currently experiencing the drought conditions or flood conditions as in other regions of the country, the PWSB does not want to purify more water than necessary in order to be cost effective. If we can find a model that best predicts effluent flow, The PWSB would be very interested in using it, as would other water authorities around the country.

The Providence Water Supply Board controls a system that relies entirely on surface water. That is water which is retained in an inland water body as a result of precipitation and associated runoff from the watershed. This water is first "freshened up". It is transmitted, via an underground pipe, which is dosed with a settling agent, or a coagulant that helps to settle particulates. It eventually gets to the aerators to get "aired out". This is done to improve the water's taste.

Lime is then added to increase the pH levels and decrease its corrosive nature, and the water is moved to the settling ponds where impurities settle to the bottom of these ponds. Next, it is chlorinated to control bacteria. The water is then moved to the rapid sand filters. These filters remove any additional particles still attached in the water. Finally, fluoride is added. Before entering the distribution system, the water goes to a waiting area: the clear well. In general, there is about a two-day trip ahead before entering customer's homes.

The PWSB is interested in monitoring and predicting the effluent, the flow of clean water out of the system to the consumers. Certainly weather could be a factor. We were interested in evaluating whether a linear regression or an ARIMA model would best predict the effluent with the variables given to us by the PWSB.   Further, we wanted to identify which periodicity of predictability (monthly or quarterly) would predict the effluent with more accuracy.

EXAMINING THE DATA

We set out to test the weather predictor variables from the PWSB to see if we could predict the amount of effluent with accuracy. We received 4,017 observations (11 years of daily data), from 1/1/2001 until 12/31/2011.   After cleaning the data, we ran several time series models to identify which periodicity would have a higher quality of predictability. We certainly expected that a seasonality factor would affect the effluent. The first question to address was the question of how the data responds to changing the periodicity. The entire data set was used to run a regression based on (1) using months as the seasonal period and (2) using calendar year quarters as the seasonal period. See data below. The one dependent variable was effluent, and that variable was regressed on two independent variables: time and a second, indicator variable, that would capture a seasonal impact. The model which represents monthly data would have an indicator for January, February, March, *etc.* The Model which represents quarterly data would have an indicator value to signify the different quarters each year. The R squared terms for the two Models are shown below. Using a monthly time variable, the R^2 value was 0.88 compared to an R^2 value of 0.69 for the quarterly regression. Based on comparison of the two R^2 values, it appears that using monthly data would significantly increase accuracy for this data set.
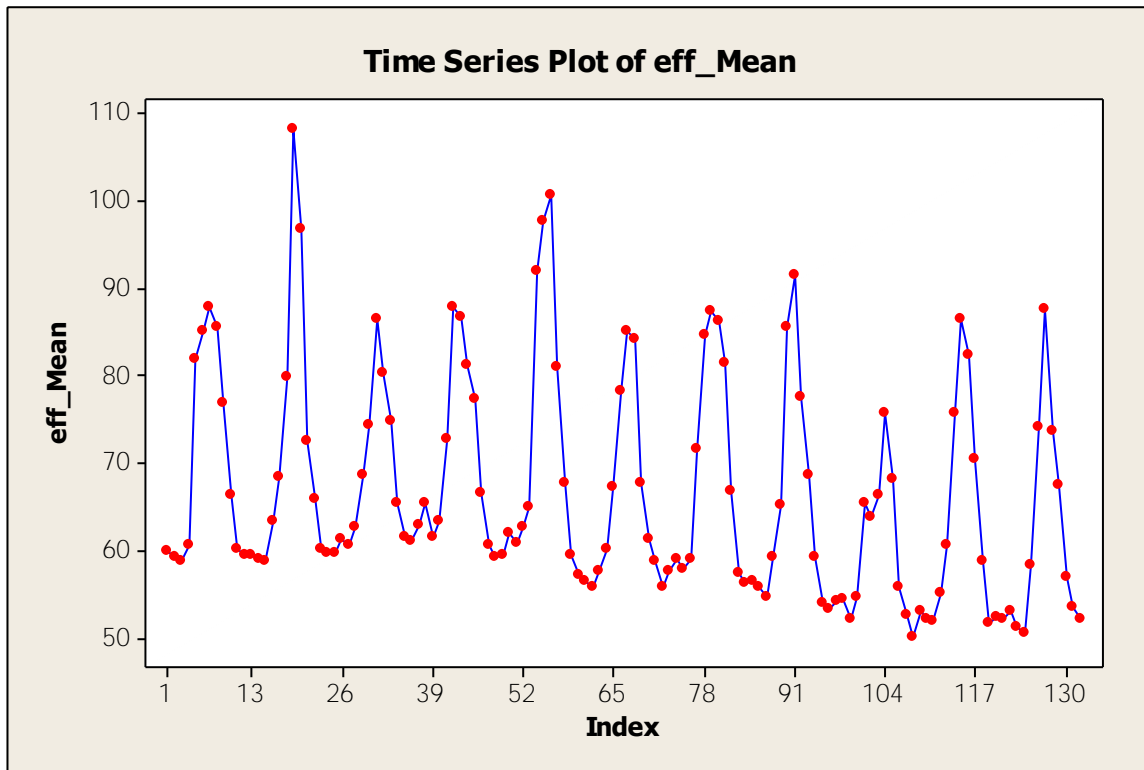
Quarterly Data			
R-Square	Coeff Var	Root MSE	eff_Mean Mean
0.69	10.72	7.15	66.75

Monthly Data			
R-Square	Coeff Var	Root MSE	eff_Mean Mean
0.88	6.84	4.56	66.75

Proceeding with our analysis using the data condensed to monthly averages, we therefore had 132 readings.

Figure 1.   Times Series Plot of the Average Effluent

The above graph illustrates the monthly mean amount of effluent over the 11 year period. The seasonality factor is certainly evident in this graph. There are also interesting peaks which seem to be declining over this 11 year period. Perhaps customers are practicing conservation of water on their own, which would be of interest to the PWSB.

Noting the cyclical nature of the data from the above graph, we also looked at a scatter diagram of mean effluent per month by maximum mean temperature per month. Of all of the variables

that were given from the PWSB, the effluent mean was most directly affected by temperature. The other given variables such as dewpoint, sky cover, or barometric pressure shared multi-collinearity with temperature. The temperature reading was the best predictor of effluent, since it stands to reason that as the temperature goes up, the flow of water would be greater.
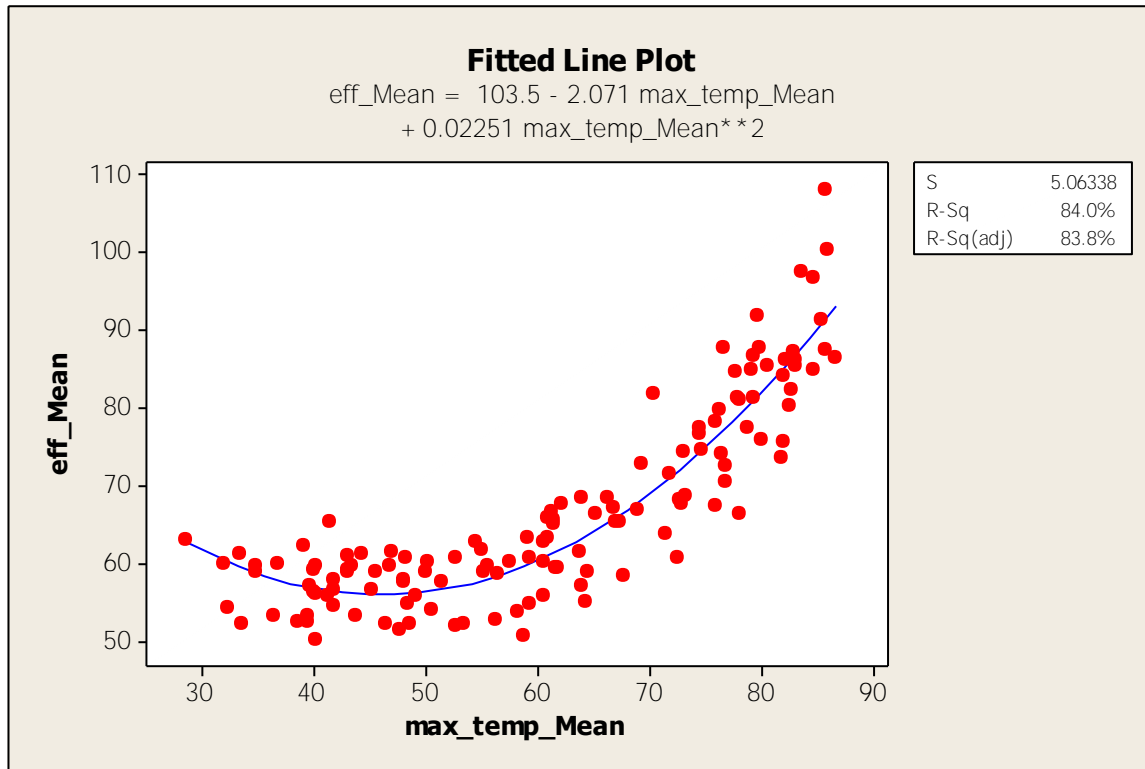

Figure 2. The Relationship between the Monthly Mean Temperature and the Monthly Effluent Mean

Interestingly, the scatter diagram demonstrates curvature. Therefore, we fit a quadratic model by adding the square of mean temperature to a model already containing the linear mean temperature term. It can be observed that as the maximum daily temperature increases, the amount of effluent increases at an increasing rate. We certainly expected that flow would increase as temperature went up. However, surprisingly, at the lower temperatures, the graph is curving up as well. We can surmise that the lower temperatures may occur during holiday and vacation times, so there may be more going on in the homes to cause a higher effluent. We also see that this regression model has a very good R square (coefficient of determination) value of 0.84. This suggests that a regression model may be a good predictor of effluent.

Our next analysis tests two predictive models, namely the autoregressive integrated moving average (ARIMA) and time regression, to determine which can better predict monthly effluent.

The autocorrelation function (ACF) and partial autocorrelation function (PACF) are very important at the identification stage of ARIMA modeling. They measure the statistical

relationship between observations in a single data series. The ACF and the PACF measure the correlation for a given lag. That is for a 1 month lag, a 2 month lag, or any other monthly lag. Using the ACF, if a chosen lag time was 3 months with a starting month of January, then the data compared would be data from January back to October, December to September, November to August, and so on. Using the PACF, a lag of 3 months with a start time of January would compare the data of January to October, but the effects of December and November would be removed. They are used to infer the structure of the underlying pattern that has given rise to the data being studied. The ACF and PACF are most useful when presented in graphical form. Some data series show very clear and obvious patterns while others do not.
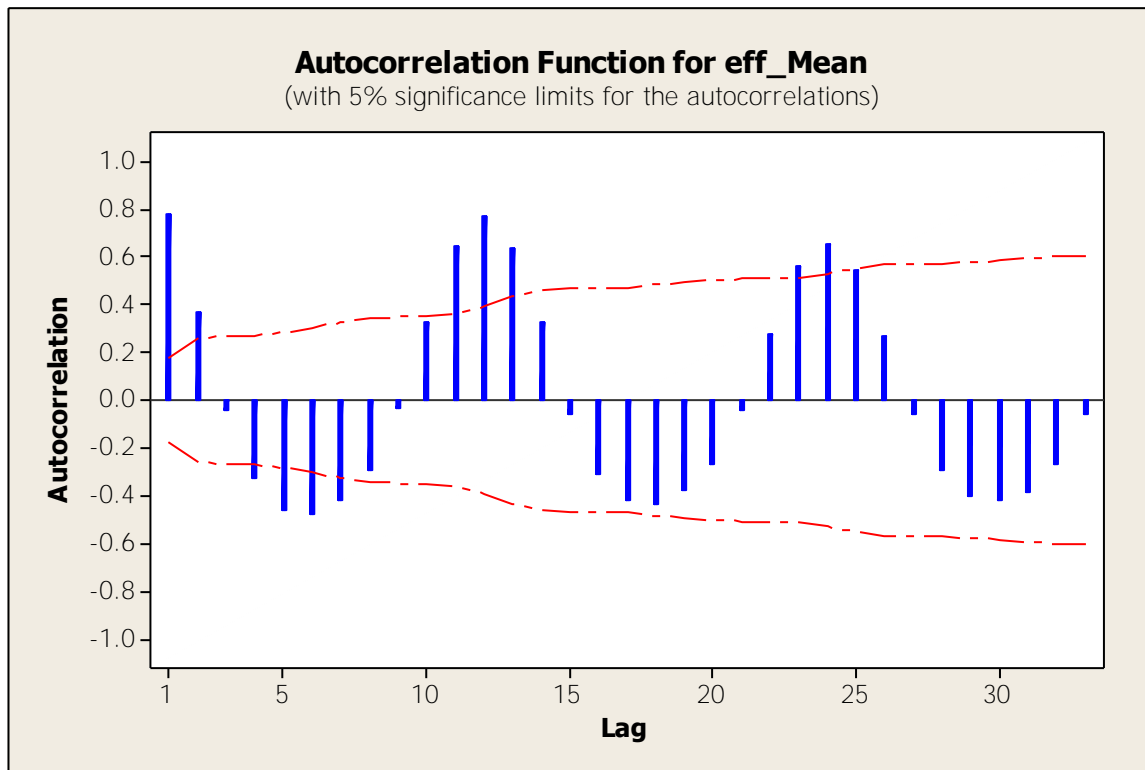
Figure 3. ACF for Effluent Mean

From this plot, it is obvious that a lag of 1 period (month) yields a strong autocorrelation. The seasonality factor of the data is clearly identified again by a strong autocorrelation with a lag of 12 months, as might be expected. It is also interesting that there are negative autocorrelations as the seasons change.

We also examined a partial autocorrelation plot, noted below. This plot has a strong spike at 1 and 2. This indicates that a lag of 1 of 2 months within the data is important. This could corroborate the reasoning for using an ARIMA model with a moving average affect. We might expect then that not only regression but also an ARIMA model would be a good predictor of the effluent. Also on any ARIMA model a lag of 1 is always a good place to start.
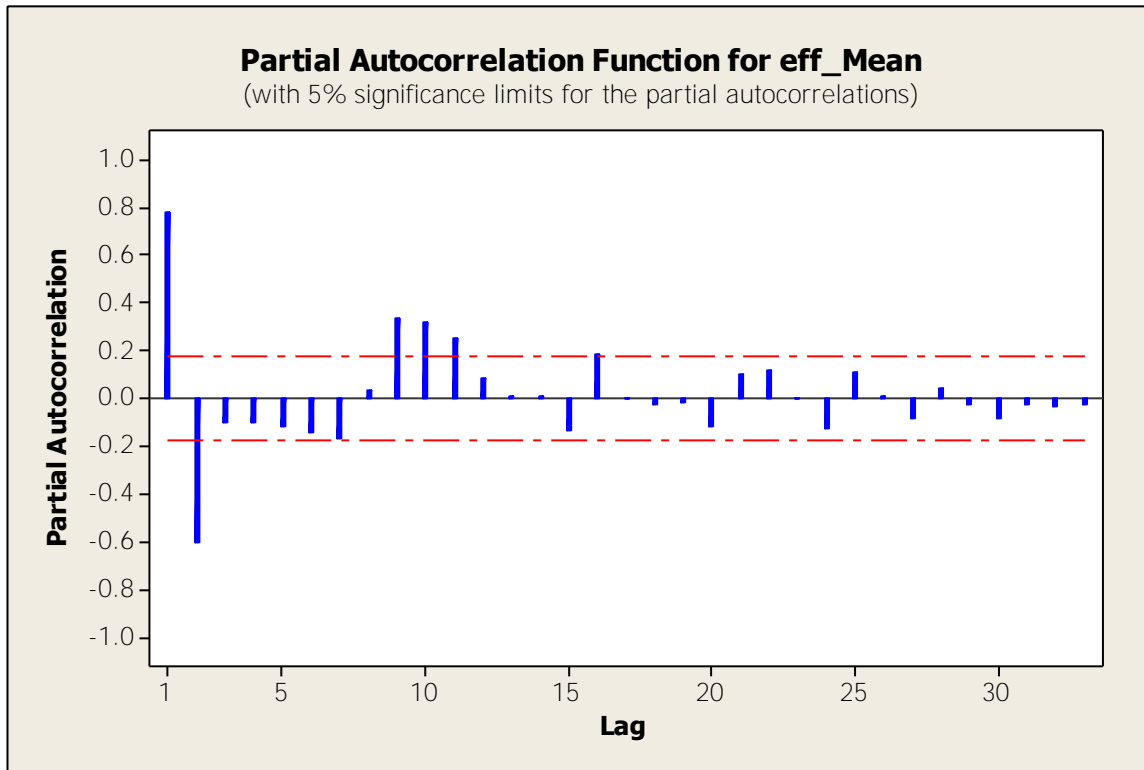
Figure 4. PACF for Effluent Mean

The lag of 1 to 2 months is clearly significant. We decided to construct the ARIMA model with an autoregressive term of one month, AR(1), and a seasonal autoregressive term, SAR(12), and a moving average term, MA(1),to account for any correlation among residuals.

The ARIMA model output is as follows:

```
Final Estimates of Parameters

Type          Coef  SE Coef      T      P
AR   1      0.2517   0.1294   1.95  0.054
SAR  12     0.7997   0.0636  12.57  0.000
MA   1     -0.5113   0.1128  -4.53  0.000
Constant   9.9111    0.7090  13.98  0.000
Mean        66.109    4.729

Number of observations:  132
Residuals:    SS =  3662.76 (backforecasts excluded)
              MS =  28.62  DF = 128
```

We see that the autoregressive AR(1) term, the seasonal SAR(12) term, and the moving average MA(1) terms are all significant with the AR(1) term just qualifying. The model has a mean square error of 28.62.

We also ran a linear regression with the following results so that we could compare the two models.

Regression output:

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	12	18228.42	1519.04	72.93	<.0001
Error	119	2478.62	20.83		
Corrected Total	131	20707.05			

R-Square	Coeff Var	Root MSE	eff_Mean Mean
0.88	6.84	4.56	66.75

Source	DF	Type III SS	Mean Square	F Value	Pr > F
New	1	1558.59	1558.59	74.83	<.0001
month	11	16824.89	1529.54	73.43	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	79.51B	1.55	51.16	<.0001
New	-0.09	0.01	-8.65	<.0001
month apr	-14.52B	1.95	-7.46	<.0001
month aug	10.62B	1.95	5.46	<.0001
month dec	-16.91B	1.95	-8.69	<.0001
month feb	-15.974B	1.95	-8.20	<.0001
month jan	-16.53B	1.95	-8.49	<.0001
month jul	14.80B	1.95	7.60	<.0001
month jun	6.54B	1.95	3.36	0.0010
month mar	-16.86B	1.95	-8.66	<.0001
month may	-5.91B	1.95	-3.04	0.0029
month nov	-15.78B	1.95	-8.11	<.0001
month oct	-10.37B	1.95	-5.33	<.0001
month sep	0.00B	.	.	.

The independent time variable (new) for the regression analysis represents time in months and can be considered significant. The independent variable month represents dummy variables to identify each individual data value with a month, for example, Jan = 1, Feb = 2, etc. These indicator variables account for the seasonality observed in the data. For the regression analysis, month was significant with a p-value of < 0.0001.

The ARIMA model has a mean square error (MS) of 28.6, whereas the mean square error for the Regression analysis is a little smaller with a value of 20.8, indicating that the Regression model is a better fit for the data.

CONCLUSIONS

This study has produced results while looking at different options. Certainly it confirms that water usage is related to temperature, but for the Northeastern US, this implies it is also related to time as we have a strong seasonal component. This follows from the graphs.

The Time Series Plot suggests that regression would be a good predictor of effluent for the PWSB. However we also ran ACF and PACF analysis. This suggested that ARIMA modeling might also be considered as a method to predict the effluent for the given data. Thus we chose to compare both types of analyses.

Due to the ACF and the PACF graphs, we thought that the ARIMA model would be a good choice as a predictive model. The AR(1) term, the seasonal SAR(12) term, and the MA(1) terms were all significant; however the AR(1) term just qualified, which is somewhat contradictory from the graph information. It is not uncommon for this apparent contradiction to occur when an AR(1) term and a MA(1) term are included in a model. If the MA(1) is removed from the model the AR(1) term becomes highly significant, however the mean squared error increases . The best (having lowest mean squared error) ARIMA model had a mean square term of 28.6. It was edged out by a linear regression predictive model that employed judicious choices of indicator variables and which had a smaller mean square term (20.8). This indicates that the regression model was a slightly better predictor of effluent for this data set. This regression also came in with a rather convincing R-square of 0.88.

When comparing ARIMA models to Time Regression models, it is more common for ARIMA models to result in a better fit to the data. It is interesting that for this time series the result was reversed. The seasonal component had the most prominent effect on effluent and had a highly predictable pattern exhibiting little noise from randomness. This consistent pattern may have contributed to the better performance of the regression model. ARIMA models seem to have an advantage when dealing with messy data.

This analysis raised several other questions as well that can be considered in future work:
 (1) are the conservation efforts of this water supplier paying off or are the water habits of its customers shifting, independent of this conservation effort ?
 (2) are the slight up-ticks in the end-of-calendar year's usages due to holiday preparations or just randomness ?
 (3) What are the characteristics of a Time Series that result in one model type outperforming another?

In addition to its practical nature, this analysis is a good pedagogical example: it requires the use of some basic regression techniques, more advanced ARIMA knowledge, and the ability to understand and interpret the results to finally come to an objective, correct conclusion.

APPENDIX

Aerators -Large, water-sprinker type water jets that shoot water into the air

Barometric pressure -   the air pressure as measured by a barometer. Air pressure is
the weight of the air above a particular location on the surface of
the earth (i.e., the product of the gravitational acceleration at the
location and the mass of the unit area column of air above the
location)

Chlorine - A chemical used to disinfect the raw water

Coagulant - Chemicals that are added to the water that bind to particles in the water to help them settle
to the bottom of the settling basins

Dew point - the temperature to which air must be cooled at a constant
pressure to reach saturation (i.e., when evaporation rate equals
condensation rate)

Effluent - The drinking water that leaves the purification plant

Flouride - A chemical added to the water to help prevent tooth decay

Influent - Raw, untreated water directly from the source

Lime - A compound added to the water to increase the pH (i.e., decrease the acidity) of the water and
thus to retard the corrosive effects of the water

Precipitation - Any and all forms of water, liquid or solid, that falls from clouds and reaches the ground.
This includes drizzle, freezing drizzle, freezing rain, hail, ice crystals, ice pellets, rain, snow, snow pellets,
and snow grains

Runoff - Water that runs uncontrolled along the surface and drains into a reservoir

Watershed - The area that drains water to a reservoir. It can be identified by tracing a line along the
highest elevations separating two areas on a map. The watershed contains the reservoir and the
surrounding protected drainage basin

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RECENT TREND IN UNITED STATES PRESIDENTIAL ELECTION STATE VOTING POWER

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ABSTRACT

This paper examines the recent trend of states that take a pivotal role in determining the outcome of United States Presidential Elections. Computer simulation will be used within to estimate both the theoretical voting influence of all 51 voting entities (including the District of Columbia), and, the voting influence only considering recent pivotal states (such as Ohio). There are 19 states that have voted both Democrat and Republican at least once in the past six elections. The Bahnzof measure of power is used to determine the relative influence of these 19 states. Additionally, normal distribution simulation will be performed for each of the 19 states using historical voting data. The simulation results reveal both the theoretically powerful states, as well as, the states that are powerful due to the current breakdown of state voting patterns.

INTRODUCTION/BACKGROUND

To measure a state's power, we use the ideal definition of Banzhaf [1]: the probability that the state will determine the outcome of the election under the assumption that states vote independently with probability 1/2 for each of two candidates. If all possible voting outcomes are considered equally likely to occur in this manner, then a state has "power" over any overall outcome in which that state could have changed the overall outcome by switching their vote to the other party.

Consider the following example originally devised by Banzhaf: suppose that there are four states A, B, C, and D with electoral votes equaling 7,7,7, and 3 respectively. One should not consider this to mean that state D has 12.5% (3/24) of the power in the election. Actually, state D has no power over the election at all. The election will be decided by the outcomes of states A, B, and C regardless of which way state D votes. To a much lesser degree this is also true for the electoral breakdown in the United States.

 Rather than attempt to compute all possible voting combinations of the 51 voting entities (2^{51} possibilities), we will simulate elections by randomly assigning a 0 or 1 to represent whether each state voted Democratic or Republican for a particular election. This gives every possible outcome an equal chance of occurring.

Repeating simulated elections independently one hundred thousand times gives us a reasonable and unbiased method of determining what proportion of the time each state will influence the result. Recently, simulation has been more widely used online to make

predictions about election outcomes [5]. These simulations are routinely run each time new polling data is made available during the election season.

Four simulation models were performed using Visual Basic programming within Excel using the built in random number generator.

SIMULATION 1

Each simulated election was performed by simulating each state vote (with all electoral votes being added to either the democratic or republican candidate) based on a random number generation with 50% chance of going either Democrat or Republican. Once the simulated election has been performed and the number of electoral votes tallied, then the program will switch the vote for the state of interest and determine whether this change would change the overall election result. If so, then the state is considered to have "Power" over that particular simulated election. So "Power" is defined as the number of simulations such that the outcome would have revered had that state voted for the opposite candidate. If the election would result in a tie then the state is considered to have half Power over that election.

Elections were simulated 100,000 times, and for each simulated election all 51 voting entities were measured with regard to weather they had power to overturn the election. "Relative Power" is measured as:

Relative Power = (Power / n) / (state electoral votes / 538)

The simulation results for this model show that California has Relative Power that is approximately 10.7% higher than its proportion of electoral votes (110.7% Relative Power). All of the other states were between 96.2% and 102.4%. Texas was at 102.4% and essentially no other state had an advantage. The correlation coefficient of number of electorates compared to Relative Power was .562 and so smaller states were showing a disadvantage but not of any significant magnitude. Of course, in general, the small states have the advantage of the two additional electoral votes giving them an advantage relative to their population size. As a side note, there were approximately 0.73% ties in the simulation.

SIMULATION 2

Now consider that 32 voting entities have voted the same way for each of the past six presidential elections. If we consider these votes to be fixed, and use the same methodology for simulating elections as was done in the first case, then the Relative Power of the remaining 19 states can be approximated. Note that this implies that the 32 voting entities are considered to have Power zero.

One consequence of defining the model in this way is that 242 electoral votes are already fixed as being won by the Democratic Party. Therefore, most of the simulations would have the democrats winning and often by a large margin. Only 27 more votes to guarantee at least a tie (for example, Florida going democrat would be all that is needed

to lock up a democratic victory). When the same simulation as before is run, but only considering these 19 states to have power, we obtain a better understanding of the relative importance of these "swing" states.

The result of 100,000 simulations shows that the smaller states have a disproportional amount of Power. This is mainly due to the fact that generally the close races in the simulations occur when the larger swing states vote republican. Since the democrats still win the overall election in these cases, the large states do not influence the election (a switch to a democratic vote would not change the overall outcome).

New Hampshire comes out with the highest Relative Power at 142.0% and Florida the lowest at 53.4%. Results are displayed in Appendix 1.

SIMULATION 3

Now consider the 19 states that are considered "in play" as in simulation 2 above. Rather than simulating state votes randomly with probability 50% for each party, we consider possible future voting probabilities based on state voting patterns over the past 14 presidential elections. The votes for each state will be simulated based on the normal distribution with a mean that is equal to the actual 2012 popular vote percentage for that state. The variance will be the sample variance for each state based on the past 14 actual popular vote election percentages (going back to 1960 when Hawaii and Alaska joined as states).

The result of 100,000 simulations shows that the smaller states have a disproportional amount of Power. This result is similar to the findings in simulation 2. above, however, the range of results is not as dramatic. In this case, the states that have a tendency toward voting Democrat have a Relative Power advantage over those states with a Republican voting tendency.

Florida has Relative Power 66.8% and the other republican swing states are between 77.5% and 114.9%. The Democratic swing states are between 118.5% and 138.7%. Results are displayed in Appendix 1.

SIMULATION 4

Now consider a modification of the model in simulation 3 above. In this case, we model a future election scenario by assuming the popular vote percentage is approximately 50% for each candidate. To this end, subtract 50% from the actual 2012 democratic popular vote percentage (51.9853%) and subtract this "advantage" from every state percentage that was used as the mean of the normal distribution simulation in simulation 3 above. The variance in this case is left unchanged. This allows us to evaluate a future close election using recent state-by-state voting information.

The result of 100,000 simulations is that power in democratic states is still very high. In this case, the states that have a tendency toward voting Democrat have a Relative Power advantage over those states with a Republican voting tendency. However, the

Relative Power for each party is within a tighter band and some Republican states have a high Relative Power.

Florida has Relative Power 72.0%, and Montana 112.2%. The Democratic swing states are between 111.5% and 129.8%. In this case Ohio has the lowest Relative Power and Nevada the highest. Results are displayed in Appendix 1.

CONCLUSION

The first simulation described above presents a purely theoretical view of the power of the various states in determining the outcome of an election based on the Electoral College. California shows a significant advantage over all other states in its ability to impact an election. This advantage is 10% greater than its already large number of electoral votes.

The second simulation presents a mix of theory and reality. The reality is that most states are known to be voting for one candidate or the other ahead of time, and so we can theoretically determine the power of those states that could go either way. The results show that smaller democratic states have an advantage in this regard and republican states are at a disadvantage (relative to their electoral votes).

The third and fourth simulations described within present a view of key states that are likely to have pivotal power to influence Presidential elections in the near future. For these simulations, the current 2012 vote for each state was considered, as well voting data over the past 14 elections as a variation estimate. The results show that unless there is a major shift in the way states vote, democratic swing states have more power to influence an election than republican states. However, the power of the democrats is not as great as their theoretical power suggests based on the 2012 state voting pattern. If the next election is close, the democrats still have a swing state advantage.

Appendix A

Table 1 - Influencial States "Relative Power" Results				
		Relative Power		
State	**Electorates**	**50% democratic vote**	**2012 vote percentage**	**2012 vote percentage - 1.9873%**
Arizona	11	1.145	0.886	0.924
Arkansas	6	1.214	0.989	1.060
Colorado	9	1.186	1.353	1.236
Florida	29	0.534	0.668	0.720
Georgia	16	0.928	0.811	0.900
Iowa	7	1.217	1.376	1.246
Indiana	11	0.958	0.844	0.885
Kentucky	8	1.186	0.887	0.961
Louisiana	8	1.163	0.926	1.005
Missouri	10	1.113	0.919	0.966
Montana	3	1.283	1.149	1.122
North Carolina	15	0.913	0.989	0.993
Nevada	6	1.161	1.362	1.298
New Hampshire	4	1.420	1.314	1.197
New Mexico	5	1.329	1.494	1.308
Ohio	18	0.837	1.185	1.115
Tennessee	11	1.108	0.775	0.842
Virginia	13	1.086	1.387	1.248
West Virginia	5	1.384	1.018	1.058

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DECISION ANALYSIS AS CONTEXT FOR GRADUATE-LEVEL INTRODUCTORY BUSINESS STATISTICS COURSES

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ABSTRACT

In this paper, we suggest using decision analysis and Monte Carlo simulation as the setting for the required statistics course in graduate programs enrolling mid-career participants. We show the setting can support coverage of all traditional topics, and report early results on improved student attitudes toward statistics and anecdotal evidence of useful statistical applications made by students at their workplaces.

INTRODUCTION

As our society grows more complex, an increasing number of people find themselves in need of mid-career, post-baccalaureate education [1]. This paper proposes a context for graduate-level Business Statistics courses that exploits the differences between these students and undergraduates, who have received the bulk of attention in statistics education research [4] [2]. For our purposes, the most important differences are mid-career Business Statistics students

1. have committed to their career choices

2. bring considerable experience to the course

3. come to class with problems that are important to them, and hence, bring specific learning goals that may be at odds with those of their classmates and the learning resources typically used by the instructor

4. expect to draw technical specialists into their decision-making process rather than be drawn into analysis of technical issues

THE CONTEXT

We propose that items 1, 2 and 4 above can be addressed by motivating all course work with an ongoing scenario, called the class reference decision, involving a one-off, multivariate decision under uncertainty. In our experience, students at this level easily commit to improving their skills in this area. To address item 3, we ask each student to develop his/her own reference decision scenario via the homework assignments throughout the term.

Each of our reference decisions is evaluated through a metric. The metric tells the decision maker why the decision mattes. Once defined, the metric is expressed as a function of a set of

variables. Uncertain variables are modeled by distributions, and a distribution of metric outcomes is generated by Monte Carlo simulation [5]. Bringing students through this analysis, motivates the coverage of random variables, along with all the traditional topics of discrete and continuous distributions.

We have prepared a MS-EXCEL spreadsheet template that allows students to specify their metric, decision variables and uncertainty models to generate a histogram of metric outcomes. See Figure 1. Students then develop criteria for making an initial decision that incorporates the distribution of metric outcomes and their attitudes toward risk. In guiding the development of student reference decisions, we recommend focusing on GO/NO GO decisions involving mostly tangible variables so that spreadsheet specifications and template modifications are as simple as possible.

The distributions for uncertain variables are initially specified intuitively. We ask for a 90% range estimate of an individual value and a choice of distribution shape from a short list that includes bell-shaped, uniform, skewed and bi-modal. We motivate the need for data through a discussion of opportunity loss [5]. For each variable, we calculate the metric outcome assuming the variable in question takes on a specific value and all others take on their average values. We average the unfavorable outcomes given our initial decision by the model distribution of the variable in question. This is essentially the Expected Value of Perfect Information (EVPI) for the variable in question. We use the EVPIs to indicate the variables most in need of additional information. This motivates our discussion of sampling and sample statistics. Incorporating the sample results into the models motivates conditional probability and Bayes' Theorem. We provide a spreadsheet template to revise model distributions based upon sample results.

FIGURE 1.
Spreadsheet template for reference decision analysis.
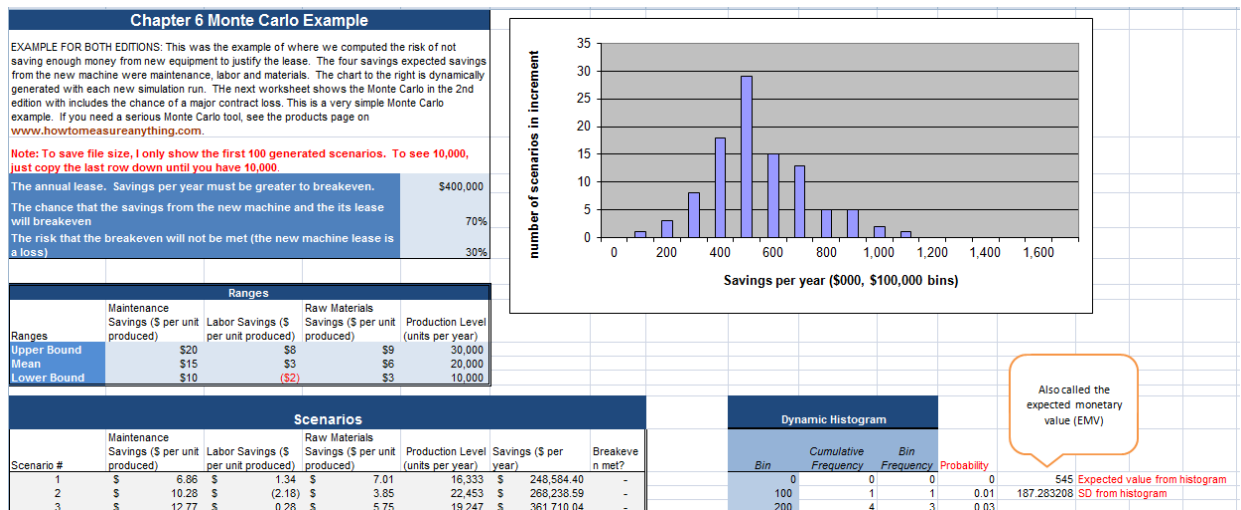
Our class reference decision involves whether to lease a new machine for production, and our metric is cost savings expressed as a function of per unit maintenance savings, per unit labor savings, per unit raw materials savings, the number of contracts won in the coming year and the average contract size for the coming year. We set our specifications so that average contract size

has a high EVPI, which motivates the development of confidence intervals for the mean of a population and the sampling distribution of the mean.

Hypothesis testing is motivated by a sample of material savings from other users of our machine. We use a sample that varies significantly from our assumption of normality for this variable. After discussing the goodness of fit test, we develop scenarios that illustrate the need for tests involving population means and/or proportions. These tests can be applied to the distribution of metric outcomes to give additional decision-making insight. We use MS-EXCEL for all calculations. This allows us to speak of the test statistics intuitively as measures of the difference between observed and expected results, and avoids getting bogged down in messy arithmetic. For this audience, the large amount of time saved is much better spent discussing statistical reasoning and having students share how they are applying our new concepts to their reference decisions.

Which brings us to correlation and regression. To motivate these topics, we consider a new scenario. Expressing the metric of our class reference decision is easy.

total savings = (total per unit savings) x (# contracts) x (average contract size)

What if one faces a decision to launch an advertising campaign based upon a test campaign in which the metric is spending amount that a purchasing customer will yield, and the decision variables are number of purchases in the preceding year, whether the customer purchased by web order at least once, gender, and size of last purchase? Since there is no clear formula expressing this metric as a function of the variables, we establish the need to model a response, the metric in this case, through sample data and modeling assumptions.

 In addition to using the response model in the Monte Carlo simulation, we also use regression modeling to expand our hypothesis tests to include testing the significance of individual coefficients and testing the significance of the full model through ANOVA. Confidence intervals for the mean response given x and individual responses given x are also covered.

RESULTS

We report pre and post test results for 29 students from the Survey of Attitudes Towards Statistics (SATS) [6].

	Strongly Disagree			Neither Agree nor Disagree			Strongly Agree
Statistics is not useful to the typical professional (Pre)		1	4	4	12	8	
Statistics is not useful to the typical professional (Post)	1	4	17	7			
I will have no application for statistics in my profession. (Pre)				8	11	10	
I will have no application for statistics in my profession.(Post)		2	13	9	5		
I find it difficult to understand statistical concepts. (Pre)					7	12	10
I find it difficult to understand statistical concepts. (Post)		2	2	17	6	2	

Based on our experience to date, we can also offer a few anecdotes. Csikszentmihályi's Flow model [3] can be used to describe students' likelihood of success in terms of attitude resulting from the combination of student skill level and course challenge level. A combination of low skill and high challenge produces anxiety and a low likelihood of success. Low likelihood of success can also result from the boredom that accompanies a combination of high skill and low challenge. High skill combined with high challenge produces flow, i.e., full immersion, energized focus and, ultimately, success.

 In our EMBA recruiting interviews, we hear more anxiety about the Statistics course than any other, leading us to believe there is a perceived mismatch between skill level and challenge.

Shifting our focus to decision-making, to which students at this level bring a considerable amount of skill, has generated the following evidence of achieving flow.

1. High quality, high energy student activity in class, including detailed and articulate sharing of experience with students' own reference decisions and frequent anticipation of the next topic based upon needs for the reference decisions.

2. Attempts to apply class concepts to work problems and opportunities have increased, resulting in requests from students for help in framing requests for data.

3. Improved accuracy and completeness of assignments and quiz scores. Late submissions of assignments have almost disappeared despite the usual interruptions for business travel and family obligations that are typical with students at this level.

One of the better-developed student reference decisions involved estimating the distribution of project costs for a company the relies upon fixed-price bidding. The student assembled a database of standards for labor, materials, etc., and modeled the uncertainty in labor, services and materials to produce a distribution of project costs. The student reported that he was able to present his work to his supervisors, and that they responded with resources for further development, testing, and, hopefully, eventual implementation.

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Knowledge Management as a Precursor to Effective Formulation of Business Level Strategies

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Research has shown knowledge management to be an effective method of systematically improving an organization's competencies. However, much of the research in knowledge management focuses on either the value generated or the tools and techniques for gathering and sharing organizational knowledge.

This study proposes that alignment of available knowledge in an organization with its core competencies is an underlying foundation for successful formulation of business level strategies and gaining competitive advantage. The research introduces a knowledge audit framework that rates an organization's knowledge competencies as a precursor for formulation of business level strategies. In addition, this framework provides information regarding the areas that the organization lacks adequate knowledge and core competencies. The utilization of this framework can provide a guideline for the management of an organization to improve its knowledge and expertise for successful formulation of business level strategies.

INVENTORY MANAGEMENT WITH ADVANCE DEMAND INFORMATION UNDER INTERMITTENT DEMAND

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ABSTRACT

We investigate an inventory management problem when Advance Demand Information (ADI) is available. In a supplier-customer setting, ADI is provided by the customer to the supplier regarding a future demand. In our model the demand by the customer is intermittent. The intermittence could be due to the ordering policy of the customer, or product's nature. We are interested in the minimization of supplier's cost. We assume that the supplier employs a high-low ordering policy as the replenishment policy. We provide a Markov chain model of the intermittent demand in presence of ADI.

1. INTRODUCTION

Advance demand information (ADI) is increasingly available in the business world. With the help of ADI, customers place orders from their suppliers easier. ADI is a form of information sharing between supplier and customer, and with the increase in internet usage companies are able to go directly to the consumer to obtain ADI. Also, an important characteristic of many firms' demand structure is intermittence. Demand is intermittent if the orders from customers are lumpy, that is, the supplier is unlikely to see another order right after an order. For instance, in the spare parts industry demand is intermittent. Spare parts are needed when machines break down, and the component that needs to be replaced may be different at different incidents, which makes demand intermittent. Demand might also become intermittent when customers order in batches, due to customers ordering policies. In this paper an inventory model with ADI, under intermittent demand is studied. In the model there is a supplier who satisfies or backorders the demand coming from a customer. The supplier has a constant manufacturing leadtime (l). The customer expects to have the item immediately when the order is placed, so the supplier keeps finished goods inventory, so as not to suffer the linear backordering cost. Inventory holding cost for the supplier is linear as well. Supplier's customer want the supplier begin production in advance by providing the supplier with ADI. The customer is motivated to place advance orders if it is certain that amount will be needed in that particular future period. In this study ADI is assumed to be firm, meaning, the customer promises to buy the amounts that are ordered in advance. For orders that are placed further ahead than the supplier's leadtime, the order will be ready exactly when needed and no holding or penalty costs are charged to the supplier. For orders within the supplier's leadtime, any backorder will be fulfilled sooner. If there was no advance ordering option, all these demands would be "regular" orders. This paper is on the positive effect of ADI on inventory holding and penalty costs via reduction of leadtime between parties.

When the customer is using an (*s, S*) policy a state dependent base-stock policy is optimal. In order to make supplier's job simpler, instead of using a state dependent policy a high-low policy can be used, which has two order-up-to levels, S^l and S^h. If the likelihood of getting a positive demand exceeds a threshold level, the supplier switches from the low order-up-to level (S^l) to the higher one (S^h). This switching decision is made based on the *number of periods since the last demand* (L_n) (i.e. If $L_n \geq K$ then the order-up-to level is increased to S^h). This study explores appropriate levels of S^l and S^h and also the switching point K. Further, it explores how the optimal solution changes with problem parameter and compares the high-low policy with the one-parameter base stock policy and the ADI model with non-ADI model. This paper is related to two streams of literature, one dealing with intermittent demand and the other with inventory management when ADI is available. Intermittent demand has been studied by many researchers; these studies are mainly on forecasting. The first important study on intermittent demand is by Croston [1]. This early paper highlights the inadequacies of available forecasting methods to estimate the demand pattern for items with intermittent orders. Croston suggests estimating the average interval between orders and the average size of an order when it occurs and to combine these statistics to give an unbiased estimate of the variability of the demand [1]. Johnston and Boylan address the same problem [3]. The order arrival process for the items with intermittent demand is modeled as Poisson stream and, therefore, an exponential distribution is used to model the inter-order interval. Order size is also another random variable. The paper aims to determine, under what conditions, intermittent demand requires its own model.

There are many studies dealing with inventory management with ADI, which is the other stream of literature. Heath and Jackson propose a general probabilistic model for modeling the evolution of demand forecasts, referred to as the Martingale Model of Forecast Evolution (MMFE) [2]. Research which deals with state dependent policies where the demand is governed by either an external process or updated by advance demand information has been conducted by Song and Zipkin [4].

In this paper we study the relationship between a supplier and a customer from the point of view of the supplier. We assume that in this relationship the strategic objectives of the supplier and the customer are compatible. We address a periodic-review, infinite horizon production system faced by a supplier who has the ability to get advance demand information while the demand is stochastic and intermittent. To our knowledge, this study is first on inventory management with ADI when demand is intermittent. In our model ADI allows the customer to signal the supplier that there will be a demand, of the signaled size, in a future period. This is coupled with the situation where the supplier gets intermittent orders from the customer. Due to the demand structure the supplier's replenishment policy is assumed to be a "High-Low" base-stock policy. With this policy, the supplier starts with a low order-up-to level, then switches to a higher order-up-to level if she does not see any demand for a certain number of consecutive periods and this number is called switching point. Therefore the parameters of the policy are: Low order-up-to level, high order-up-to level and switching point. We use a Markov chain model of the intermittent demand with ADI. We compare the high-low policy with a one-parameter base-stock policy in terms of cost and investigate the value of ADI.

2. MODELING OF THE PROBLEM

In this paper a single item, single location, periodic review inventory model is considered. The supplier observes the following demand vector

$$D_n = (d_{n,n}, d_{n,n+1}, \ldots, d_{n,n+H})$$

where $d_{n,n}$ is the order amount to be satisfied immediately, which will be called *regular* demand throughout this paper. The other components of the demand vector are considered as Advance Demand Information (ADI), which will be called *advance* demand throughout this paper. In period n, there is outstanding advance demand for the following H periods if

$$\sum_{i=m-H}^{n} d_{i,m} > 0$$

for any

$$m \in \{n + 1, \ldots , n + H\}.$$

The demand vectors D_n signal new demand registered in each period. Therefore, in order to find the demand for a particular period the components of the vectors which have that particular period in their range have to be added. Hence the demand that has to be fulfilled in period n is as follows:

$$\sum_{i=n-H}^{n} d_{i,n}.$$

The model assumes that an advance demand is firm, that is, the customer will not renege on this order. H is the *ADI horizon* for the problem, meaning the customer can order at most H period ahead. The supplier has a deterministic leadtime, l. That is, when the customer places orders in period n, her order is going to be satisfied no later than period $n + l + 1$. In this paper the upper stage of the supply chain is called as the supplier, and it is assumed that she has no capacity constraint. Leadtime is a manufacturing leadtime. If the upper stage does not do manufacturing and just ordering from an upper supplier with ample stock then the leadtime would be ordering leadtime.

The sequence of events in a period is as follows: First, replenishment arrives at the supplier. Second, demand occurs. Demand is immediately satisfied if possible, otherwise it is fully backlogged. Demand is satisfied from on hand inventory with priority of existing backorders.

A penalty cost of b for backorders and holding cost of, h, for any inventory left on hand are incurred. Both costs are per unit, per period. Finally, a new order is placed, which may include any advance demand. In the model, the supplier keeps a certain amount of inventory (i.e. base stock) and orders the exact amount of the total demands (regular and advance), that she sees in that period. This kind of ordering policy can be called a state dependent base stock policy where the state is the amount of the outstanding advance orders from the customer.

An important point is the following: For an advance demand $d_{n,n+y}$, if $y > l$, no cost is incurred. In such a case, demand can be satisfied just-in-time without incurring any penalty or holding costs; therefore this case is not considered here. The notation in this paper is as follows:

I_n = On-hand inventory at the beginning of the period n. This is the inventory that is physically on the shelf, which cannot be negative.

L_n = Number of periods since last order in period n. L_n is 1 if a demand occurred in period $n − 1$.

Q_n = Order amount which will arrive by the beginning of period $n + l + 1$.

B_n = Backorder in period n.

NI_n = Net inventory in period n, which is inventory on hand minus backorder,

$$NI_n = I_n − B_n.$$

IP_n = Inventory position, which is net inventory plus amount of the order in period n,

$$IP_n = I_n - B_n + Q_n.$$

IIP_n = Informed inventory position, which is inventory position minus the advance demands which have been signaled but have not been materialized,

$$IIP_n = IP_n - \sum_{j=n+1}^{n+H} \sum_{i=j-H}^{n} d_{i,j}.$$

2.1 Stationary Demand Case

In a stationary demand process, the probability of having a positive demand and the distribution of demand do not change over time; they are the same in every period.

Let p_i be the probability of being informed of a positive demand $i - 1$ periods ahead. That is,

$$p_i = Pr\ (d_{n,n+i-1} > 0)$$

for any period n. For example, p_1 is the probability of having regular positive demand this period. The demand process is stationary as this probability is not dependent on n or L_n. In this case the probability of having no advance demand information can be written as follows:

$$1 - \sum_{i=1}^{H+1} p_i.$$

The demand itself can be distributed with any distribution. This policy can be called a base stock policy based on IIP.

The expected cost per period under this model is as follows:

$$G(IIP) = hE[IIP - D]^+ + bE[IIP - D]^-$$

where,

D = Demand over the leadtime,

$$D = \sum_{i=1}^{l+1} \sum_{j=i}^{l+1} d_{i,j}.$$

2.2 Intermittent Demand Case

In the model the demand is not stationary; it is dependent on the number of periods since the last demand. Specifically, the probability of having nonzero demand of any type in a period increases as the number of periods since the last positive demand increases. To model this we let the probability of having information of a positive demand i − 1 periods ahead be as follows:

$$p_i^{(k)} = 1 - [(1 - p_i)\theta^{k-1}]$$

for all $i \in [1,\ H + 1]$, where θ is a positive real number less than 1 and k is the number of periods since last demand (the same as L_n). It can be observed that if θ = 1 then the demand process is stationary; and when θ = 0 there is positive demand for every period.

Because of the complexity of a state-dependent optimal policy, a simpler policy which is more applicable in practice is studied: a "High-Low Policy" that has only two order-up-to levels. The low level is S^l, and if there is no order from the customer for K periods in a row, the supplier switches to the high order-up-to level, S^h.

A Markov chain can represent this situation. To ensure a parsimonious exposition to illustrate the model, the pairs of S^l and S^h are limited so that,

$$S^h - S^l \leq \min d_{i,j}\ ,$$

for any i and j. This guarantees that, if a demand is observed when $IIP = S^h$, the next IIP level is going to be S^l. Therefore the IIP levels which are between S^h and S^l may be eliminated, saving a dimension in the state space of the Markov chain. This assumption reduces the numerical work that is required to find the stationary probabilities of the states. If this assumption is not made the methods in this paper are still applicable, but computations are more intensive. Rather than solving a simple set of balance equations as below matrix geometric methods may need to be applied. The state of this Markov chain is the *number of periods since last demand*. : (1), (2), ... , (K), $(K + 1)$, $(K + 2)$, ... In the next period the state number is going to increase by one if there is no demand in the period, and is going to be 1 otherwise.

Let $R^{(k)}$ be the probability of not having any positive demand (advance or regular) given that number of periods since last positive demand is k. Therefore,

$$R^{(k)} = R^{(1)} \theta^{(H+1)(k-1)}.$$

The transition probabilities are as follows: Let $P_{i,j}$ be the transition probability from state i to state j. Then,

$$P_{i,i+1} = R^{(i)},$$
$$P_{i,1} = 1 - R^{(i)},$$

for all $i \in \{1, 2, ...\}$.

This Markov chain is positive recurrent ergodic as long as some $p_i > 0$ and $\theta \le 1$. Therefore the stationary probabilities of the Markov chain are calculated as:

$$\pi_1 = \frac{1}{\sum_{i=0}^{\infty}(R^{(1)})^i \theta^{\frac{(H+1)(i-1)i}{2}}},$$

$$\pi_j = \pi_1 \prod_{i=1}^{j-1} R^{(i)},$$

for all $j \in \{2, 3, \dots\}$.

The cost of a state consists of linear penalty and holding cost over the leadtime period. At the beginning of the leadtime period, the IIP level is either S^h or S^l, and at the end of this period, the on hand inventory would be the IIP level minus the *leadtime demand*. Hence the cost of a state can be written as follows:

(1) $$G[k] = hIIP(k) - hE[D(k)] + (h + b) \sum_{i=IIP(k)}^{D_{max}} (i - IIP(k)) \Pr(D = i),$$

where,

$$IIP(k) = \begin{cases} S^l & \text{If } k \le K, \\ S^h & \text{If } k > K, \end{cases}$$

and $D(k)$ is demand over leadtime,

$$D(k) = \sum_{i=1}^{l+1} \sum_{j=1}^{l+1} d(k)_{i,j},$$

where,

$$d(k)_{i,j} \sim \begin{cases} 0 & \text{with probability } 1 - p_{j-i+1}^{(k)}, \\ d & \text{with probability } p_{j-i+1}^{(k)}. \end{cases}$$

And d is the distribution of demand regardless of the number of periods since last positive demand. For simplicity, it is taken identical for all the regular and advance parts of demand vector.

Given that the stationary probability and expected cost of each state is available, then total expected cost is as follows:

$$\sum_{i=1}^{\infty} \pi_i G[i].$$

This cost can be found numerically, and eventually optimal parameters $(K; S^l; S^h)$ can be found.

3. NUMERICAL STUDY

For the numerical study the same discrete uniform distribution is used for all the components of the demand vector for simplicity. The numerical study is done to see results for a sample problem. The following parameter values are used for the numerical example: $l=2$, $H=2$, $p_1=0.05$, $p_2=0.03$, $p_3=0.01$, $h=1$, $b=2$. Any realized demand is distributed by discrete uniform distribution between 4 and 7. To see the effect of intermittence the following values for θ are used: 0.99, 0.975, 0.95, 0.9, 0.75, 0.5 and 0.1.

The average number of consecutive demandless periods increases as the intermittence increases (i.e. θ increases). When the demand is highly intermittent ($\theta = 0.99$), the demand occurs every 4.44 periods, on the average. Demand occurrence becomes more frequent with smaller θ as it is shown in Table 2.

The stationary distribution of the states become negligible after only a few states. (The stationary distributions for $\theta= 0.99$ and 0.1 are tabulated in Table 3.) Therefore, even if there are infinite number of states in the model's Markov chain, only a small number of them are used in the numerical experiments.

The search is done over $K = 1$ to 7, $S^l = 1$ to 20 and $S^h = S^l$ to $S^l + 4$. (The search is for $S^h = S^l$ to $S^l + 4$ for every S^l because of the assumption that $S^h - S^l \leq \min d = 4$)

For example for $\theta = 0.99$, the optimal high-low policy parameters are: $S^l = 1$; $S^h = 5$ and $K = 4$, (i.e. the supplier should keep inventory of 1 unit when she sees a demand, and if she does not see any demand for 4 periods in a row, she should order 4 more units.)

θ	Avg. number of periods without any
0.99	4.44
0.975	3.33
0.95	2.70
0.9	2.22
0.75	1.78
0.5	1.56
0.1	1.48

Table 1: Average number of consecutive periods without any demand

	θ	
	0.99	0.1
π_1	0.173991	0.522707
π_2	0.158729	0.476858
π_3	0.140506	0.00044
π_4	0.12068	3.97E-10
π_5	0.100573	3.62E-19
π_6	0.081327	3.30E-31
π_7	0.063811	0
π_8	0.04858	0
π_9	0.035886	0
π_{10}	0.025722	0
π_{11}	0.017889	0
π_{12}	0.012072	0
π_{13}	0.007904	0

	θ	
	0.99	0.1
π_{14}	0.005022	0
π_{15}	0.003096	0
π_{16}	0.001852	0
π_{17}	0.001075	0
π_{18}	0.000605	0
π_{19}	0.000331	0
π_{20}	0.000175	0
π_{21}	9.02E-05	0
π_{22}	4.50E-05	0
π_{23}	2.18E-05	0
π_{24}	1.02E-05	0
π_{25}	4.67E-06	0

Table 2: Stationary distribution of the Markov chain

	θ						
	0.99	0.975	0.95	0.90	0.75	0.50	0.10
S^l	1	1	2	5	7	10	15
S^h	5	5	6	7	11	14	19
K	4	1	1	1	1	1	1
Cost	4.12	4.64	5.09	5.59	6.15	6.45	5.73
Fill rate	82.50%	86.70%	86.50%	89.20%	62.00%	92.70%	94.70%

Table 3: Optimal values for various intermittence levels

A summary of optimal high-low parameters for various θ values is in Table 4. It seems that the

$$\min d \geq S^h - S^l$$

constraint is binding, and neither cost nor service level is monotone in intermittence.

4. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

In this study a Markov chain model is developed to find the optimal parameters of the high-low policy for the supplier. By conducting a numerical study stationary distribution of the Markov chain is calculated. The optimal parameters for the proposed high-low policy are also calculated by a computational study. The Markov chain model in this paper assumes that, if a demand occurs when the supplier is in a high state, it will be large enough (namely, at least in the amount of $S^h - S^l$) to make the next state a low state eliminating intermediate states. As a future work, the assumption can be relaxed. The θ used in the model provides the intermittent nature of the demand and it is taken as a constant as the number of periods since the last demand (L_n) increases. θ can be a function of L_n and its effects can be studied.

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SOLVING SEQUENCE-DEPENDENT DISASSEMBLY LINE BALANCING PROBLEM USING A HYBRID GENETIC ALGORITHM

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ABSTRACT

In this paper, we consider a sequence-dependent disassembly line balancing problem (SDDLBP) with multiple objectives that requires the assignment of disassembly tasks to a set of ordered disassembly workstations while satisfying the disassembly precedence constraints and optimizing the effectiveness of several measures considering sequence-dependent time increments. A hybrid genetic algorithm is proposed to solve the SDDLBP.

Keywords: disassembly, sequence-dependent disassembly line balancing, metaheuristics, hybrid genetic algorithm

1. INTRODUCTION

Product recovery becomes increasingly significant. Gungor and Gupta [8], Ilgin and Gupta [12] provide an extensive review of product recovery which involves the recovery of materials and parts from returned or end-of-life (EOL) products. The most critical and time consuming step of product recovery is disassembly. Due to its high productivity and suitability for automation, disassembly line is the most suitable layout for disassembly operations [9].

Disassembly Line Balancing Problem (DLBP) is a multi-objective problem that is described by Gungor and Gupta [10] and has mathematically been proven to be NP-complete by McGovern and Gupta [23] making the goal to achieve the optimal balance computationally expensive. Exhaustive search works well enough in obtaining optimal solutions for small sized instances; however its exponential time complexity limits its application on the large sized instances. An efficient search method needs to be employed to attain a (near) optimal condition with respect to objective functions. Although some researchers have formulated the DLBP using mathematical programming techniques [3] [4] [19], it quickly becomes unsolvable for a practical sized problem due to its combinatorial nature. For this reason, there is an increasing need to use metaheuristic techniques such as genetic algorithms (GA) [14] [23], ant colony optimization (ACO) [1] [7] [21], simulated annealing (SA) [18], tabu search (TS) [15], artificial bee colony (ABC) [17] and particle swarm optimization (PSO) [16]. See McGovern and Gupta [24] for more information on DLBP.

In this paper, we consider a sequence-dependent disassembly line balancing problem (SDDLBP) with multiple objectives that requires the assignment of disassembly tasks to a set of ordered disassembly workstations while satisfying the disassembly precedence constraints and optimizing the effectiveness of several measures considering sequence-dependent time increments. A hybrid genetic algorithm (HGA) is proposed to solve the SDDLBP.

The rest of the paper is organized as follows: In Section 2, notation used in this paper is presented. Problem definition and formulation is given in Section 3. Section 4 describes the proposed HGA algorithm for the multi-objective SDDLBP. The computational experience to evaluate its performance on numerical examples is provided in Section 5. Finally some conclusions are pointed out in Section 6.

2. NOTATION

c	Cycle time (Maximum time available at each workstation)
cr	Crossover rate
d_i	Demand; quantity of part i requested
er	Elitism rate
h_i	Binary value; 1 if part i is hazardous, else 0.
IP	Set (i,j) of parts such that task i must precede task j
i	Part identification, task count $(1,\dots,n)$
j	Part identification, task count $(1,\dots,n)$
k	Workstation count $(1,\dots,m)$
m	Number of workstations required for a given solution sequence
m^*	Minimum possible number of workstations
M	Sufficiently large number
mr	Mutation rate
n	Number of parts for removal
N	The set of natural numbers
ps	Population size
PS_i	i^{th} part in a solution sequence
r	Uniformly distributed random number between 0 and 1.
sd_{ij}	Sequence dependent time increment influence of i on j
t_i	Part removal time of part i
t_i'	Part removal time of part i considering sequence dependent time increment
$tlimit$	Time limit of the algorithm to be executed
ts	Tournament size

2. PROBLEM DEFINITION AND FORMULATION

The sequence dependent disassembly line balancing problem (SDDLBP) investigated in this paper is concerned with a paced disassembly line for a single model of product that undergoes complete disassembly. The difference between disassembly line balancing problem (DLBP) and sequence-dependent disassembly line balancing problem (SDDLBP) is task time interactions. If task j is performed before task i, its standard time t_j is incremented by sd_{ij}. This sequence dependent increment measures the prolongation of task j forced by the interference of already waiting task i.

Illustrative example: The precedence relationships (solid line arrows) and sequence dependent time increments (dashed line arrows) for an 8 part PC disassembly process are illustrated in Figure 1 and their knowledge database is given in Table 1. This example is modified from Gungor and Gupta [10].
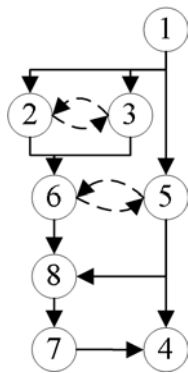

Figure 1: 8-part PC example

Table 1 Knowledge database for the PC example

Part	Task	Time	Hazardous	Demand
PC top cover	1	14	No	360
Floppy drive	2	10	No	500
hard drive	3	12	No	620
back plane	4	18	No	480
PCI cards	5	23	No	540
RAM modules	6	16	No	750
power supply	7	20	No	295
motherboard	8	36	No	720

Sequence dependencies for the PC example are given as follows: $sd_{23} = 2, sd_{32} = 4$, $sd_{56} = 1$, $sd_{65} = 3$. For a feasible sequence $\langle 1,2,3,6,5,8,7,4 \rangle$; since part 2 is disassembled before part 3, sequence dependency $sd_{32} = 4$ takes place because when part 2 is disassembled, the obstructing part 3 is still not taken out, i.e., the part removal time for part 2 is increased which results in $t'_2 = t_2 + sd_{32} = 14$; similarly since part 6 is disassembled before part 5, sequence dependency $sd_{56} = 1$ takes place because when part 6 is disassembled, the obstructing part 5 is still not taken out, i.e., the part removal time for part 6 is increased which results in $t'_6 = t_6 + sd_{56} = 17$.

In this paper, the precedence relationships considered are of AND type and are represented using the immediately preceding matrix $[y_{ij}]_{n \times n}$, where

$$y_{ij} = \begin{cases} 1 & \text{if task } i \text{ is executed after task } j \\ 0 & \text{if task } i \text{ is executed before task } j \end{cases} \tag{1}$$

In order to state the partition of total tasks, we use the assignment matrix $[x_{jk}]_{n \times m}$, where

$$x_{jk} = \begin{cases} 1 & \text{if part } j \text{ is assigned to station } k \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

The mathematical formulation of SDDLBP is given as follows:

$$\min f_1 = m \tag{3}$$

$$\min f_2 = \sum_{i=1}^{m} (c - t_i')^2 \tag{4}$$

$$\min f_3 = \sum_{i=1}^{n} i \times h_{PS_i}, \quad h_{PS_i} = \begin{cases} 1 & \text{hazardous} \\ 0 & \text{otherwise} \end{cases} \tag{5}$$

$$\min f_4 = \sum_{i=1}^{n} i \times d_{PS_i}, \quad d_{PS_i} \in N, \forall PS_i \tag{6}$$

Subject to:

$$\sum_{k=1}^{m} x_{jk} = 1, \quad j = 1, \dots, n \tag{7}$$

$$\left\lceil \frac{\sum_{i=1}^{n} t_i}{c} \right\rceil \leq m^* \leq n \tag{8}$$

$$\sum_{j=1}^{n} \left(t_j + \sum_{i=1}^{n} sd_{ij} \times y_{ij} \right) \times x_{jk} \leq c \tag{9}$$

$$x_{ik} \leq \sum_{k=1}^{m} x_{jk}, \quad \forall (i, j) \in IP \tag{10}$$

The first objective given in equation (3) is to minimize the number of workstations for a given cycle time (c) [5]. The second objective given in equation (4) is to aggressively ensure that idle times at each workstation are similar, though at the expense of the generation of a non-linear objective function [23]. As the third objective (see equation (5)), a hazard measure developed to quantify each solution sequence's performance, with a lower calculated value being more desirable, thereby rewarding the removal of hazardous parts early in the part removal sequence. [23]. As the fourth objective (equation (6)), a demand measure was developed to quantify each solution sequence's performance, thereby rewarding the removal of high demand parts early in the part removal sequence [23]. The constraints given in; equation (7) ensures that all tasks are assigned to at least and at most one workstation (the complete assignment of each task), equation (8) guarantees that the number of work stations with a workload does not exceed the permitted number, equation (9) ensures that the work content of a workstation cannot exceed the cycle time and equation (10) imposes the restriction that all the disassembly precedence relationships between tasks should be satisfied.

3. PROPOSED HYBRID GENETIC ALGORITHM APPROACH

Since SDDLBP falls into the NP-Complete class of combinatorial optimization problems, it is necessary to use alternative methods in order to reach (near) optimal solutions faster. Metaheuristics such as GA seem to be particularly suited for this task because they process a set of solutions in parallel, possibly exploiting similarities of solutions by recombination that provides an alternative to traditional optimization techniques to locate (near) optimum solutions in complex landscapes.

In the HGA, we use a task based representation. The length of the chromosome is defined by the number of tasks and each gene of the chromosome represents a task. Tasks are assigned to workstations using next fit algorithm according to the task sequence in the chromosome, as long as the predetermined cycle time is not exceeded. Once the cycle time is exceeded, a new work station is opened for assignment, and the procedure is repeated until there are no more tasks to assign. Flow diagram of proposed HGA is depicted in Figure 2.
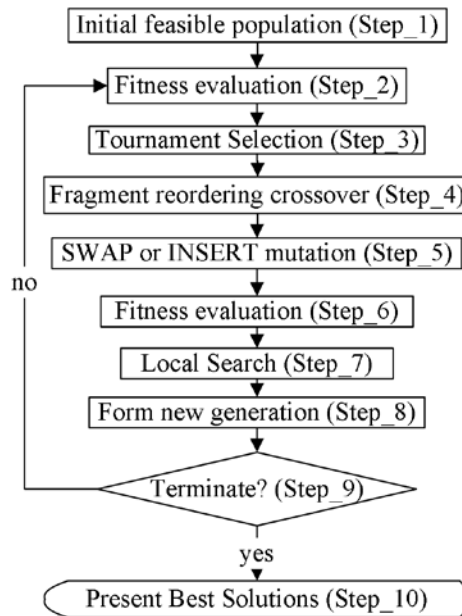
Figure 2: Flow diagram of the proposed hybrid genetic algorithm

Initial solutions are randomly generated for the HGA. We use station-oriented procedure for a solution constructing strategy in which solutions are generated by filling workstations successively one after the other [7].

The fitness functions provide a measure of an individual's performance in the search space. The proposed HGA algorithm tries to minimize the fitness functions according to the priority of first (1), second (2), third (3) and fourth (4) objective functions, respectively.

The individuals for mating are selected by tournament selection. According to the tournament size defined, tournament size times randomly selected chromosomes are compared to each other and fitter chromosome becomes the parent to be mated in crossover operations.

Three part fragment reordering crossover [2] [20] is used as crossover operation as follows: Two points, which cut each of the parent into three parts (first part, middle part and last part), are generated randomly. As demonstrated in Figure 3, parent-1 is recombined with parent-2 in order to form new children to ensure that the resulting offspring are always feasible. In the disassembly line balancing problem, recombination must guarantee feasibility because of the precedence constraints. The offspring keeps the head and tail parts of the first parent. The middle part is filled in by adding all missing tasks in the order in which they are contained in the second parent.
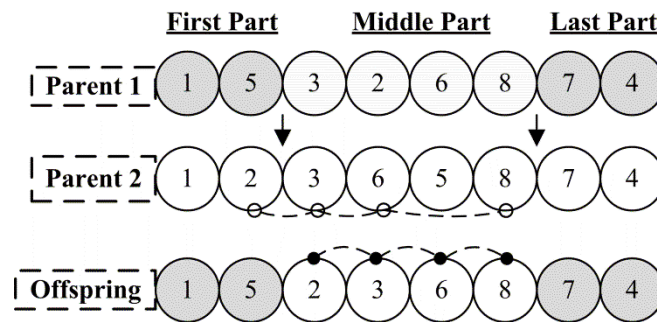

Figure 3: Fragment reordering Crossover

In the proposed HGA algorithm, interchanging two tasks (SWAP) or inserting a task to a different work station (INSERT) is implemented as a mutation strategy such that the new neighboring solutions are ensured to be feasible. By guaranteeing feasibility in each operation, the necessity of the repair function is prevented. In SWAP, two randomly selected tasks from two randomly selected workstations are exchanged and in INSERT, a randomly selected task from a randomly selected workstation is inserted into another randomly selected workstation while satisfying the precedence constraints.

In the local search step; the best individual of the population from the HGA is used as the starting solution for an embedded tabu search (TS) function. The output of the TS operation is fed to the new population selection process. Whenever an improved solution is found, this solution is taken under the consideration of elitism strategy. The elitism strategy chooses a predetermined number of the best individuals at each generation is used as replacement strategy to create the next generation. The individuals of the new generation may be individuals from the current generation, offspring produced by crossover operator, individuals that underwent mutation or an improved solution found by local search regarding their fitness values.

4. NUMERICAL RESULTS

The proposed algorithm was coded in MATLAB and tested on Intel Core2 1.79 GHz processor with 3GB RAM. After engineering, the program is investigated on two different scenarios for verification and validation purposes. After the full factorial set of experiments, the parameter set with $er = .2$, $cr = .8$, $mr = .2$, $ts = 2$ was determined as the best parameter set while ps parameter was fixed to be 600. The first scenario is for a product consisting of $n=10$ components. The knowledge database and precedence relationships for the components are given in Table 2 and

Figure 4, respectively. The problem and its data were modified from McGovern and Gupta [22] with a paced disassembly line operating at a speed which allows $c=40$ s for each workstation to perform its required disassembly tasks. The sequence dependencies for the 10 part product are given as follows: $sd_{14}=1, sd_{23}=2, sd_{32}=3, sd_{41}=4, sd_{45}=4, sd_{54}=2, sd_{56}=2, sd_{65}=4, sd_{69}=3,$ $sd_{96}=1$. While the exhaustive search method was able to find optimal solutions in $215t$ time on average, the proposed approach was able to successfully find the optimal solution in just over $5t$ time on average under the restriction of the system specifications given above. Table 3 depicts an optimal solution sequence. The fitness function values of the optimal solution are found to be: $f_1=5, f_2=67, f_3=5, f_4=9605$. According to this sequence, sequence dependent time increments $sd_{56}, sd_{96}, sd_{41}, sd_{45}, sd_{32}$ are added to the part removal times of part 6, 6, 1, 5, 2 respectively.

Table 2 Knowledge database for the 10-part product

Task	Time	Hazardous	Demand
1	14	No	0
2	10	No	500
3	12	No	0
4	17	No	0
5	23	No	0
6	14	No	750
7	19	Yes	295
8	36	No	0
9	14	No	360
10	10	No	0
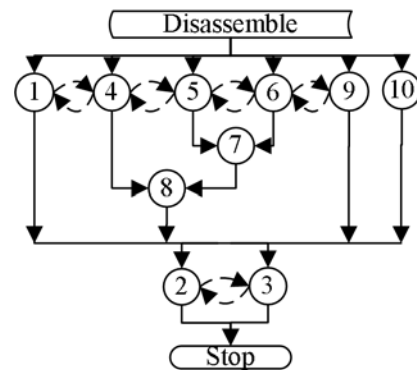
Figure 4: 10-part product disassembly

Table 3 An optimal solution sequence for 10 Part product disassembly

		I	II	III	IV	V	
	6	14(+**2**+**1**)					
	1	14(+**4**)					
	10		10				
	5		23(+**4**)				
	7			19			
	4			17			
	8				36		
	9					14	
	2					10(+**3**)	
	3					12	
Total time		35	37	36	36	39	
Idle time		5	3	4	4	1	

(Left axis label: **Part removal sequence** ↓; Right axis label: Time to remove parts (in seconds))

The second scenario consists of a cellular telephone instance with $n=25$ components. The knowledge database and precedence relationships for the components are given in Table 4 and Figure 5, respectively. The problem and its data were modified from Gupta et al. [11] with a disassembly line operating at a speed which allows $c=18$ for each workstation to perform its

required disassembly tasks. The sequence dependencies for the 25 part product are given as the follows: $sd_{45} = 2$, $sd_{54} = 1$, $sd_{67} = 1$, $sd_{69} = 2$, $sd_{76} = 2$, $sd_{78} = 1$, $sd_{87} = 2$, $sd_{96} = 1$, $sd_{13,14} = 1$, $sd_{14,13} = 2$ $sd_{14,15} = 2$, $sd_{15,14} = 1$, $sd_{20,21} = 1$, $sd_{21,20} = 2$, $sd_{22,25} = 1$, $sd_{25,22} = 2$.

Table 4 Knowledge database of cellular telephone instance

Part	Task	Part Removal Time	Hazardous	Demand
Antenna	1	3	Yes	4
Battery	2	2	Yes	7
Antenna guide	3	3	No	1
Bolt (type 1) A	4	10	No	1
Bolt (Type1) B	5	10	No	1
Bolt (Type2) 1	6	15	No	1
Bolt (Type2) 2	7	15	No	1
Bolt (Type2) 3	8	15	No	1
Bolt (Type2) 4	9	15	No	1
Clip	10	2	No	2
Rubber Seal	11	2	No	1
Speaker	12	2	Yes	4
White Cable	13	2	No	1
Red/Blue Cable	14	2	No	1
Orange Cable	15	2	No	1
Metal Top	16	2	No	1
Front Cover	17	2	No	2
Back Cover	18	3	No	2
Circuit Board	19	18	Yes	8
Plastic Screen	20	5	No	1
Keyboard	21	1	No	4
LCD	22	5	No	6
Sub-keyboard	23	15	Yes	7
Internal IC Board	24	2	No	1
Microphone	25	2	Yes	4
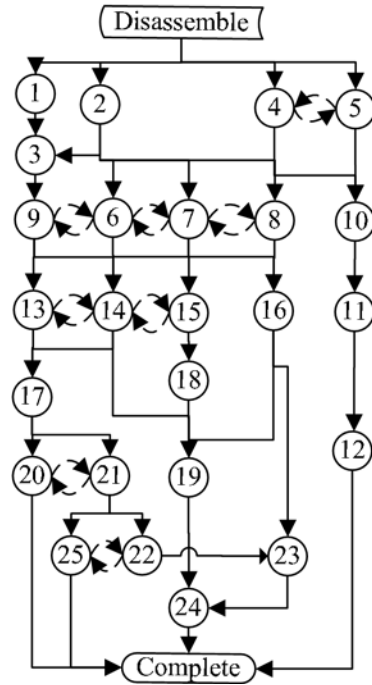
Figure 5: Cellular telephone instance

Since within the vast search space (25!), the exhaustive search is prohibitive due to the exponential growth of the time complexity, the optimal solution is unknown. The proposed HGA algorithm was able to find the best solution given in Figure 6 within a reasonable time (500t) under the system specifications given above.
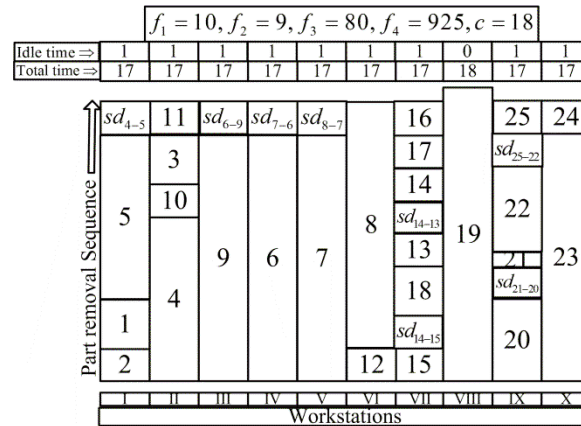
Figure 9: A typical solution found using the cellular telephone instance

6. CONCLUSIONS

SDDLBP is a recently reported multi-objective NP-complete optimization problem. The main objective of this paper was to solve sequence-dependent disassembly line balancing problem (SDDLBP). A fast, near-optimal, hybrid genetic algorithm was developed and presented in this paper to solve multi-objective SDDLBP. The algorithm was tested on two different scenarios that include a small sized and a large sized disassembly instance. HGA was very fast to solve this small sized instance. For the second instance, it was found out that HGA performed well in terms of solution quality according to the predetermined objective priorities.

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A STUDY ON OPTIMAL PURCHASE POLICY FOR MULTIPLE ITEMS

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ABSTRACT

Recently, commodity price has become an important measure of Customer Satisfaction. In this paper, we investigate commodity prices for combination sales. It is supposed that a retail store sells its items separately and/or in various combinations which include different types of items. Our analysis shows the properties of commodity pricing under different conditions.

INTRODUCTION

Customer Satisfaction (CS) is an important function in the field of marketing research [5]. CS has several performance measures, one of which is the price of the item. Appropriate prices for combinations of items attract customers and encourage them to purchase more. In addition, there are customers who desire to purchase items for particular purposes. If they purchase the items as a combination, another measure of CS becomes the number of item types in the combination. Increasing the number of item types tends to please customers.

In this study, we seek to determine the optimal prices for multiple items that will maximize total profit. In the following model, we suppose that a retail store sells its items separately and/or in various combinations. Each item has a purchase probability that is assumed to be a normal distribution. We can calculate the optimal price of each item and that of each combination. The problem is formulated by Dynamic Programming (DP)[1,2] subject to the inventory levels. Numerical analysis shows the effect an optimal sales policy has under different conditions.

MODEL DESCRIPTION

We consider a store that deals with multiple retail items, for example a grocery store. The store sells the items separately and/or in various combinations. In this model, the problem becomes how many combinations with what prices should be sold to maximize profit.

Notations

i: index of item ($i=1,2,..., M$)

j: index of combination sale ($j=1,2,..., J$)

p_i: selling price of item I

s_j: selling price of combination sale j

c_i: cost of item I

D: number of customers

CS_j: customer satisfaction for combination sale j

CS_{low}: lowest value necessary on CS measure

$F_i(p_i)$: purchase probability density of item i

$G_j(s_j)$: purchase probability density of combination sale j

$EP(p_i)$: profit gained from sale of item i per customer

$EP_s(s_j)$: profit gained from sale of combination j per Customer

a_{ij}: number of items i in combination sale j

I_i: inventory level of item i

$N(i)$: number of items i sold individually

$NS(j)$: number of combination sale j

n_j: number of items which are included in combination sale j

m_j :number of item types which are included in combination sale j

$R(p_i)$: profit gained by selling one unit of item i

$R_S(s_j)$: profit gained by selling combination sale j

$N_j(i)$ number of items i sold in combination sale j

V_{ij}: cumulative number of item i for combination sale j

$H(j)$: maximum profit on sales of combination 1 to j

$CH_j(V_{ij})$: maximum cumulative profit on sales of combination 1 to j

Purchase Probability

It is assumed that the customers have a general idea of prices for items. So, we define the purchase probability density of item i by the following normal distribution with mean, μ_i and standard deviation, σ_i [3, 6].

$$F_i(p_i) = \frac{1}{\sigma_i \sqrt{2\pi}} \exp\{-\frac{(p_i - \mu_i)^2}{2\sigma_i^2}\} \tag{1}$$

For combination $j(=1, 2,..., J)$, we also define the purchase probability density with mean, $\mu_j^{'}$ and standard deviation, $\sigma_j^{'}$ as follows:

$$G_j(s_j) = \frac{1}{\sigma_j \sqrt{2\pi}} \exp\{-\frac{(s_j - \mu_j^{'})^2}{2\sigma_j^{'2}}\}. \tag{2}$$

FORMULATION

We define the CS measure of combination j by

$$CS_j = 1 - \frac{n_j - m_j}{n_j} = \frac{m_j}{n_j}. \tag{3}$$

It is assumed that each combination satisfies $CS_j \geq CS_{low}$. For combination j, it holds that

$$R_s(s_j) = s_j - \sum_{i=1}^{M} a_{ij} c_i. \tag{4}$$

Therefore, we have

$$EP_s(s_j) = \begin{cases} R_s(s_j)G_j(s_j), & if \ \frac{NS(j)}{D} \geq G_j(s_j), \\ R_s(s_j)\frac{NS(j)}{D}, & otherwise. \end{cases} \tag{5}$$

As a result, we can obtain the optimal price of combination j, s_j^{*} which satisfies the following equation:

$$EP_s(s_j^{*}) = \max_{s_j} EP_s(s_j). \tag{6}$$

For $N_j(i)$, it holds from Table 1 that

$$N_j(i) = \sum_{j=1}^{J} a_{ij} NS(j). \qquad (7)$$

Table 1 Number of items in each combination

item i	combination j			
	1	2	....	J
1	$a_{11} NS(1)$	$a_{12} NS(2)$	...	$a_{1J} NS(J)$
2	$a_{21} NS(1)$	$a_{22} NS(2)$	...	$a_{2J} NS(J)$
⋮	⋮	⋮	⋮	⋮
M	$a_{M1} NS(1)$	$a_{M2} NS(2)$	...	$a_{MJ} NS(J)$

From Eq. (7), we have

$$N(i) = I_i - N_j(i). \qquad (8)$$

We can obtain the following relations from the same argument in Eq. (4) and (5).

$$R(p_i) = p_i - c_i. \qquad (9)$$

Therefore, we have

$$EP(p_i) = \begin{cases} R(p_i)F_i(p_i), & if \dfrac{N(i)}{D} \geq F_i(p_i), \\ R(p_i)\dfrac{N(i)}{D}, & otherwise. \end{cases} \qquad (10)$$

Therefore, we can determine the optimal price of item i, p_j^* which satisfies the following equation:

$$EP(p_j^*) = \max_{p_j} EP(p_j). \qquad (11)$$

For combination j, it holds that

$$H(V_{ij}) = EP_s(s_j^*) \qquad (12)$$

From the principle of optimality, we obtain the following equation:

$$CH_j(V_{ij}) = \max_{0 \leq V_{i(j-1)} \leq V_{ij}} \{ CH_{(j-1)}(V_{i(j-1)}) + H(V_{ij} - V_{i(j-1)}) \} \qquad (13)$$

Then, we can determine the optimal sales policy that maximizes the profit by Dynamic Programming[2].

NUMERICAL EXAMPLES

We consider the following case in which the number of items is 3 and the number of combinations is 4, i.e. $M=3$ and $J=4$. We set the parameters as $D=1000$ and $I_1=I_2=I_3=200$. It is assumed that the combination is composed of various item types and that the number of items per item type is restricted to one. For example, the following four types of combinations are taken under $CS_1=CS_2=CS_3=CS_4=CS_{low}=1.0$.

Table 2 Number of each item in each combination under $CS_i=1.0$

item i	Combination j			
	1	2	3	4
1	0	1	1	1
2	1	0	1	1
3	1	1	0	1

Then, we consider three cases with each item having purchase probability $F_i(p_i)$ with mean and standard deviation (shown in Table 3). We also calculate the mean and standard deviation of each combination [4].

Table 3 Mean and standard deviation of each item (μ_i, σ_i)

Case	Item 1	Item 2	Item 3
1	$(200,20^2)$	$(200,30^2)$	$(250,40^2)$
2	$(200,30^2)$	$(200,40^2)$	$(200,50^2)$
3	$(200,40^2)$	$(200,50^2)$	$(200,60^2)$

In case 2, we obtain the optimal sales policy as shown below:

$$NS(1)= NS(2)= NS(4)= N(1)= N(2)=0, \ NS(3)=200 \ and \ N(3)=200.$$

Figure 1 shows the behavior of total profit in the each case. We can observe the correlation between total profit and customer satisfaction. Also, the data shows that the total profit decreases as the variance of the purchase probability increases.
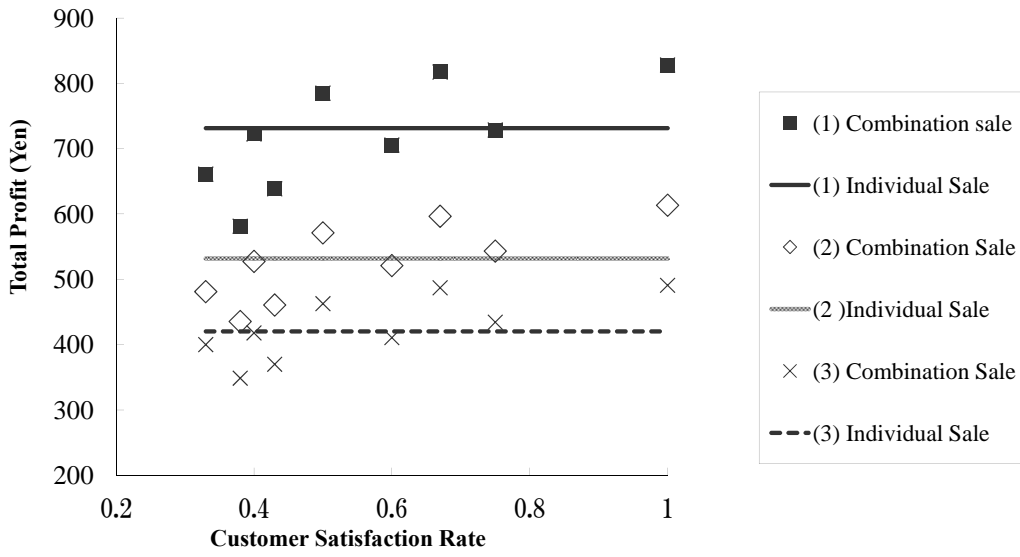
Figure 1: Behavior of Total Profit (CASE1)
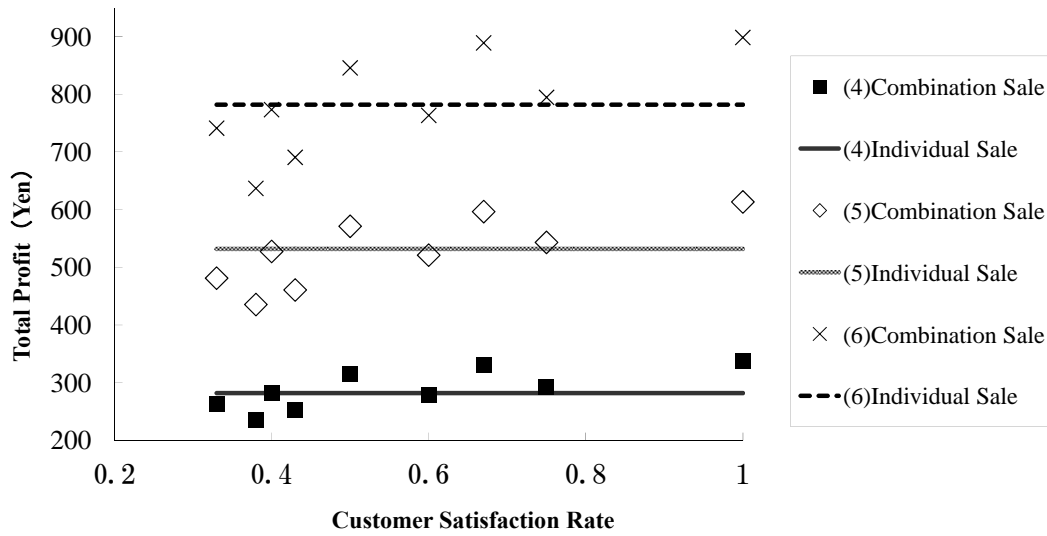
Figure 2: Behavior of Total Profit (CASE2)
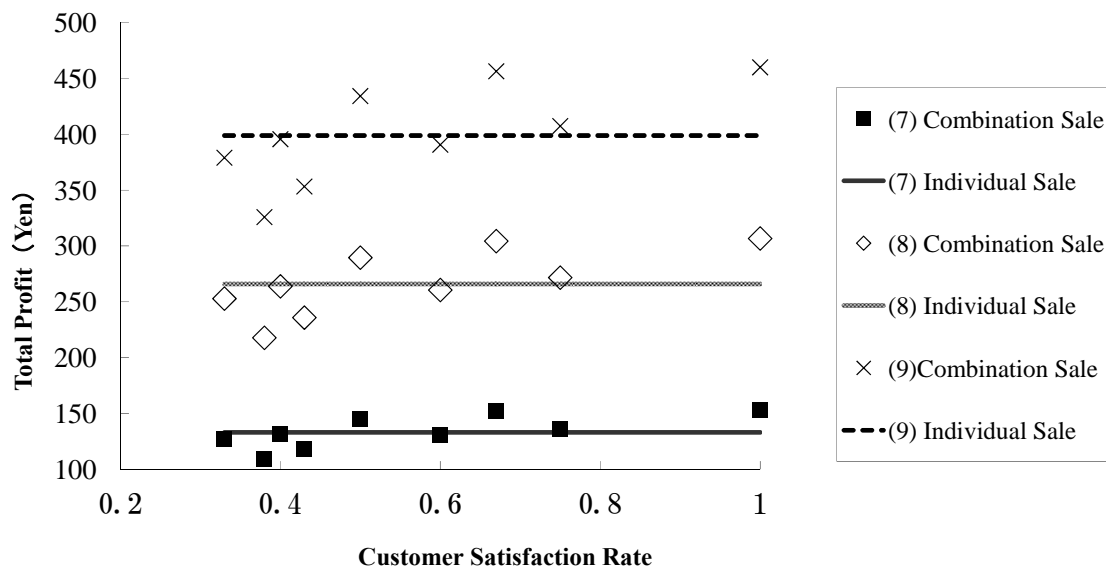
Figure 3: Behavior of Total Profit (CASE3)

CONCLUSION

We considered a store system that retails items separately and/or in various combinations that include various item types. The problem is formulated by dynamic programming subject to the inventory levels. The results of our analysis showed the properties of commodity prices under the different conditions mentioned.

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SELECTING SUPPLIER FOR A LONG-TERM RELATIONSHIP

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ABSTRACT

The purpose of this paper is to develop a quantitative methodology based on Data Envelopment Analysis (DEA) by considering both product and process characteristics as outputs of the suppliers since we believe both are required by the buyer. Three extensions of DEA are employed and combined for ranking and selecting suppliers. A real example illustrates the applicability and discriminating power of the proposed model compared to a similar study.

Keyword; Data envelopment analysis (DEA); Supplier selection; Long-term relationship with suppliers

INTRODUCTION

Traditionally, companies held the view that multiple sources of supply were best in order to increase cost competition and ensure supply security. This view has been challenged for quite some time, and the notion of single sourcing is becoming the acceptable norm. Single sourcing focuses on building closer supplier relationships and cooperation between buyers and suppliers and is a move away from arms-length relationships. Having a single source of supply, however, is risky in practice. By relying on one or few suppliers, the buyer is vulnerable if there is a disruption in the supplier production process, such as a fire at a plant, a labor strike, or a supplier going out of business. It is important for a buyer to evaluate a supplier's process and technological capabilities and how the supplier runs its business. It has been shown that companies that have lean operations and are productive have high disruption–free performances, or resilience (Marley 2006; Womack, and Jones 1996). As a result, these suppliers are preferred

by their customers and establish long-term relationships with them. This paper is about selecting the best self-efficient suppliers for a long term relationship.

BACKGROUND

Most supplier selection procedures evaluate suppliers based on three primary criteria (1) cost or price (2) quality and (3) delivery (Weber et al.1991, Dickson 1996). These three elements of performance are generally associated with the product exchanges between supplier and buyer. However, a long-term relationship with a supplier needs an in-depth analysis of the suppliers' capabilities, an analysis which deals with factors related to the processes and activities of the supplier. In these situations, factors such as design and development capabilities, quality improvement practices, process capabilities, cost reductions and improvements, among others which directly or indirectly relate to the relative efficiency of the suppliers' operations, become important and critical (Talluri and Narasimhan 2004; Narasimhan, Talluri and Mendez 2001; Araz and Ozkarahan 2007; Levary 2007; Liu, Ding and Lall 2000).

The purpose of this article is to describe a prescriptive model for supplier selection that takes into account both product characteristic data such as price, quality, and on-time delivery as well as process capability data such as design and development capability, quality-improvement practice, process capability, and cost-reductions improvement. We will also force our suppliers to be self-efficient because we believe self-efficiency of these suppliers is required for their long-term survival in the turbulent environment (Marley 2006). This model, which is based loosely on Data Envelopment Analysis (DEA), and its extensions, integrates various approaches and is used to rank and determine the best supplier. The aim is to provide managers of buying organizations with a tool for selecting a supplier that provides them with long-term strategic advantages.

DEA RANKING METHODS

There are myriad ranking methods for DEA. Among the most popular of these are cross-efficiency (Sexton *et al.* 1986), benchmarking (Sinuany-Stern *et al.* 1994), and virtual DMUs (Golany and Roll 1994). In the following, we will briefly explain each of these ranking methods. The reader interested in the details of these approaches is referred to Sexton *et al.* (1986), Sinuany-Stern *et al.* (1994), and Golany and Roll (1994).Finally, a note on the applicability of the super-efficiency approach is included.

Cross-efficiency Approach

The cross-efficiency approach was developed by Sexton, *et al* (1986) and introduced ranking capability in DEA. This method links one decision-making unit's (DMU) performance with others and has the appeal that scores arise from peer evaluation (Wu and Chen, 2009). The cross-efficiency method consists of two stages. In the first stage, the basic DEA model is run and efficiency measures for various DMUs are calculated. In the second stage, an average efficiency for each DMU is calculated using its own input and output weights as well as the weights of other DMUs. A comparison can then be made using these averages, allowing a ranking of all DMUs, including those on the efficient frontier. While averaging cross-efficiencies, sometimes called arbitrary formulation (Doyle and Green, 1991), may be the most obvious summary of the peer appraisal of a DMU, some authors (Sexton *et al¸* 1986) have proposed the more sophisticated "aggressive" and "benevolent" models. In the aggressive model, one finds the weights that maximize the efficiency of a specific DMU while minimizing the cross-efficiency of others. In the benevolent model, one seeks the weights that increase the efficiency of a specific DMU and the cross-efficiency of all other DMUs. Cross-efficiency helps eliminate one problem with DEA, where most of the weight in an output to input ratio can be placed on a single variable, with the rest being given near zero weights – refer to Doyle and Green (1994) and Torgersen *et al* (1996).

Benchmark Ranking Approach

Another approach for ranking efficient units in the DEA model is to count the number of times a particular efficient DMU is referred to by other non-efficient DMUs. A number of studies have

used this procedure – refer to Sinuany-Stern *et al* (1994) and Torgersen *et al* (1996). Originally, this approach was used as a tool for benchmarking and improving inefficient DMUs, as it allows the identification of a group of efficient firms for each inefficient one. A DMU which appears frequently in the reference set of many non-efficient DMUs is likely to be a unit which is efficient with respect to a large number of factors, and is probably a good example of overall desirability. By contrast, an efficient unit that seldom appears in the reference set of other units likely possesses an uncommon input/output mix, and is not a suitable example for overall need requirements. In other words, the peer count number can be considered a ranking approach for efficient DMUs.

Virtual DMUs Approach

This approach, initially proposed by Golany and Roll (1994), creates a virtual DMU by selecting the best values of various criteria (inputs and outputs) and includes it with the existing DMUs. This ensures there is only one efficient DMU, with all other real DMUs as inefficient. This approach, then, serves to rank all other DMUs now penalized for not operating at the same efficiency level as the virtual DMU. More detailed comparisons of the above approaches can be found in Adler, *et al* (2002).

THE MODEL AND CONCLUSION

This section explains the proposed mathematical framework based on rankings of various suppliers using DEA. In phase 1, a modified DEA is used as a means to determine efficient suppliers by considering both product and process characteristics as outputs of the decision making units, as we believe both the products characteristic as well as the process capability of the supplier is required in maximizing the competitiveness of the buyer. We also restrict our suppliers to those that are self-efficient because we believe self-efficiency of the suppliers is prerequisite for their long-term survival in a turbulent environment. In phase 2, three extensions of DEA are used for ranking various suppliers and then combined in one overall ranking. The advantage of the combined ranking results from incorporating various DEA extension methods, each with some

advantage. This paper introduces a new method for selecting suppliers with an improved discriminating power. From this research, we suggest a two-phase methodology. In phase 1, a modified DEA is used as a means to determine efficient suppliers by considering both product and process characteristics as outputs of the decision making units, as we believe both the products characteristic as well as the process capability of the supplier is required in maximizing the competitiveness of the buyer. We also restrict our suppliers to those that are self-efficient because we believe self-efficiency of the suppliers is prerequisite for their long-term survival in a turbulent environment. In phase 2, three extensions of DEA are used for ranking various suppliers and then combined in one overall ranking. The advantage of the combined ranking results from incorporating various DEA extension methods, each with some advantage.

The model proposed here, similar to other DEA models, provides a powerful analytical tool for selecting suppliers whereas traditional prescriptive models lack a quantitative framework. The model minimizes the subjectivity of the selection process since a major advantage of a DEA-based model is that it does not require that the relative importance or weights of criteria for selection be known a *priori.* It shows also how both product and process characteristics can be maximized from the buyer's point of view, while at the same time the efficiency of the supplier is guaranteed.

Full references available upon request

A Synthetic Cloud Model for Third-Party Logistics Partner Evaluation

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Abstract

Partner evaluation of Third party logistics is and will always be a very critical issue in supply chain management, with many practical methods and models applied. However, many quantitative and qualitative data can only be got from some fuzzy responds in the actual evaluation, especially from the ambiguity of human language comments, such as 'very good' and 'general'. However, these fuzzy words are not suitable for quantitative partner evaluation that was concerned on multi-level indicators. This paper applies Synthetic Cloud Model to third-party logistics partner evaluation. It tries to provide a simple and reliable evaluation method to the logistics managers, and to provide a feasible idea for the application of Cloud Model in the supply chain management research field.

Key Words : Synthetic Cloud Model, Partner evaluation, Third-Party logistics

I. Introduction

In recent years, the logistics industry has been rapidly developed. The third-party logistics has been more and more important in enterprises as a competitive mode of operation. The date from U.S. authorities investigating agency showed that when companies use third-party logistics services, their logistics costs will decline 11. 8%, logistics assets decline 24. 6%, and the turnaround time of orders reduces to 3. 9 days from previous 7. 1 days. [1] Logistics outsourcing is an effective way to reduce costs and optimize resources, so how to evaluate and choose the third-party logistics companies have become the main consideration in logistics outsourcing [2], as Zhou (2006) once said.

Faced with this problem, many scholars have done research from several aspects: such as Liu(2005), Ma(2005), Huo & Wang(2007), Yan(2010), while their methods are always AHP and Fuzzy Math. These methods can not avoid the interference of subjective factors from people, and the evaluation result is just the model result, which doesn't make sense to the practice. So we must find a new method to solve this problem, which is simple, feasible and most importantly, can avoid

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[1] Niu (2010)

[2] Zhou & Zhang (2006)

the interference of subjective factors. It is particularly urgent to find an effective way to solve this problem.

II. Literature Review

1. Third party logistics and Partner selection

According to Wikipedia, A third-party logistics provider is a firm that provides a one stop shop service to its customers of outsourced(or "third party") logistics services for part, or all of their supply chain management functions. After the mid-90s of the 20th century, the Chinese third-party logistics companies began to flourish. But compared to the foreign advanced companies, there are many flaws in management scale, physical transportation, service levels, quality of personnel and many other fields[3]. Facing so many third-party logistics companies on the market, how to choose the right one is the problem to many companies.

To choose the right third-party logistics company, we need to do the evaluation of customer satisfaction of every companies. At this field, there are few research results in China. Zhu(2003) pointed out that "To get the third-party logistics company rating, we need to calculate the index weights of every aspect, because the customer satisfaction is always psychological and personal experience". So the rating scale is very fuzzy. In the methodology, many experts used AHP and Fuzzy Math. Wang&Li(2006) and Deng etc. (2009) used the AHP to make the evaluation, while Zhao(2010), Wu(2010), Yang(2010) use the Fuzzy Math method.

Compared to the research results in China, foreign researchers are more advanced in methods. Ashayeri , Tuzkaya & Tuzkaya(2012) proposed a "chouquets"integral operator based on fuzzy math, and analyzed the sensitivity of the weight changes on the selection criteria, which proves that certified "chouquet" integral operator is feasible in partner selection.

Banomyong(2011) identified and categorized into six dimensions based on the SERVQUAL model: reliability, assurance, tangibility, empathy, responsiveness, and cost from a shippers' perspective. The purpose of the study is to define key freight logistics service quality attributes and their respective impact on shippers' decision-making process when choosing a third-party logistic partner.

There are also some scholars analyzing the index system from the transaction motive and the construct validity of the partner selection. Lai & Cheng (2002), Schmitz & Platts (2004), Dekker (2008), Graddy (2006), they all agreed that transaction cost is one of the most valued indicators of clients.

But there exist deficiencies in terms of the man-made interference and large amount of computation in the AHP and fuzzy math, which are obstructions on evaluation process. At the same time the cloud model is a good alternative to solve this problem.

2. Cloud model

Cloud model is determined by Li in 1995, a proposed exchange of qualitative and quantitative uncertainty model. Many experts had carried out the researches from all aspects only in about ten years:

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[3] Zhou & Zhang (2006)

Song & Li(2000) used the cloud model to do decision-making for the first time. Chen(2010) listed the literature of cloud models in detail in recent years. Wang & Xiao(2010) used an improved cloud model to make the evaluation of the viability of the radar. Fan(2003) made clothing selling evaluation by it, guiding the cloud model into the field of economic management.

In this paper, we will get the evaluation of third -Party logistics company, therefore we only discuss the one-dimensional cloud. As Li(2005) introduces the cloud generator and definition of variables, we will only discuss the outline algorithms and production of cloud.

3. Calculation of the Synthetic Cloud Model

According to the definition of the cloud by Li, the three digitals(Ex, En, He) represent a cloud, named Cloud(Ex, En, He).

Ex means the expectation of the cloud.

En means the variance and the entropy of the cloud. Entropy means the fuzziness and randomness.

He means the hyper entropy, which describes the agglomeration of cloud droplets.

There are two clouds : cloud1(Ex_1, En_1, He_1)and cloud2(Ex_2, En_2, He_2), and suppose $CT_1(X)$

and $CT_2(X)$ are the two expectation lines of cloud. The algorithm of comprehensive

cloud(Ex, En, He) is as follow :

$$\begin{cases} Ex = \dfrac{Ex_1 En_1 + Ex_2 En_2}{En_1 + En_2} \\[2mm] En = En_1 + En_2 \\[2mm] He = \dfrac{He_1 En_1 + He_2 En_2}{En_1 + En_2} \end{cases}$$

III. Methodology

Step 1 Determine the index system

Divide the goal of evaluation into a series of targets, and each target element is called a factor. Then these elements are divided into several groups, constituting different levels. Elements of the same level as a criterion to control the next layer of elements form a series of index system.

Step 2 Determine the weight of each element

Establish the weight at all levels of indicators by the method of consultants, when it is in the bilateral between the maximum and minimum constraints, and show it out by normal cloud. The different cloud image means the different importance. All the weights constitute the weight set

W={ W_1, W_2, W_3……W_n }.

Step 3 Determine the final evaluation level

The determine of evaluation level is graded on qualitative concept on the field. Commonly evaluators define the linguistic cloud, and then we will get the three value numbers of cloud from the data analysis, not directly by human.

In the object [0, 1], we can canton five levels: "very good", "good", "medium", "poor", " very poor", corresponding Cloud_1 (1, 0. 1031, 0. 013), Cloud_2 (0. 691, 0. 064, 0. 008), Cloud_3 (0. 5, 0. 039, 0. 005), Cloud_4 (0. 309, 0. 064, 0. 008), Cloud_5 (0, 0. 1031, 0. 013). [4]

Step 4 Get the dates based on Delphi

Invited 10 experts to evaluate, and each expert will score on the maximum and minimum values for each index score of bilateral constraints. Then all the dates will be transformed to the cloud drawing by the backward reverse cloud generator, as experts shave different understanding of it. The results from cloud's drawing of the first rating will be very vague, which shows a large difference in degree, entropy and hyper entropy are also too great, these evaluation results are meaningless. Therefore, feedback of the results to experts by the Delphi method, and repeated operation of 2~4 times is required until getting the satisfactory cloud drawing.

Step 5 Final evaluation

After we get all the clouds and the given weight by step2, count the father cloud of two son cloud. We name the father cloud of indicator I is Ai, then the result of ultimate goal level will be made of all the next layer levels, as follows：

$$Vi = \sum_{i=1}^{n} \frac{Ai \times Wi}{Wi},$$

Then we can obtain the ultimate cloud model and the final scale by step 3.

IV. Example

Based on the above cloud model, we selected X company as a third party logistics partner selection evaluation object. X Company is a third-party logistics company, specializing in distribution of household appliances in Qingdao. We invite 10 experts from the relevant departments to evaluate.

According to the literatures of Zhu, Arino and Ashayeri, We find the best number of second level indicators are 3~5. These second level indicators should be comprehensive, systematic, and independent. Because we can not calculate accurately so many indicators such as the enterprise flexibility, management, compatibility and flexibility, the cloud model has a unique advantage of dealing with fuzzy indicators.

So we build the evaluation system of third-Party Logistics Company including four second level indicators: product, ability, cooperation, sustainability. Product includes quality, cost and flexibility. Ability includes financial position, management and development capabilities. Cooperation includes exchange, communication and cooperation compatibility. While sustainability includes flexibility, economic and technical policies and social returns.

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[4] Fan & He(2003)

In order to evaluate the level of the cloud, we divide them into five levels: very important, more important, important, general, and not important, corresponding $Cloud_1(1, 0.055, 0.005)$, $Cloud_2(0.66, 0.055, 0.005)$, $Cloud_3(0.33, 0.055, 0.005)$, $Cloud_4(0, 0.055, 0.005)$.

Assessed by 10 experts, product is very important, corresponding $CloudN_1(1, 0.055, 0.005)$.

Ability and cooperation are more important, with corresponding $CloudN_2(0.66, 0.055, 0.005)$.

Sustainability is general, which corresponds $CloudN_3(0.33, 0.055, 0.005)$.

Here is the scoring statistics table of ten experts:

	Indicators	max	min	average	variance	En	He
X_1	highest cloud	95.0	80.0	86.0	26.7	0.050	0.016
	lowest cloud	85.0	70.0	76.5	28.1	0.065	0.009
X_2	highest cloud	90.0	70.0	82.0	40.0	0.063	0.009
	lowest cloud	85.0	60.0	72.0	56.7	0.073	0.020
X_3	highest cloud	90.0	60.0	76.5	89.2	0.094	0.009
	lowest cloud	80.0	40.0	63.5	139.2	0.110	0.042
X_4	highest cloud	75.0	40.0	61.5	111.2	0.098	0.040
	lowest cloud	65.0	30.0	48.5	94.7	0.085	0.047

Data analysis by Backward Cloud Generator, we get the final cloud as shown:

Indicators	highest Cloud H_i	lowest Cloud L_i	Father Cloud X_i
X_1	(0.85, 0.050, 0.016)	(0.74, 0.065, 0.009)	(0.788, 0.115, 0.012)
X_2	(0.82, 0.063, 0.009)	(0.72, 0.073, 0.020)	(0.766, 0.136, 0.015)
X_3	(0.765, 0.094, 0.009)	(0.635, 0.110, 0.042)	(0.696, 0.204, 0.027)
X_4	(0.615, 0.098, 0.040)	(0.485, 0.085, 0.047)	(0.545, 0.183, 0.043)

Then after using step5, we get the end result of cloud:(0.729, 0.01, 0.001)

According to the five levels: very important, more important, important, general, not important, the end result of cloud(0.719, 0.039, 0.013), whose expectation "Ex" is 0.719, is close to the $Cloud_2(0.691, 0.064, 0.008)$, as the two cloud graphics are basic coincidence in the image display. So this third-Party logistics company is rating "good" by step3.

V. Results Analysis

In the evaluation process, we found that En reflects the discrete nature of expert scoring. As the lowest cloud of X_1 whose En is 0.65, while the same of X_3 is 0.11, it reflects the differences of understanding on product and ability, showing a different attitude of experts on: the ability to cooperate and the product. The product factor is basically approved, and most experts disagree with the ability to cooperate. So the company needs strengthening its co-capacity. By comparison of En, we can find the comparison relationship between the various elements. The bigger En is, the more it needs to be improved.

Among these four major indicators, X_1 is more important than X_2 and X_3, while X_4 is the least one. Therefore, in the formation process of the father cloud, the number of characteristics of the father clouds is nearer to the X_2 and X_3. Because the cloud model is a generalization of fuzzy cloud droplets, the digital features of the father cloud willl be prone to thoes son clouds which have more cloud droplets and are more obvious in data. In the result estimating process, we can analyze most level of the indicators to determine the final classification of the aggregation tendency of the cloud, and to approve the final cloud image.

Using the cloud model for business evaluation, the most prominent advantage is to avoid the inconsistencies understanding of multi-criteria scoring. In the real life, different people have different understanding on the measure of "good". Therefore, the quantitative level of the cloud model makes the end result convincing.

. Implications and Conclusion

It can be seen from the above analysis that it is feasible to evaluate third-party logistics enterprises by synthetic Cloud Model. Using expert scoring method in the evaluation of bilateral constraints, between these maximum and minimum scores, has retained the ambiguity of the information, and avoids the interference of human factor and the loss of information. The results fully retain the people's tendencies to the evaluation objects.

Cloud model offers a new perspective in the partner selection. It no longer concerns with error analysis, because the cloud model is a fuzzy model, and all the valuable information contained in the operations is involved in the process of calculation. The integrity of information is its great advantage. In addition, it does not require complex computations in the actual operation, or even the results can be obtained easily by hand-counted, which can reduce the using cost of first-line manager.

The application of the cloud model to the field of partner selection on economic management expands the applications of artificial intelligence theory and reflects the supporting role of the engineering science for the other sciences once again. Although the cloud model is only at the early research stage, the cloud model can solve more and more problems, as the research goes on. We can get the final evaluation order among many customers by comparing the value of Ex, or we can get the public satisfaction in business to help improve the corporate image in the comparison of En, and so on.

As the cloud model resolutes the problem of third party logistics partner selection successfully and avoids the drawbacks of existing methods, the prospect of cloud model in the fields of logistics, economics and management are broad and hopeful.

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A MULTI-OBJECTIVE APPROACH TO MODELING COST-EFFECTIVE, RELIABLE AND ROBUST EMERGENCY LOGISTICS NETWORKS

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ABSTRACT

This paper considers a design problem of emergency logistics network (ELN), which consists of finding the optimal emergency response facility (ERF) location and transportation/distribution scheme. We extend a cost‐based model to include such a risk of facility disruptions and adopt a multi‐objective decision analysis to allow use of trade‐offs between cost and risk. We present formulations for the strategic design of ELN to simultaneously determine the locations of ERF, to assign the possible disaster area to ERF to optimize the cost and risk objectives. Based on the results, we show how to identify the most robust ERF locations and transportation plans.

Keywords: Emergency Logistics Network, Response Facility Location, Multi-Objective Decision

INTRODUCTION

Preliminaries

A emergency logistics network (ELN) design has become an important strategic decision, due to the major damage inflicted by several weather‐related events, such as Hurricane Katrina in 2005 which was the costliest disaster and was one of the five deadliest hurricanes in the history of the United States. In 2012 alone, Hurricane Issac's slow, rainy march through Louisiana caused as much as $2.0 billion in insured losses, leaving extensive flood and wind damage in several states. Issac left more than 644,000 without power in Louisiana, Mississippi, Alabama and Arkansas. The weather‐related emergencies have brought issues of natural disaster planning again. Indeed, after emergencies, it is critical through emergency response facilities (ERFs) to distribute emergency supplies to the affected areas in a timely and efficient manner for rapid recovery. The distribution of emergency supplies from the emergency response facilities to the affected areas must be done via a transportation network that we call an emergency logistics network (ELN). The emergency response facilities considered in this paper include (i) distribution warehouses (*DWHs*), where emergency relief goods are stored, (ii) intermediate response facilities termed Commodity Distribution Point (*CDP*) or Break of Bulk (*BOB*) point, where people can more effectively gain access to relief goods, and (iii) neighborhood locations in need of relief goods.

This research is built upon the work done by Horner and Downs [3], Shukla *et al*. [4], and Hong *et al*. [2], and is also motivated by the recent trend in facility location studies to consider risks caused by critical infrastructure disruptions. ELN design problem can be divided into two levels: strategic and operational. The primary objective of the strategic level is to determine the most cost&effective location of *DWHs* and *CDPs*, distribution of emergency supplies throughout the ELN, and assignment of neighborhood location to *CDPs* and *CDPs* to *DWHs*. In fact, determining these is a critical area in the design of an effective ELN. However, traditional cost& based facility location models, such as set&covering models, *p*&center models, *p*&median models, and fixed charge facility location problems (Daskin, [1]), implicitly assume that located facilities will always be in service or be available and do not consider the impact of disasters on the facilities. In fact, in the case of emergency, some of these facilities may be damaged or completed destroyed and, as a result, cannot provide the expected services. In other words, the ELN is susceptible to risk of the emergencies. For such a case, other facilities instead of the initially assigned facilities will have to satisfy the demands of the affected areas. This obviously will increase the distribution cost and transportation time in supplying relief goods to the affected areas. Thus, there is a definite need to consider not only the logistics costs, but also a risk of network disruptions. Thus, ERN is less likely to be disrupted and still perform well in the case of disruption at the operation level. In this paper, using a multi&objective approach, we seek to integrate strategic and operational planning for an ELN design, subject to network disruptions caused by emergencies. We evaluate trade&offs between these two design levels and analyze such trade&offs.

Development of Multi-Objective Optimization Model

Let *M* be the set of all neighborhoods and potential distribution warehouse (*DWH*) locations, indexed by *m*. We separate *M* into two sets: *M={N, I}*, where *I* denotes the set of potential *DWH* locations (indexed by *i =1, 2, …,w*) and *N* represents the set of neighborhoods (indexed by *n =1, 2, …, p*). In this research, we assume *CDPs* can be located at any neighborhoods and potential *DWH* locations, while *DWH* can be built at candidate *DWH* locations only, since *DWH* locations must satisfy realistic requirements. Based on these two assumptions, let *J* be the set of potential *CDP* locations indexed by *j ∈ {M}*, where *j = 1, 2, ...p, p+1, p+2, ...p+i, ...p+w*. Given this problem setting, we formulate the following integer quadratic programming (IQP) model that minimizes the total logistics cost (TLC), which is the sum of fixed facility costs and the transportation costs from *DWHs* to *CDPs*, between *CDPs* and neighborhoods (including candidate *DWH* locations that are not selected), and from *DWHs* to neighborhoods directly and call it the **Economical Facility Location (EFL)** model:

$$Minimize\ TLC = \left[\sum_{i \in I} a_i W_i + \sum_{i \in I} \sum_{j \in M} \left(\sum_{m \in M} D_m y_{jm} \right) d_{ij} x_{ij} \right]$$

$$+ \left[\sum_{j \in M} b_j B_j + \sum_{j \in M} \sum_{m \in M} D_m d_{jm} y_{jm} \right] + \left[\sum_{i \in I} \sum_{m \in M} D_m d_{im} x_{im}^d \right] \quad (1)$$

subject to

$$\sum_{i \in I} W_i \le D_W, \tag{2}$$

$$W_i + B_{p+i} \le 1, \qquad \forall i \in I \tag{3}$$

$$W_i + \sum_{j \in M} y_{j(p+i)} + \sum_{g \in I} x^d_{g(p+i)} = 1, \quad \forall i \in I \tag{4}$$

$$\sum_{j \in M} y_{jn} + \sum_{i \in I} x^d_{in} = 1, \qquad \forall n \in N \tag{5}$$

$$W_i\, k_i \le \sum_{j \in M} x_{ij} \le W_i K_i, \quad \forall i \in I \tag{6}$$

$$\sum_{i \in I} x_{ij} = B_j, \qquad \forall j \in M \tag{7}$$

$$\sum_{j \in M} B_j \le D_B, \tag{8}$$

$$y_{jm} \le B_j, \qquad \forall j \text{ and } \forall m \in M \tag{9}$$

$$B_j \cdot L_j \le \sum_{m \in M} y_{jm} \le B_j \cdot U_j, \qquad \forall j \in M \tag{10}$$

$$\sum_{m \in M} D_m y_{jm} \le B_j D^{max}_j, \qquad \forall j \in M \tag{11}$$

$$\sum_{j \in M} \sum_{m \in M} D_m y_{jm} x_{ij} + D_i W_i + \sum_{m \in M} D_m x^d_{im} \le W_i D^{max}_i, \qquad \forall i \in I \tag{12}$$

$$Max\{0,\, x_{ij} + y_{jm} - 1\} \le z_{ijm} \le \frac{x_{ij} + y_{jm}}{2}, \qquad i \in I \text{ and } \forall j, \forall m \in M \tag{13}$$

where,

a_i − *Fixed cost for contructing and operating DWH i;*
b_j − *Fixed cost for contructing and operating CDP j;*
B_j − *1 if neighborhood j is selected as a CDP, 0 otherwise (decision variable);*
d_{ij} − *Distance between DWH i and CDP j;*
d_{im} − *Distance between DWH i and location m;*
d_{jm} − *Distance between CDP j and location m;*
D_B − *Maximum number of CDPs can be built (set to 5);*
D^{max}_i − *Capacity of DWH i (2,500 for each DWH in this study);*
D^{max}_j − *Capaciy of CDP j (1,000 for each CDP in this study);*
D_m − *Demand of location (can be either neighborhood or DWH) m;*
D_W − *Maximum number of DWHs can be built (set to 3 in this study);*

H_i − *Maximum number of locations DWH i can directly handle (up to* 3);
k_i − *Minimum number of CDPs a DWH must handle (set to* 1 *in this study*);
K_i − *Maximum number of CDPs a DWH can handle (set to* 5 *in this study*);
L_j − *Minimum number of neighborhoods a CDP needs to cover (set to* 2);
U_j − *Maximum number of neighborhoods a CDP can cover (set to* 6);
W_i − 1 *if a candidate warehouse i is selected,* 0 *otherwise (decision variable)*;
x_{ij} − 1 *if CDP j is covered by DWH i,* 0 *otherwise (decision variable)*;
x_{im}^d − 1 *if location m is covered by DWH i,* 0 *otherwise (decision variable)*;
y_{jm} − 1 *if location m is covered by CDP j,* 0 *otherwise (decision variable).*
z_{ijm} − 1 *if location m is covered by DWH i through BOB j,* 0 *otherwise (decision variable.)*

Now, to design a reliable ELN, it will be important to locate ERFs at minimally risked areas, so that the number of relief items lost due to facility shutdown caused by the emergency is minimized. We define the expected number of the disrupted relief item as the Expected Disrupted Item (*EDI*). If a risk probability (i.e. the probability that a facility is shut down) for each facility is known, The *EDI* can be given by

$$EDI = \left\{ \sum_{j \in M} \left[\sum_{m \in M} (y_{jm} D_m) - \sum_{i \in I} p(i) \left(\sum_{m \in M} z_{ijm} D_m \right) \right] q(j) + \sum_{i \in I} \left[p(i) \left(\sum_{j \in M} \sum_{m \in M} z_{ijm} D_m + D_i W_i \right) \right] \right\}, \qquad (14)$$

where

$p(i)$ − *probability that the DWH i is shut down (or risk probability)*;
$q(j)$ − *probability that the BOB j is shut down (or risk probability).*

Minimizing EDI in (14) with the same constraints given by Equations (2)&13) is called the **Reliable Facility Location (RFL)** model. Now, we propose two kinds of **multi-objective facility location (MOFL)** models, which simultaneously consider the objective functions for EFL and RFL models. The first MOFL, which minimizes the maximum deviation from the deviation and can be stated as follows:

$$\text{Minimize } Q \qquad (15)$$

subject to

Equations (2) - (13)

$$\alpha \frac{(TLC \text{ in } (1) - TLC_{min})}{TLC_{min}} \leq Q, \qquad (16)$$

$$(1 - \alpha) \frac{(EDI \text{ in } (14) - EDI_{min})}{EDI_{min}} \leq Q, \qquad (17)$$

where TLC_{min} *and* EDI_{min} denote the minimum TLC and the minimum EDI found by solving EFL and RFL model, respectively, and α is a weight factor ranging from 0 and 1. We call the

above model as **MOFL-Q**. Note that when α = 1, MOFL&Q model is equivalent to EFL, whereas it becomes RFL model for α = 0. Equations (16) and (17) are the constraints that indicate that the weighted percentage deviation (WPD) from the minimum TLC and EDI must be less than or equal to Q. Thus, as the MOFL&Q model minimizes Q, but may not minimize the weighted total percentage deviations, which is defined as

$$W(\alpha) = \alpha \frac{(TLC \ in \ (1) - TLC_{min})}{TLC_{min}} + (1 - \alpha) \frac{(EDI \ in \ (14) - EDI_{min})}{EDI_{min}}. \tag{18}$$

Setting up (18) as an objective function, the second MOFL model, we call **MOFL-W**, is stated as follows:

$$Minimize \ W(\alpha) \ in \ Equation \ (18) \tag{19}$$

subject to

Equations (2) - (13).

CASE STUDY AND OBSERVATIONS

To demonstrate the applicability of the mathematical models and the framework presented, we conduct a case study using major disaster declaration records in South Carolina. Forty six counties are clustered based on proximity and populations into twenty counties. Then, we choose one city from each clustered county based on a centroid approach and assume that all population within the clustered county exists at that city. The distance between these cities is considered to be the distance between counties. Table 1 shows all twenty cities, associated counties represented by those cities, and population in thousands. The last column lists the risk probability which is interpreted as the shutdown probability of an emergency facility if it is located at the corresponding city, when a major disaster occurs.

When a man&made or natural major disaster occurs, the President determines the need of providing supplemental federal aid. Based on it, there are major relief and recovery activities conducted for the affected areas where a major disaster is declared. According to FEMA database (FEMA, 2012), South Carolina (SC) has experienced fifteen major natural disaster declarations from 1964 to 2011. The database also provides a list of counties where a major disaster was declared. We assume that when a major disaster is declared, the emergency facility in that county is damaged and shut down. Based on the historical record and the assumption, the risk probability for each neighborhood (a county or a clustered county) is calculated in Table 1. For example, a facility in Charleston will be shut down with a 33.3% chance when a major disaster occurs. The table also lists the potential five locations for *DWHs*, Aiken, Charleston, Columbia, Florence, and Greenville, in the last five rows starting from the 16th row.

Since the main purpose of this paper is to demonstrate how the proposed model works, we simplify the objective function given by Equation (1) by excluding the fixed cost terms for *CDPs* and for *DWHs*. Also, the numbers of *CDPs* and *DWHs* to be built are pre&specified. For real& world applications, once the real data are available, such restrictions can be readily relaxed to generate meaningful results. Thus, the following parameters are predetermined for case studies. The maximum numbers of *CDPs* and *DWHs* that can be built, D_B and D_W, are set to 5 and 3, respectively. The minimum and maximum number of *CDPs* that a *DWH* must handle, k_i and

K_i, are set to 1 and 10, respectively. Each *CDP* must handle at least 2 neighborhoods ($L_j = 2$) and at most 6 ($U_j = 6$). For simplicity, we set $H_i = 0, \forall i$ and assume that no more than one warehouse is simultaneously shut down. The capacity of a *CDP* and a *DWH* is set to 1,000 K and 2,500 K in terms of the quantity of relief items.

Using CPLEX for Excel Add-in and Excel Solver, we solve the two MOFL models for α =0, 0.1, 0.2, …1, and present the results of facility locations and distribution scheme in Tables 2(a) and 2(b). The resulting emergency logistics network for EFL model (α = 1) is displayed in Figure 2, which shows the selected *DWH* locations, *CDP* locations, and distribution schemes between *DWHs* and *CDPs* and between *CDPs* to neighborhoods. From Tables 2(a) and 2(b), we observe that TLC decreases and EFI increases as α increases, regardless of the model. We also observe that MOFL&W model produces smaller TLCs than MOFL&Q, whereas MOFL&Q model yields smaller EDIs for α = 0.4, 0.5, …, 0.9, and vice versa, for α = 0.1, 0.2, and 0.3. Notice that RFL (α = 0) and EFL models (α = 1) yield the minimum EDI and TLC, respectively, and that only two DWHs are selected for RFL model.

To show how robust the MOFL models are, two scenarios are considered. The first scenario assumes that all selected *DWHs* remain available after disastrous events, whereas the second one considers the shutdown/unavailability of a *DWH*. Hereinafter, these scenarios are referred to as normal and shutdown scenarios, respectively. We select each of *DWHs* to be unavailable after disaster, evaluate the two models, and present the results also in Tables 3(a) and 3(b) under the shutdown scenario. We exclude RFL model (α = 0) for the shutdown scenario, since the shortage of relief items will occur if one of the two selected *DWHs* is unavailable under shutdown scenario. To compare TLCs of EFL (α = 1) with those of MOFL models under the shutdown scenario for α = 0.1, 0.2, …, 0.9, we highlight TLCs with light gray color if the TCL of MOFL models is less than or equal to that of EFL. We observe that MOFL&W seems to be more robust than MOFL-Q model, since under the shutdown scenario MOFL&W model yields smaller TCLs for ten cases, whereas MOFL&Q yields for seven cases. As said before, MOFL models yield more reliable results but turn out to be less robust in terms of TLC, as α decreases. Thus, from Tables 2(a), 2(b), 3(a), and 3(b), we see that MOFL&W model with α = 0.6 might be the best ELN in terms of average ($319,747), standard deviation ($23,774), and range ($45,752) of TLCs are less than those of EFL model under shutdown scenario, whereas TLC of the model with α = 0.6 under normal scenario, $198,923, is slightly higher than TLC of EFL, $196,274.

SUMMARY AND CONCLUSIONS

In this paper, we consider an emergency logistics network (ELN) design problem, where the logistics cost, reliability, and robustness are major performance measures. We develop two multi-objective facility location (MOFL) models, MOFL&Q and MOFL&W, taking those performance measures into consideration simultaneously. We formulate the MOFL problem as a mixed integer linear programming model and solve it using CPLEX for Microsoft Excel Add-in and Excel Solver Platform. Case studies are conducted to demonstrate the developed models' capability to deal with uncertainties in ELN. From the numerical results, we observe that the developed models perform well and these models can help federal and local emergency response officials develop efficient and robust disaster relief plans.

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Table 1. Data for Locations

No	City	County	Population (K)	Probability
1	Anderson	Anderson/Oconee/Pickens	373	0.133
2	Beaufort	Beaufort/Jasper	187	0.067
3	Bennettsville	Marlboro/Darlington	96	0.367
4	Conway	Horry	269	0.467
5	Georgetown	Georgetown/Williamsburg	93	0.433
6	Greenwood	Greenwood/Abbeville	92	0.100
7	Hampton	Hampton/Allendale	33	0.100
8	Lexington	Lexington/Newberry/Saluda	318	0.222
9	McCormick	McCormick/Edgefield	35	0.167
10	Moncks Corner	Berkeley	178	0.333
11	Orangeburg	Orangeburg/Bamberg/Calhoun	123	0.289
12	Rock Hill	York/Chester/Lancaster	321	0.289
13	Spartanburg	Spartanburg/Cherokee/Union	367	0.333
14	Sumter	Sumter/Clarendon/Lee	157	0.378
15	Walterboro	Colleton/Dorchester	135	0.200
16	Aiken*	Aiken/Barnwell	184	0.200
17	Charleston*	Charleston	350	0.333
18	Columbia*	Richland/Fairfield/Kershaw	461	0.356
19	Florence*	Florence/Dillon/Marion	203	0.400
20	Greenville*	Greenville/Laurens	521	0.200

*potential locations for *DWH*

Table 2(a). Numerical Results for MOFLQ Model

α	0(RFL)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1(EFL)
TLC	$818,389	$376,494	$351,256	$300,884	$285,021	$264,642	$248,744	$237,005	$219,944	$205,995	$196,274
EDI	1,197.015	1,354.798	1,469.335	1,513.768	1,551.372	1,624.770	1,673.978	1,789.911	1,794.388	1,837.562	1,945.856
Q*	0.00	0.09	0.15	0.16	0.18	0.17	0.16	0.15	0.10	0.05	0.00
WPD(TLC)	0.00%	8.90%	15.28%	15.99%	18.09%	17.42%	16.04%	14.53%	9.65%	4.46%	0.00%
WPD(EDI)	0.00%	8.79%	15.24%	18.52%	17.76%	17.87%	15.94%	14.86%	9.98%	5.35%	0.00%
W(α)	0.00%	17.69%	30.51%	34.51%	35.85%	35.28%	31.98%	29.39%	19.63%	9.81%	0.00%
Anderson	1	1	1	1	1	1	1	1	1	1	1
Beaufort	1	1	0	0	0	0	1	1	1	1	0
Bennettsville	0	0	0	0	0	0	0	0	0	0	0
Conway	0	0	0	0	0	0	0	0	0	0	0
Georgetown	0	0	0	0	0	0	0	0	0	0	0
Greenwood	1	1	1	1	1	0	1	0	0	0	0
Hampton	1	1	1	1	1	1	0	0	0	0	0
Lexington	0	1	1	1	1	1	1	1	1	1	1
McCormick	0	0	0	0	0	0	0	0	0	0	0
Moncks Corner	0	0	0	1	1	1	1	1	1	1	1
Orangeburg	0	0	0	0	0	0	0	0	0	0	0
Rock Hill	0	0	0	0	1	0	0	0	0	0	0
Spartanburg	0	0	0	0	0	1	0	0	1	1	1
Sumter	0	0	0	0	0	0	0	0	0	0	1
Walterboro	0	0	1	0	0	0	0	1	0	0	0
Aiken	1	1	1	1	1	1	0	0	0	0	0
Charleston	0	1	1	1	1	1	1	1	1	1	1
Columbia	0	0	0	0	0	0	1	1	1	1	1
Florence	0	0	0	0	0	0	0	0	0	0	0
Greenville	1	1	1	1	1	1	1	1	1	1	1

Table 2(b). Numerical Results for MOFLA&W Model

α	0(RFL)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1(EFL)
TLC	$818,389	$482,057	$384,229	$308,940	$208,995	$199,806	$198,923	$198,923	$198,923	$196,360	$196,274
EDI	1,197.015	1,234.048	1,322.276	1,474.525	1,837.562	1,867.522	1,875.062	1,875.062	1,875.062	1,939.116	1,945.856
WPD(TLC)	0.00%	14.56%	19.15%	17.22%	1.98%	0.90%	0.81%	0.94%	1.08%	0.04%	0.00%
WPD(EDI)	0.00%	2.78%	8.37%	16.23%	32.11%	28.01%	22.66%	16.99%	11.33%	6.20%	0.00%
W(α)	0.00%	17.34%	27.52%	33.45%	34.09%	28.91%	23.47%	17.94%	12.41%	6.24%	0.00%
Anderson	1	1	1	1	1	1	1	1	1	1	1
Beaufort	1	1	1	0	1	1	0	0	0	0	0
Bennettsville	0	0	0	0	0	0	0	0	0	0	0
Conway	0	0	0	0	0	0	0	0	0	0	0
Georgetown	0	0	0	0	0	0	0	0	0	0	0
Greenwood	1	1	1	1	0	0	0	0	0	0	0
Hampton	1	1	1	1	0	0	0	0	0	0	0
Lexington	0	0	1	1	1	1	1	1	1	1	1
McCormick	0	0	0	0	0	0	0	0	0	0	0
Moncks Corner	0	0	0	1	1	1	1	1	1	1	1
Orangeburg	0	0	0	0	0	0	0	0	0	0	0
Rock Hill	0	0	0	0	0	0	0	0	0	0	0
Spartanburg	0	0	0	0	1	1	1	1	1	1	1
Sumter	0	0	0	0	0	0	0	0	0	1	1
Walterboro	0	1	0	0	0	0	1	1	1	0	0
Aiken	1	1	1	1	0	0	0	0	0	0	0
Charleston	0	1	1	1	1	1	1	1	1	1	1
Columbia	0	0	0	0	1	1	1	1	1	1	1
Florence	0	0	0	0	0	0	0	0	0	0	0
Greenville	1	1	1	1	1	1	1	1	1	1	1

Table 3(a). Comparison Between Normal and Shutdown Scenarios for MOFL&Q Model

α	0(RFL)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1(EFL)
DWH 1	Aiken	Aiken	Aiken	Aiken	Aiken	Aiken	Charleston	Charleston	Charleston	Charleston	Charleston
DWH 2	Greenville	Charleston	Charleston	Charleston	Charleston	Charleston	Columbia	Columbia	Columbia	Columbia	Columbia
DWH 3	—	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville
TLC	$818,389	$376,494	$351,256	$300,884	$285,021	$264,642	$248,744	$237,005	$219,944	$205,995	$196,274
Overall Average						$276,665					
Overall STD						$57,981					
Shutdown Scenario					Total Logistics Cost for Shutdown Scenario						
DWH 1 Shutdown		$429,836	$401,161	$401,161	$378,273	$360,602	$348,715	$344,590	$317,950	$317,950	$293,235
DWH 2 Shutdown		$456,248	$356,389	$356,389	$346,055	$319,961	$360,989	$337,036	$324,979	$324,979	$337,841
DWH 3 Shutdown		$500,290	$405,829	$405,829	$438,419	$421,712	$385,678	$361,307	$370,731	$370,731	$380,348
Average		$462,125	$387,793	$387,793	$387,582	$367,425	$365,127	$347,644	$337,886	$337,886	$337,141
STD		$35,593	$27,297	$27,297	$46,880	$51,218	$18,826	$12,421	$28,660	$28,660	$43,561
Range		$70,455	$49,440	$49,440	$92,364	$101,751	$36,963	$24,271	$52,781	$52,781	$87,114
Overall Average						$371,840					
Overall STD						$46,408					

Table 3(b). Comparison Between Normal and Shutdown Scenarios for MOFL&W Model

α	0(RFL)	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1(EFL)
DWH 1	Aiken	Aiken	Aiken	Aiken	Charleston	Charleston	Charleston	Charleston	Charleston	Charleston	Charleston
DWH 2	Greenville	Charleston	Charleston	Charleston	Columbia	Columbia	Columbia	Columbia	Columbia	Columbia	Columbia
DWH 3	–	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville	Greenville
TLC	$818,389	$482,057	$384,229	$308,940	$208,995	$199,806	$198,923	$198,923	$198,923	$196,360	$196,274
Overall Average						$264,128					
Overall STD						$105,149					
Shutdown Scenario					Total Logistics Cost for Shutdown Scenario						
DWH 1 Shutdown		$423,570	$456,248	$356,389	$317,950	$317,950	$312,273	$312,273	$312,273	$293,235	$293,235
DWH 2 Shutdown		$485,360	$429,836	$401,161	$324,979	$324,979	$300,608	$300,608	$330,608	$337,841	$337,841
DWH 3 Shutdown		$524,298	$500,290	$405,829	$370,731	$370,731	$346,360	$346,360	$346,360	$380,348	$380,348
Average		$477,743	$462,125	$387,793	$337,886	$337,886	$319,747	$319,747	$329,747	$337,141	$337,141
STD		$50,794	$35,593	$27,297	$28,660	$28,660	$23,774	$23,774	$17,060	$43,561	$43,561
Range		$100,728	$70,455	$49,440	$52,781	$52,781	$45,752	$45,752	$34,087	$87,114	$87,114
Overall Average						$364,696					
Overall STD						$63,238					

The Cost, Energy Analysis, and Sustainability of Wood Pellet Heating Systems

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ABSTRACT

The installation of a wood pellet boiler in the newly renovated Renewable Energy Laboratory marked the completion of a full suite of alternative energy learning and research systems. The wood pellet boiler, together with a calorimeter, was integrated into a working laboratory. The two new additions to the existing laboratory allowed teaching and research on bioenergy systems to proceed in tandem with teaching and research on solar, wind and geothermal energy systems. As far as we know, this wood pellet boiler system is the first to be directly installed in a teaching and research laboratory in the northeastern United States. The system, a Heatilator Eco Choice Bio-Flow 60 Pellet Boiler, has been outfitted with ports for emission testing and Btu meters for efficiency testing. The C 2000 calorimeter was used for determining gross calorific values of liquid, solid and biomass samples including wood pellets, saw dust, hay, corn and biofuels. The calorimeter was used to measure the heat created by a sample under controlled conditions. The consequent measurement result yielded important quality, physiological, physical and chemical findings, as well as financial conclusions about the samples. The system has been fully operational for over a year, and Mechanical Engineering faculty, support staff and students have been trained in its operation. Moreover, a Handheld Gas Analyzer has been utilized to measure CO, HC, and CO_2 levels, while an industry standard electro-chemical sensor evaluated O_2 levels. The wood pellet market has experienced a high rate of growth in recent years, driven by concerns about climate change and renewable energy targets. Through our innovative program, we have taken the initiative to teach students the dynamics of wood pellet supply chains from the purchase of the raw material to its conversion into heat or electricity. In that context, cost structures, primary energy inputs and mitigation of greenhouse gas emissions are also explored and taught.

Sustainable Energy Demand Using TEMPES For Low Heat Industry Rejected Energy

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Abstract – TEMPES is a highly efficient Engine with Metastable Power Extraction Step for low temperature heat recovery. In this paper we present the impact of TEMPS on reduction of energy use in industry.

This groundbreaking, innovative and highly efficient Thermal Engine with Metastable Power Extraction Step recovers low to medium industrial waste. TEMPES is a closed cylinder 2-cycle engine which is designed to illustrate energy recovery from low grade industrial wasted heat. The basic operating principle of the TEMPES engine is a closed cylinder piston assembly that converts heat energy in a working fluid to mechanical energy using innovative chemical processes to extract greater than 50% more energy from a thermal energy source relative to traditional heat engines restricted to bulk thermodynamic equilibrium processes.

With continuous global population growth that leads to a continuous increase in energy demand it is of utmost importance to streamline global energy use to create a balanced and sustainable energy system.
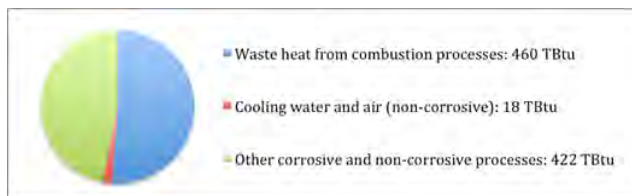

Figure 1. Wasted Heat Energy

The significantly improved conversion efficiency of the TEMPES engine enables cost effective conversion of low-temperature heat to electric power generation. Consequently, the target application for the proposed development effort is recovery of low-grade waste heat energy, 230°C and lower, for the purpose of standardized electric power generation. As shown in Figure 1, this low-grade waste heat represents an excess of 900 trillion BTUs annually.

The TEMPES technology can be the core of a scalable electricity generation system using low-grade waste heat as fuel. The approach is a significant departure from both the Organic Rankine cycle (ORC) and Kalina cycle in two important ways. First, the method of conversion from heat energy to work is accomplished via formation of metastable non-equilibrium states in portions of the thermodynamic cycle. The improved performance is so great for a low quality heat source, greater than 50% relative improvement, such that any development effort can focus on significant trades and practical design considerations of an operational system with large economics of scale and scope. No other known conversion process has such near-term potential for low quality heat sources.

WILLINGNESS TO PAY FOR SUSTAINABLY PRODUCED FOODS: AN ECONOMIC APPLICATION IN EXPERIMENTAL AUCTIONS

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ABSTRACT

This paper presents the results of an experimental auction conducted to examine the influence of sustainable, organic, and local production labels on food choice and in particular to estimate consumer willingness to pay for sustainably produced apples and steak. An economic analysis is employed to achieve this goal. The findings suggest a preference ordering such that Organic > Sustainable > Local. Additionally, this work supports other findings in the literature of positive price premiums on these credence attributes. Potential for differentiation through marketing is discussed.

Economic Analysis, Consumer Behavior, Experimental Auctions, Sustainability

INTRODUCTION

A current trend in the US food system toward organic, sustainable, or local foods has created a wealth of recent literature on the valuation of such credence attributes. Of these trends, sales in the organic food sector have grown the fastest, encouraged by the strength of its broad promotion and marketing. Most of the industry's growth has occurred in the years since the establishment of the USDA's National Organic Program, in 2002, creating a system of standards for certifying and labeling organic products. However, unlike USDA-certified organic products, foods designated as sustainably produced carry no government-endorsed certification and bear no standardized label. The USDA National Institute of Food and Agriculture provides limited information on the purported sustainability of different agricultural practices and warns that, "guidelines about what specific practices meet long-term environmental, economic, and social goals and constitute sustainable agriculture is still under debate".

"Economic sustainability" is a term used to identify strategies for using available resources in a way that promotes efficiency and responsibility, with a goal of providing long-run benefits. Many interpret this to mean that a sustainable system supports and sustains local economies by investing in community businesses, including but not limited to, agriculture. Local foods have become more available following a dramatic increase in demand and succeeding a significant expansion of farmers markets across the country. The term "local" remains undefined, with individual interpretations abound. However, interest in locally grown foods continues to rise, matched, in response, by the inception of many state-sponsored marketing campaigns. Understanding these growing trends and how they interact is therefore worthy of further examination.

If sustainable agricultural systems possess similar environmental management practices as organic and support local farms and the communities they feed, can the consumer differentiate between these competing claims? Comprehending consumer attitudes towards and preferences between these three trends, as well as determining WTP for these production attributes is of importance to producers and marketers in determining the effectiveness of their labeling schemes and marketing programs.

The primary goal of this research is to determine consumer preferences and WTP for foods labeled as sustainably produced when offered alongside their local and organic counterparts. In the extension of this work, the goal of this paper is complemented by three additional objectives: (1) determine if and how consumer WTP is impacted by information on sustainability from different sources, (2) use a combination of hypothetical and non-hypothetical choice data to simulate market demand for this attribute, and (3) develop a set of recommendations designed to guide industry-specific producers in the development and implementation of a local marketing plan.

To accomplish these objectives, data gathered from a series of experimental auctions held in the fall of 2010 will be utilized in several economic models of choice. The data obtained in experimental auction procedures is believed to be more representative of actual behavior as demand-revealing, non-hypothetical methods are used. The experimental auction participants form a subset of respondents to a nation-wide survey with a hypothetical choice experiment component. Collectively, the use of experimental auctions augmenting hypothetical choice experiment data yield a more detailed and reliable understanding of consumer behavior. The use of multiple sources of data will allow for a more robust understanding of how consumers define and value the "sustainably produced" label.

LITERATURE REVIEW

Sustainability

Food produced using sustainable production practices is receiving increasing attention both in public and private arenas as a greater number of food products are being marketed and labeled using sustainable certification schemes for the purposes of differentiation. However, investigation into the valuation of consumer-desired attributes of food system sustainability do not have a proportional representation in the literature. Notably, Clonan et al [5] created a framework for evaluating consumer priorities with regard to sustainable foods based on seven guiding sustainability principles. Utilizing a five point Likert scale, embedded in a structured questionnaire, the authors explore attitudes towards sustainable components such as fair trade, organic, local, and animal welfare, finding that consumers responded positively towards environmental responsibility metrics related to food production. Similarly, Saunders et al [20] focus on the results of a Likert scale rating of sustainability attributes, in the context of carbon emissions and other contributions to global climate change.

Three studies, to the author's knowledge, address consumer driven changes in food marketing channels as related to sustainable food claims. First, Onozaka et al [17] find evidence, from a conjoint choice experiment, of significant heterogeneity in valuing various food differentiation

claims among shoppers in different marketing venues. This study notes that consumers' belief in their role in improving sustainability tends to raise the value of sustainable product claims. Additionally, Onozaka and McFadden [18] explore the interactive effect of different sustainable production claims, finding that locally grown differentiation is most highly valued since consumer preferences for local food have been found to go beyond basic quality characteristics and are significantly related to economic sustainability. Closely related, Onken, Bernard and Pesek [16] conducted a choice experiment to determine WTP for organic, locally grown, and natural food labels across different purchasing venues. The authors note significant differences in preference ordering across a number of Mid-Atlantic states.

Experimental Auctions

A growing literature exists on the design, implementation and evaluation of experimental auctions with agricultural or food related applications. Due to the advantage of experimental auction methods in isolating the effect of information provision, it has become an increasingly popular avenue for investigating the impact of labeling schemes on consumer WTP for food products. Applications of experimental auction procedures, used to evaluate information provision or labels, range most recently across health and nutritional information [9] [10], country of origin labeling [4], traceability and food safety [11] [15], genetic modification and biotechnology [6] [7] [11] [12], and other quality attributes such as "grass-fed" [8] [21], and "hormone-free" [1].

A small number of known studies have used experimental auctions in the valuation of macro-level food system credence attributes. Rousu and Corrigan [19] utilize experimental auctions to compare several alternative fair trade labels in order to determine the welfare loss from labels that inadequately inform consumers. More recently, Briggeman and Lusk [2] use a model of inequality aversion and altruism paired with experimental auctions to investigate consumer WTP for organic foods and to better understand preferences for fairness and equity in the food system. To the author's knowledge, our study is the first to employ experimental auctions to investigate consumer preferences and WTP for food products labeled with broadly interpreted sustainable production claims.

EXPERIMENTAL AUCTION DESIGN AND IMPLEMENTATION

A series of five experiment sessions, held in October 2010 and attended by a total of seventy-six participants, informs this study. The participants were recruited by the lead author from three different grocery stores in the greater Lansing, Michigan area with the aid of a promotional poster. Grocery stores were targeted for recruitment for the purposes of attracting primary household food shoppers. Demographic statistics on the experiment participants can be found in Table 2 and a copy of the promotional poster image can be found in the Appendix.

All experiment sessions were held in a classroom space at Michigan State University's Pavilion for Agriculture and Livestock Education. At the time of their recruitment, each participant signed up for a specific experiment session by providing a name and phone number. In return, each recruit was given information about the session, including: date, time, compensation, directions to the facility, and a token green MSU pencil to incentivize follow-through. The

recruited participant information sheet can be found in the Appendix. Participants were called one day before the session with a reminder.

Upon arrival at the Pavilion, participants were given a unique ID for anonymity purposes and then were instructed to begin an online survey at one of the mobile laboratory laptops. The survey accompanying the experiment was identical to a nationwide survey, disseminated in the summer of 2010 to roughly one thousand households, eliciting information about perceptions and preferences towards sustainable farming practices and sustainably labeled foods. As each participant completed the online survey, they signed the informed consent and received a copy of the auction instructions. These forms can also be found in the Appendix. Auction instructions were read aloud, including an example bidding strategy from a proposed auction scenario, and then participants were invited to view each of the products that were to be auctioned.

Each experiment session consisted of a series of eight auctions corresponding to the eight food products available; a 1 lb bag of apples labeled as sustainably produced, organic, local, or unlabeled and a 0.5 lb rib-eye steak labeled as sustainably produced, organic, local, or unlabeled. The order of the auctions was randomized for each food product in every session. All products were roughly identical and sourced from the same farm that was certified organic, local to the participant population, and made farm-level claims of sustainable production. However, the products were stripped of their original labeling and given only one of the following labels for presentation to experiment participants: "Sustainable", "Organic", "Local" or "Typical". It should be noted that the new labels for experimental purposes made no false claims, but allowed the researchers to isolate the effect of the "sustainably produced" credence label while controlling for other observed quality attributes such as color, consistency, or size.

This experiment utilized the second-price Vickrey auction with full bidding. This choice of auction mechanism is popular in the literature for its relative performance compared to alternatives. Additionally, this auction is easy to explain to participants and has been shown to adequately measure "on margin" bidding [14]. No reference prices were provided and no bids were revealed as auction rounds progressed. Participants were randomly assigned to a group of 6-8 people, against whom they would be bidding in each auction. The identity of group members was never revealed. Smaller groups were used to retain the incentive compatible nature of the auction, while keeping participants engaged. When the auctions were undertaken, each participant wrote down a WTP bid on a sheet of paper provided to them, labeled with the product auctioned in that round. Bid sheets were collected by one researcher and immediately recorded into an electronic spreadsheet. At the conclusion of all eight auctions, one auction for each food product was randomly selected as binding for purposes of payment.

Each participant was endowed with $25 to bid on the four 0.5 lb rib-eye steaks and $5 to bid on the four 1 lb bags of apples, knowing that only one round, for each product, would require binding payment. Participants were informed that this money was theirs and if they chose not to bid on any product, or did not win the binding auction they would go home with their full endowment. However, if they won the binding auction, they would go home with the product and their endowment less the second highest bid. After the binding auction was announced for each product, participants were called up, one at a time, to receive their endowments less any payments made for products won in the binding auctions, the corresponding food products if

applicable, and a $25 gift card to the grocery store where they were recruited to compensate them for their time. Full disclosure of farm-of-origin information was provided to participants that took home food products.

DATA AND METHODS

Raw Data

In total, 76 participants were recruited from Lansing area grocery stores for the described series of experimental auctions. A summary of demographic statistics can be found in Table 2. In general, the participant population was more female, younger, more frequently white, and had lower household income than the larger survey sample of 1000 households collected earlier in 2010.

Eight participants self-identified as vegetarian and bid $0.00 in all four rounds of steak auctions and therefore were removed from the steak data analysis. Vegetarians made up 13.16 % of this sample population. According to a 2006 study, employed by the Vegetarian Resource Group, in a national poll only 6.7 % of the research population identified as vegetarian or never ate meat, making our sample twice as vegetarian as the purported United States population. It may be hypothesized that the nature of the self-selected participant group may lead vegetarians, or other people with restrictive diets, to be more interested in food related studies. Furthermore, two participants were deemed "unengaged bidders" as a result of a $0.00 bid in all eight auctions and were removed from the sample for analysis. Table 1 summarizes the average bids received for the 74 engaged bidders on apples and the 66 engaged, non-vegetarian bidders on steaks.

TABLE 1. SUMMARY OF AVERAGE BIDS

	Steak(S)	Steak(O)	Steak(L)	Steak(T)	Apple(S)	Apple(O)	Apple(L)	Apple(T)
Mean ($/lb)	7.43	7.68	6.77	4.80	1.54	1.60	1.43	0.91
StDev ($/lb)	4.51	4.61	4.24	3.94	0.87	0.98	0.93	0.67

TABLE 2. DEMOGRAPHIC STATISTICS FOR EXPERIMENT PARTICIPANTS

Variable	Definition	Mean (SD)	Frequency
Gender	1 = Male		37%
	2 = Female		63%
Age	Average age in years	31.43 (12.1)	
Race	White/ Caucasian		84.21 %
	Black/African American		3.95 %
	Asian		3.95 %
	Hispanic/Latino		2.63 %
	Other[*]		5.26 %
Adults	Number of Adults in Household	2.35 (2.40)	
Children	Number of Children in Household	0.41 (0.99)	
Meals	Number of Meals/Week with Product (Out of 21 possible)	3.98 (3.59)	
Shop	% of Total Food Shopping at Location		
	Grocery Store	56.53 (32.1)	
	Health Food Store	7.89 (14.2)	
	Food Co-op	9.07 (18.9)	
	Convenience Store	3.00 (6.0)	
	Farmers Market	16.16 (22.7)	
	Restaurant	5.46 (18.1)	
SNAP	1 = On Food Assistance		11.84 %
	2 = Otherwise		88.16 %
Education	Highest Level Completed		
	1 = Did not graduate high school		3.95 %
	2 = Graduated high school, no college		18.42 %
	3 = Attended college, no degree earned		7.89 %
	4 = Attended college, associates degree		40.79 %
	5 = Attended college, bachelors degree		18.42 %
	6 = Graduate or advanced degree		10.53 %
Income	Range of Pre-tax Income		
	1 = Less than $20,000		51.32 %
	2 = $20,000 - $39,999		14.47 %
	3 = $40,000 - $59,999		14.47 %
	4 = $60,000 - $79,999		11.84 %
	5 = $80,000 - $99,999		1.32 %
	6 = $100,000 - $119,000		3.95 %
	7 = More than $120,000		2.63 %

[*] Six participants wrote in "human".

Statistical Methods

The main focus of the analysis presented here is to identify predictors of bid behavior by estimating several regression models with the auction data. For all regression models the dependent variable is the WTP bid. In keeping with the literature, this work employs a double-censored tobit specification, as bids obtained in the auction are censored on the left by zero and at the right by the endowment; $5 for apples and $25 for steaks. The regression of interest is specified as an unobserved latent variable, y_i^*,

$$y_i^* = x'_i \beta + \varepsilon_i \qquad (1)$$

where $\varepsilon_i \sim N(0, \sigma^2)$ and x_i is the (K X 1) vector of exogenous and fully observed regressors [3]. The observed variable y_i is related to the latent variable y_i^* through the following rule:

$$y_i = \begin{cases} L & if \ y^* \leq L \\ y^* & if \ L < \ y^* < U \\ U & if \ y^* \ \geq U \end{cases} \qquad (2)$$

where [L, U] is the censored interval of observed values. The foregoing analysis uses maximum likelihood estimation under the assumptions that the regression error is homoskedastic and normally distributed. ML estimates of (β, σ^2) solve the first-order conditions from maximization of the log likelihood based on the density function of censored observations. These equations are nonlinear in parameters and therefore the solution uses an iterative algorithm.

A detailed summary of the data on the dependent variables, *applebid* and *steakbid* respectively, provides insight into potential problems with using MLE on the parameters of the tobit model under the strict assumptions of homoskedasticity and normalcy of errors. Examining *applebid* further reveals only moderate skewness of 1.24 and slight kurtosis of -0.14 after appropriate correction. Similar examination of *steakbid* yields a skewness of 1.14 and kurtosis of -0.52. These tests offer encouraging evidence of the consistency of the MLE estimation, as the dependent variable appears to be approximately normal. Therefore, we continue with results of the linear tobit without any transformation of the dependent variable.

RESULTS

The results of the base linear tobit indicate that all dummy variables corresponding to production label are statistically significant and positive. The regression coefficients are consistent with the summary of mean bids, yielding a preference ordering of Organic > Sustainable > Local for both food products. In the apple auction, only age and number of children were statistically significant explanatory variables. Age had a very small, yet positive relationship with bids. Number of children has a slightly larger, negative, relationship with bids. In the steak auction all included demographic variables were statistically significant with the exception of age. Women, generally, bid higher than men, income and education both had moderate positive effects on bids and again the number of children in a household had a negative relationship with auction bids.

TABLE 3. APPLE TOBIT REGRESSION RESULTS

Explanatory Variable	MLE Coefficient	P value
Gender	-0.12	0.30
Age	0.01[*]	0.047
Income	-0.02	0.542
Education	-0.01	0.830
Children	-0.16[**]	0.01
Sustainable Label	0.67[**]	0.00
Organic Label	0.73[**]	0.00
Local Label	0.55[*]	0.01

[*] Statistically significant at the 5 % level
[**] Statistically significant at the 1 % level

TABLE 4. STEAK TOBIT REGRESSION RESULTS

Explanatory Variable	MLE Coefficient	P value
Gender	-2.98[**]	0.00
Age	0.04	0.22
Income	0.46[*]	0.04
Education	0.56[*]	0.03
Children	-1.18[**]	0.00
Sustainable Label	2.58[**]	0.00
Organic Label	2.82[**]	0.00
Local Label	2.07[*]	0.02

[*] Statistically significant at the 5 % level
[**] Statistically significant at the 1 % level

DISCUSSION AND CONCLUSIONS

This paper discusses the results from a series of experimental food auctions, used to examine consumer responses to a variety of production labels on apples and ribeye steaks. Overall, this study found that food labeled as sustainable, organic, or local influenced participant willingness to pay. Specifically, our results yielded a preference ordering on labels as follows: Organic > Sustainable > Local, consistent with the magnitude of the average raw bids. This is an important finding for producers and marketing managers trying to differentiate their products with respect to production practices as related to different sustainability metrics.

Our results suggest that the USDA Organic certification translates a significantly higher value to consumers. While, sustainable production claims may not yield as much purchase value as organic certification, sustainable labels appear to successfully differentiate food products from their conventional or unlabeled alternatives. This work provides evidence that third-party sustainable certification has potential profitability for producers, especially if USDA Organic certification is prohibitively expensive or otherwise intangible. Furthermore, these results suggest that consumers distinguish between locally grown and sustainably grown food products, inferring that the sustainable food label communicates value beyond traditional "economic sustainability" and the support of local economies. Thus, measuring other environmental and social consequences of sustainable production practices may be worth investigating further for their marketing potential.

Finally, our paper supports the findings in the field literature that sustainable, organic, and local food labels produce positive price premiums on food products. However, due to the makeup of our participant population, we do not suggest taking the price premiums estimated here to be representative of the general United States, or Lansing, MI population. Instead, we hope this study has produced insight into the relationship between these three credence-labeling schemes and relative consumer preferences in the market. Additionally, we consider this a contribution to the growing literature on experimental auction applications and methods.

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Consumer Preferences For Sustainably Labeled Meat and Produce

WE INVITE YOU TO PARTICIPATE IN OUR SUSTAINABILITY RESEARCH!

WHAT DO I HAVE TO DO?

1. COMPLETE A SHORT SURVEY.
2. BID ON SUSTAINABLE, ORGANIC, AND LOCAL STEAK AND APPLES.

HOW WILL I BE COMPENSATED?

- **$25 GIFT CARD** TO MEIJER JUST FOR SHOWING UP!
- **$30 IN CASH** TO BID ON STEAK AND APPLES!

  WIN THE AUCTION AND TAKE HOME THE STEAK/APPLES AND ANY REMAINING $$.
  IF YOU DO NOT WIN THE AUCTION, TAKE HOME THE $30 CASH!

WHEN AND WHERE IS THIS?

MSU PAVILLION
4301 Farm Lane
East Lansing, MI 48824

YOU CHOOSE ONE OF THE FOLLOWING TIMES:
TUESDAY NOVEMBER 2, 2010 6:00 – 7:00 PM
MONDAY NOVEMBER 8, 2010 6:00-7:00 PM
TUESDAY NOVEMBER 9, 2010 6:00 – 7:00 PM

Interested?

EMAIL: SACKET14@MSU.EDU

CONSUMER PREFERENCES FOR
SUSTAINABLY LABELED BEEF AND APPLES
INFORMATION PACKET

DATE AND TIME

Thank you for signing up to participate in our research study on
<u>MONDAY NOVEMBER 8, 2010 AT 6:00 PM</u>.

Please arrive at the *Michigan State University Pavilion for Agriculture and Livestock Education* no later than <u>5:45 PM.</u>

MAP AND DIRECTIONS

The *Michigan State University Pavilion for Agriculture and Livestock Education* is located on the corner of Farm Lane and Mt. Hope on the Campus of Michigan State University .

<u>Address</u>
4301 Farm Lane
East Lansing, MI 48824

Directions from points North

Follow US 27 South to US 127 South. Follow US 127 South to Trowbridge Road (exit 106). Follow Trowbridge Road east to Harrison Road (Trowbridge ends at Harrison). Turn south (right) onto Harrison Road. Follow Harrison Road south approximately 1½ miles to its end at Forest Road. Turn east (left) on Forest Road. Follow Forest Road approximately 3/4 mile to the entrance off College Road. Turn left. The Pavilion is on the northeast corner of Forest and College Roads.

Directions from Grand Rapids and points West

Follow I-96 to Business I-496 East (exit 95). Follow I-496 East to Trowbridge Road (exit 106). Follow Trowbridge Road east to Harrison Road (Trowbridge ends at Harrison). Turn south (right) onto Harrison Road. Follow Harrison Road South approximately 1½ miles to it's end at Forest Road. Turn east (left) on Forest Road. Follow Forest Road approximately 3/4 mile to the entrance off College Road. Turn left. The Pavilion is on the northeast corner of Forest and College Roads.

COMPENSATION

For your cooperation you will receive a **$25 GIFT CARD** to the grocery store from which you were recruited. You will have the opportunity to take home up to an additional **$30 in cash** at the conclusion of the auction. If you win the auction you will also take home the **ribeye steak or bundle of apples** you bid highest for.

CONTACT INFORMATION

If you have any questions please feel free to contact us

Rob Shupp   shupprob@anr.msu.edu   517-432-2754

Hillary Sackett   sacket14@msu.edu   517-505-5677

Please let us know if you will not be able to make it to the session you signed up for.

MICHIGAN STATE
UNIVERSITY

Consumer perceptions of and willingness-to-pay for "sustainably produced" Michigan apples and beef
INFORMED CONSENT FORM

You are invited to participate in a research study. The purpose of this study is to investigate consumer perceptions and willingness-to-pay for sustainably produced food products.

INFORMATION
Your participation will be separated into two parts. First, you will be presented with a short survey. The survey will first ask you to identify several demographic features about yourself. The remaining survey questions will ask you to make choices regarding your preferences for certain food attributes and sustainability practices. The survey should take approximately 15-20 minutes to complete. Second, you will engage in a second price auction for beef and apples with varying sustainable production characteristics. More in depth instructions for this portion are included on the next page.

BENEFITS and RISKS of THIS STUDY
It is not anticipated that you will benefit directly from the study. However, your decisions and those of others in this study will be used for research investigating consumer perceptions and willingness-to-pay for sustainably produce food products. There are no foreseeable risks from participating in this study. This study is designed so that you will not use any of your own money.

CONFIDENTIALITY
Your individual information will not be identified and shared with other participants. Only the researcher and coauthors will have access to the data which will be kept indefinitely on the secure computer of the principal investigator. Your identity will never be included as part of the published results from this experiment. Your confidentiality will be protected to the maximum extent allowable by law.

COMPENSATION
As an incentive to participate in this study you will receive a $25 gift card to the grocery store from which you were recruited. Additionally, you will be endowed with cash with which to bid on the beef and apple products presented to you in the auction. The winning bidder will take home the food product won and any leftover cash from the endowment. Bidders that did not win the item auctioned will take home the endowed cash.

PARTICIPATION
Your participation in this study is voluntary; you may discontinue participation at any time for any reason without penalty or prejudice from the researcher. If you wish not to participate or choose to leave without completing the experiment, please inform the researcher and you will be allowed to leave. Please feel free to ask any questions of the experimenter before signing this Informed Consent form, or at any other time during the experiment.

CONTACT
If you have any concerns or questions about this research study, such as scientific issues, how to do any part of it, please ask us directly before continuing.

If you have any questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, the Michigan State University Human Research Protection Program at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or regular mail at: 207 Olds Hall, MSU, East Lansing, MI 48824.' 48824

I, _____, agree to participate in this experiment for the research project entitled, "CONSUMER PERCEPTIONS OF AND WILLINGNESS-TO-PAY FOR "SUSTAINABLY PRODUCED" MICHIGAN APPLES AND BEEF." I have had the experiment explained to me and my questions have been answered to my satisfaction. I understand that I will receive a copy of this Consent Form to keep for future reference. I give my consent to participate.

<u>SECOND PRICE AUCTION INSTRUCTIONS</u>

Definition: A second price auction is an auction in which the bidder who submitted the highest bid is awarded the object being sold and pays a price equal to the second highest amount bid.

BEEF
You have been endowed with $25 cash with which to bid on ribeye steaks that will presented to you momentarily. You will be presented with multiple different alternative packages of beef ribeye steak that could be available for purchase in a retail store where you typically shop. Besides the attributes listed below, each product possesses the same characteristics and is produced in the U.S. Please consider the following information to help you interpret alternative products.

Label: The package that contains the beef ribeye steak for your purchase may be labeled as follows:

  • Sustainable: This beef was produced using sustainable practices.

  • Organic: This beef was produced using organic practices.

  • Local: This beef was produced for distribution and sale locally.

  • Typical: This beef is not labeled to suggest it was produced using any of the criteria listed above.

You will be randomly assigned to a group of 8 or 9 people against whom you will be bidding. There are four ribeye steaks available for purchase. Each steak is labeled accordingly with one of the four labels listed above. You have $25 with which to bid for each ribeye steak. As each steak is auctioned please enter into the computer the amount you wish to bid to purchase the item, not to exceed $25. For any given auctioned ribeye steak, if you entered the highest bid you will purchase the ribeye steak for the second highest bid amount, which will be disclosed to you following the completion of the auction. If the second highest bid amount is less than $25, you will also take home the endowment less the purchase price. In the presence of a tie for highest bid, the winner will be randomly selected and will purchase the ribeye steak for the third highest bid amount, which will be disclosed to you following the completion of the auction.

APPLES

You have been endowed with $5 cash with which to bid on 2 lb bundles of apples that will be presented to you momentarily. You will be presented with multiple alternative apple bundles that could be available for purchase in a retail store where you typically shop. Besides the attributes listed below, each product possesses the same characteristics and is produced in the U.S. Please consider the following information to help you interpret alternative products.

Label: The display that contains the apples for your purchase may be labeled as follows:

• Sustainable: These apples were produced using sustainable practices.

• Organic: These apples were produced using organic practices.

• Local: These apples were produced for distribution and sale locally.

• Typical: These apples are not labeled to suggest they were produced using any of the criteria listed above.

You will be randomly assigned to a group of 8 or 9 people against whom you will be bidding. There are four 2 lb bundles of apples available for purchase. Each 2 lb bundle is labeled accordingly with one of the four labels listed above. You have $5 with which to bid for each 2 lb bundle. As each apple bundle is auctioned please enter into the computer the amount you wish to bid to purchase the item, not to exceed $5. For any given auctioned 2 lb bundle of apples, if you entered the highest bid you will purchase the apple bundle for the second highest bid amount, which will be disclosed to you following the completion of the auction. If the second highest bid amount is less than $5, you will also take home the endowment less the purchase price. In the presence of a tie for highest bid, the winner will be randomly selected and will purchase the 2 lb bundle of apples for the third highest bid amount, which will be disclosed to you following the completion of the auction.

UNDERSTANDING THE IMPACT OF GREEN OPERATIONS ON ORGANIZATIONAL PERFORMANCE: AN INDUSTRY SECTOR PERSPECTIVE

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ABSTRACT

This study investigates the influence of green operations on organizational performance by sector for the top 500 publicly traded companies in the US. The results show that the impact of green operations on organizational performance varies by industry sector. For manufacturing firms, performance impacts of green operations is greater for Consumer Products, Cars and Food and Beverage, while for service companies, green operations have greater impacts in Health Care and Retail sectors. The results also show that the impacts of green operations are mixed. Some green indicators are found to have positive impacts on organizational performance, while other green indicators have negative influence on the performance. In addition, it is also found that the performance impacts of an organization's green operations initiatives decreases over the year in most sectors.

Keywords: Green operations, Environmental impact, Green policies and performance, Green reputation

INTRODUCTION

Over the past few years, environmental concerns have led organizations to wide-spread interest in sustainable practices and their relationships to business performance. This is reflected in a growing number of recent papers which explore the relationship between environmental operations and business performance [2] [28] [40] [36]. The literature in this area contains some empirical evidence suggesting a positive relationship between "green" operations and business performance [21]. However, more empirical work is needed to clarify the nature of this relationship [22] [25].

Research on environmental operations for the most part has focused on the areas of green product and process development, lean and green operations management, and remanufacturing and closed-loop supply chains [1] [28]. Only a few studies have looked at the relationship between green operations and firm performance on a comparative basis between the manufacturing and service industries. Existing empirical evidence so far is limited to a few studies that focus on the manufacturing sector [21] [25] [27] and others on the service sector [15] [17] [21]. Very few of these studies found scientific evidence that green practices have important effect on firm performance. For instance, Enz and Siguaw [11] and Schendler [45] argue that environmental practices can improve customer loyalty and employee satisfaction, reduce costs, and enhance competitiveness. In their review of published studies exploring the relationship between green operations and firm performance in the service industry, Kassinis and Soteriou

[21] found that most studies were manufacturing based case studies that predominantly identified opportunities for future research.

Historically, numerous environmental frameworks, cases and concepts have evolved around the manufacturing industry. Today, we are in the midst of a service revolution that is rapidly transforming industries and changing some fundamental assumptions we have about business and economics. Increasingly, the size of the service economy's contribution to gross domestic product is more than 70% in the U.S. and other developed countries, while the share of employment in services exceeds 80% in the U.S. and continue to rise [14] [43]. These trends imply that further research and discovery is needed to gain an enhanced perspective and insight into these issues as they are becoming increasing relevant to almost any organizational stakeholder. Environmental issues and their implications for business performance therefore present tremendous research opportunities for traversing the growing and changing gap in how environment issues uniquely and collectively impact the value adding process in manufacturing firms and service firms [43]. This gap has been acknowledged by Kassinis and Soteriou [21]. These authors conclude that "In practice, we know little about the environmental impacts of most service operations, how they can be managed, and what impact the environmental practices service firms adopt have on performance". The identification of this gap prompts us to investigate the relationship between green operations and firm's financial performance in each sector in both manufacturing and service industry and thus providing a deeper understanding of impact of green operations.

The paper identifies three key environmental operations that are important antecedents to a firm's financial performance and test the impact of the environmental operations on organizational performance in a two-year period (the year the green operations were measured and the following year). A two-year period allows us to evaluate the short-term and long-term impact of the green operation. The paper is organized as follows. In the next section, we review the literature about environmental operations and practices as well as firm-level performance. Next, we raise our research questions and put forward a theoretical framework to explain the relationship between green operations and firm's performance. Empirical data for theory testing is collected from Compustat, a database of financial, statistical and market information on active and inactive global companies throughout the world, and Newsweek, an information gatekeeper that enables consumers to access a list of environmental friendly companies. Following the presentation of the methodology and the analysis used in our study we interpret our findings, present conclusions and outline implications and future research.

THEORETICAL FOUNDATION AND HYPOTHESES DEVELOPMENT

Green Operations

Traditionally, environmental issues have attracted the attention of researchers in various areas of operations management. The scope of research ranges from studying operational problems such as green product and process development, lean and green operations management, to remanufacturing and closed-loop supply chains [3] [6] [25]. Environmental perspectives on operations lead to different terminologies with varying scope. One term emerging from the

literature is "green operations". It relates to all aspects related to product manufacturing, usage, handling, logistics and waste management once the design has been finalized [48].

Research on green metrics is evolving and is playing an important role among practitioners. It provides managers with useful metrics that can be used to monitor their firms' environmental efforts as well as to support decision making process related to business operations [16]. In the research community, MSCI ESG Research, a leading source of environmental, social, and governance ratings collaborated with NEWSWEEK to develop green metrics. Trucost, a firm that Specializes in quantitative environmental performance measurement; and CorporateRegister.com, the world's largest online directory of social responsibility, sustainability and environmental reporting also worked toward the same goal as the previous two firms. All these companies have adopted terms such as "environmental impact score", "green policies and performance score", and "reputation survey score" in their assessments of environmentally responsible (green) practices among 500 publicly traded U.S. companies.

From the above sources, a company's environmental impact score that was obtained using more than 700 metrics is a key performance indicator comprising 90 percent of the overall environmental impact of a company's global operations and 10 percent of disclosure of those impacts. To accommodate the fact that some companies operate in more than one industry, Trucost uses a benchmarking system for each of those sectors from publicly disclosed environmental data (e.g. the EPA Toxics Release Inventory). Trucost also scrutinized the quality of any outside data first before it usage.

The second metric, "Green policies and performance score", are viewed as a set of rules and guidelines that regulate all operations of a company. The Green Policies Score, derived by MSCI ESG Research, was measured with more than 70 individual indicators in five categories. Among these categories, regulatory compliance, lawsuits, controversies, and community impacts, emphasize how well each company manages its carbon or non carbon emissions to air, water, and land. MSCI ESG Research also reports that life-cycle impacts each company's products and services. It also impacts how well each company manages and uses its local resources; and the quality of each company's track record of managing environmental risks. MSCI ESG Research drew data from a variety of sources such as company-disclosed information; dialogues with companies; media coverage; and government, NGO, and third-party research.

The last metric, the "Green reputation", reflects the public image of the firm in relation to its attitude and actions toward environmental issues when managing its operations and product lines. It was obtained from an opinion survey of corporate social-responsibility professionals, academics, other environmental experts who subscribe to CorporateRegister.com and CEOs from all companies on the NEWSWEEK U.S. 500 publicly traded companies. Each respondent was asked to rate a random sample of 15 companies on a sliding scale (100 to one) from "leader" to "laggard" in three key green areas: environmental performance, commitment, and communications. Detailed procedure on how these variables were measured is available on newsweek.com.

A number of authors have proposed research frameworks to assess business performance of environmental responsible firms. Beamon [4] described performance measures appropriate for

the extended supply chain. Labuschagne and van Erck [31] and Chinander [5] also contributed frameworks and methods by which a firm can incorporate environmental objectives into their operations. Building on these environmental score and concepts from Trucost and CorporateRegister.com, we study the relationship between green operations (measured by environmental impacts, green policies and performance and reputation survey) and firm performance in each sector in both manufacturing and service industry.

Organizational Performance

Historically, financial measures such as return on sales (ROS), return on assets (ROA), return on equity (ROE), and return on invested capital (ROIC) have been used in the literature to evaluate the interests of various stakeholders in the market place [18] [19] [29] [44]. In modeling capital borrowed by stockholders from creditors and investors as well as their equity capital contribution, Konar and Cohen [30], Russo and Fouts [41], Elsayed and Paton [12], Nakao et al. [36], and King and Lenox [23] have used ROA, Tobin's $q-1$, ROS, ROE, and return on capital employed (ROCE) to measure firm financial performance. . Using the argument that managers are more open to offering their perceptions rather than offering precise quantitative data, other scholars use subjective perceptions of managers to assess firm financial performance [7] [20] [46].

The study herein is concerned with a firm's performance relative to the market and it's competition. Debt ratio (DR), profit margin (PM), return on total assets (RTA), market to book ratio (MBR), and Inventory Turnover (ITO) are recognized as important dimensions to firm's financial performance [47]. DR is defined as the total debt over total assets. PM, a primary variable most investors examine when analyzing a company's performance, measures the profitability of a company and represents the net income over the sales. The RTA represents the net income over the total assets, and the MBR represents the market price over the book value. Inventory Turnover is a measure of how often the company sells and replaces its inventory and is the ratio of cost of goods sold to average inventory.

Relationship between Environmental Practices and Organizational Performance

A review of the literature on environmental issues indicates that a significant correlation exists between green practices and corporate profitability within any organization. Companies having higher scores on environmental criteria realize stronger financial returns than the overall market, whereas companies with poor scores have weaker returns [7] [13] [32] [34]. The prevailing view is that incorporating environmental variables into firms' activities often impacts costs because additional requirements have to be met to this end. This in turn impacts firm-level financial performance [37] [39].

Empirical studies that have analyzed the relationship between environmental operations and practices and financial performance at the firm-level are fragmented across industries. Widely-cited research results relate environmental operations and practices to a firm's stock market performance, market valuation, and competitive advantage [6] [19] [29]. Most of these studies suggest that environmental performance is positively correlated with the intangible asset value of S&P 500 firms as well as firm market value [10] [26] [23] [30]. A study by Nakao et al. [36]

reveals that for the particular case of Japanese manufacturing sector, environmental performance improves ROA and Tobin's $q - 1$. From a competitive perspective, Porter and van der Linde [37], Rao and Holt [38], Dao et al. [8], and Reinhardt [39] suggest that environmental operations can improve firm-level financial performance and overall competitiveness through green products or services. These authors also argue that poor environmental performance can reduce a firm's market valuation. The literature also reveals "green" firms to be more efficient and innovative [22] [37].

Although most studies find a positive correlation between environmental performance and firm-level performance, some results are conflicting and ambiguous [22]. For example, Kiernan [24] and Derwall et al. 9] show that environmental performance and firm-financial performance is negatively correlated. A study by Min and Galle [33] suggests that compared to liabilities and product disposal costs, competitive advantage plays a relatively minor role for managers considering green purchasing. In addition, Walley and Whitehead [50] argue that corporate environmental initiatives generate unrecoverable costs, divert resources from other productive investments, and conclude that they are unsustainable.

While previous approaches linking environmental operations and practices to firm-level performance seem to be fairly comprehensive and contribute significantly to our knowledge, existing empirical evidence so far has been limited to manufacturing sector [25] [27]. However, environmental operations and practices have been shown to be an important component of a service firm's operations [21]. Despite this recognition, research on environmental issues in the context of services industry is limited. Kassinis and Soteriou [21] argue that the results found in this literature is "limited by the case study or anecdotal nature of the evidence they are based on" and acknowledge the need for further empirical work to assess the relationship between environmental practices and firm-level performance in the service industry. The relative scarcity of research examining these two variables and the fact that prior approaches do not report consistent findings with regard to explaining how green operations impact firm-level performance both in manufacturing and service industry [10] [23] [26] motivates the need for the study conducted herein It is our contention that by jointly examining the impact of environmental practices to firm-level performance in each sector in manufacturing and service industry, we can substantially contribute toward the findings of earlier studies.

Research Framework

The research framework guiding our investigation is illustrated in Figure 1. We draw on concepts from the interrelated literature streams of environmental operations, practices and corporate growth to propose a research model that assesses a direct effect between green operations and firm-level performance in each industry sector. Our framework suggests that firm-level performance is impacted by three green operation factors: environmental impact, green policies and performance, and green reputation. Other potential factors that may impact firm-level performance are not included in his study due to the limitation of the data.

FIGURE 1: Research Framework
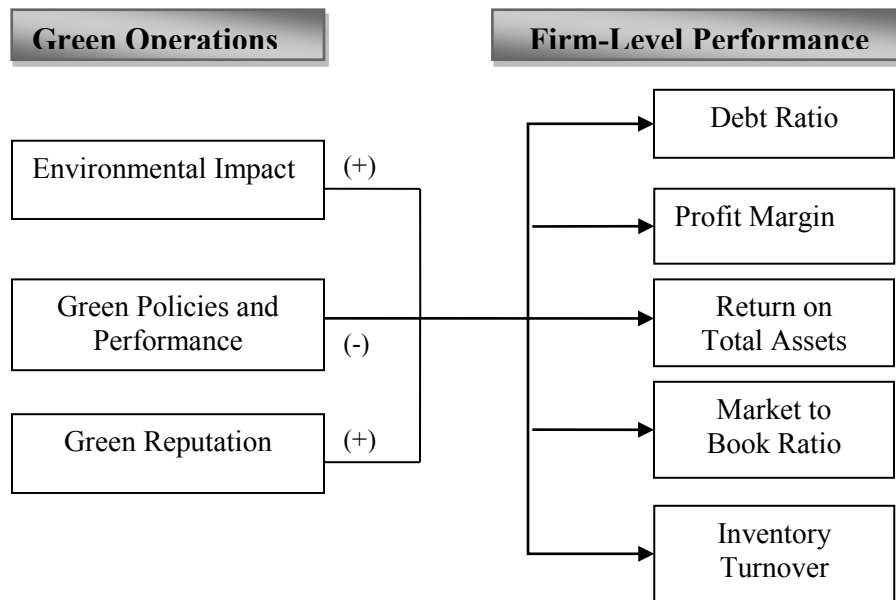
RESEARCH METHODOLOGY

The focus of this research is on the top 500 publicly traded companies of 2010 as identified by their levels of revenue, market capitalization and number of employees. The score of green operations for each company was obtained from Newsweek (Oct 18, 2010). Newsweek also classify each company into one of 15 specific industry sectors. The financial performance of each company in 2010 and 2011 was obtained from Compustat. 19 companies were dropped because of missing data in Compustat and the sample size is reduced to 481.

Based on the classification scheme on Newsweek, manufacturing industry include 10 sectors (Basic Materials; Consumer Products, Cars; Food and Beverage; General Industrials; Industrial Goods, Oil and Gas; Pharmaceuticals; Technology; Transport, Aerospace; and Utilities) and service industry include 5 sectors (Bank & Insurance, Financial Services, Health Care; Media, Travel, Leisure; and Retail). The study will adopted this classification.

Data Analysis and Discussion

In this section, the difference between green operations and organizational performance in each industry sector will be discussed first, followed by some regression analyses to test identify how green indictors impact financial performance measures. To measure financial performance, we use Debt Ratio, Profit Margin, Return on Total Assets, Market to Book Ratio, and Inventory Turnover in each industry sector.

Green Operations by Sector in Manufacturing and Services Industry

Table 1 shows that in the case of manufacturing industry, the top 3 industry sectors in Environment Impact scores category are Technology (72.54), Industrial Goods (57.27) and Transport, Aerospace (55.95). Regarding the Green Policy and Performance score, the top 3 are Pharmaceuticals (56.32), Technology (55.38), and Food and Beverage (46.21). Finally, for Green Reputation score, the top 3 industry sectors are Technology (54.84), General Industrials (54.78) and Transport, Aerospace (51.07).

TABLE 1. Green Operations by Industry Sector in 2010

Sector	Number of Companies	Environmental Impact Score	Green Policy and Performance	Green Reputation
Manufacturing	306	42.76	43.35	49.44
Basic Materials	27	16.90	43.94	49.21
Consumer Products, Cars	32	46.27	40.16	50.69
Food And Beverage	27	10.14	46.21	44.13
General Industrials	31	45.11	39.24	54.78
Industrial Goods	41	57.27	33.90	46.96
Oil and Gas	29	32.55	35.83	44.58
Pharmaceuticals	16	51.90	56.32	48.18
Technology	49	72.54	55.38	54.84
Transport, Aerospace	22	55.95	37.73	51.07
Utilities	32	13.11	44.78	50.00
Services	193	63.75	39.92	44.09
Bank And Insurance	38	79.15	45.74	40.90
Financial Services	27	60.93	41.66	44.33
Health Care	30	66.28	28.79	46.78
Media, Travel, Leisure	42	52.04	40.02	46.06
Retail	56	60.33	43.40	42.39
Total	499	50.38	42.25	47.50

The analysis reveals that technology sector is leading other sectors for the green operations variables as it is the only sector that belongs in the top 3 list in all three measurements. Table 1 also shows that in manufacturing industry, the bottom 3 performers for the Environment Impact score measure are Food and Beverage (10.14), Utilities (13.11) and Basic Materials (16.90). Regarding the Green Policy and Performance score, the bottom 3 performers are Industrial Goods (33.90), Oil and Gas (35.83), and Transport, Aerospace (37.73). Finally, for the Green Reputation score, the bottoms 3 are Food and Beverage (44.13), Oil and Gas (44.58) and

Industrial Goods (46.96). The results show that Food and Beverage is the bottom performer having the lowest score in Environmental Impact and Green Reputation. However it also ranked the third for the Green Policy and Performance score. In addition, Industrials Goods belong to the bottom 3 list both in Green Policy and Performance score and in Green Reputation whereas it is ranked the second in the Environmental Impact score.

In service industry, Table 1 shows that Banking and Insurance ranked at the top of the list in Environment Impacts score and Green Policy and Performance. However, the Banking and Insurance sector received the lowest score in Green reputation. Similarly, the Health Care sector has the highest score in Green Reputation and the lowest score in Green Policy and Performance. Those results indicated that a high score in one indicator of green operations does not necessarily correlate to a high score in another dimension.

Financial Performance by Sector in Manufacturing and Service Industry

The result of Table 2 shows that both service and manufacturing industry has very similar Debt Ratio, Profit Margin and Return on Assets in the year 2010 and 2011. Firms in the Service industry have a higher Inventory Turnover than in manufacturing firms. Table 2 also show that the average Market to Book value and Inventory Turnover in manufacturing industry has increased from year 2010 to 2011, while the average Market to Book value has dropped greatly in service industry from year 2010 (7.87) to 2011 (2.68).

The result from Table 2 also reveals that the Pharmaceuticals and Technology sectors have higher scores in profit margin and return on assets than other sectors in manufacturing industry. On the other hand, in service industry, the financial services sector has a higher profit margin and inventory turnover than other industry sectors for the years 2010 and 2011.

Green Operations and Financial Performance by Sector in Manufacturing Industry

A series of regression analysis were conducted to identify how green indictors impact financial performance measures such as Debt Ratio, Profit Margin, Return on Total Assets, Market to Book Ratio and Inventory Turnover in each section in manufacturing industry and the results are shown in Table 3.

It can be seen that the impact of green operations on financial performance is greater for Consumer Products, Cares and Food and Beverage sectors based on the number of significant impacts in those two sectors. In the Consumers Products, Cars sector, the Environmental Impact indicator has a negative impact on return on asset and market to book value while the Green Policies and Performance score has positive impact on these two measures. However, those significant relationships become non-significant in 2011. In the Food and Beverage sector, the Environment Impact score has a positive impact on profit margin while the Green Policies and Performance score has negative impact on profit margin and a positive impact on inventory turnover. Finally, the Reputation score has a positive impact on profit margin and a negative impact on inventory turnover. Out of five significant relationships, in the year that follows 2009, two relationships (a positive relationship from Environment Impact score to Profit Margin and a negative relationship from Green Policies and Performance score to Profit Margin) are still

significant with a lower regression coefficient. The other three significant relationships become non-significant.

TABLE 2. Organizational Performance by Industry Sector in 2010 and 2011

Sector	Year 2010					Year 2011				
	DR	PM	ROA	MTB	ITO	DR	PM	ROA	MTB	ITO
Manufacturing	.25	.09	.07	2.84	14.02	0.26	0.09	0.07	5.05	15.34
Basic Materials	.27	.08	.06	2.88	8.87	.29	.08	.05	2.25	8.95
Consumer Products, Cars	.26	.06	.07	3.83	7.33	.27	.07	.08	.35	7.75
Food And Beverage	.33	.11	.10	1.22	6.47	.35	.10	.09	25.84	7.52
General Industrials	.25	.05	.05	3.31	7.83	.26	.05	.04	1.79	7.96
Industrial Goods	.21	.07	.06	3.15	12.99	.22	.08	.08	5.26	13.51
Oil and Gas	.20	.12	.06	2.13	15.69	.21	.08	.05	2.06	18.73
Pharmaceuticals	.23	.16	.09	2.95	2.02	.26	.17	.09	3.30	2.15
Technology	.18	.13	.08	3.07	21.01	.18	.12	.07	2.71	29.21
Transport, Aerospace	.20	.08	.07	4.41	43.84	.21	.08	.08	5.32	43.76
Utilities	.36	.08	.02	1.45	14.15	.36	.08	.03	1.65	13.85
Services	.24	.09	.05	7.87	32.06	.25	.10	.05	2.68	33.07
Bank And Insurance	.12	.09	.01	1.12	4.43	.11	.10	.01	.92	21.36
Financial Services	.28	.18	.05	3.13	77.51	.27	.21	.05	2.67	58.55
Health Care	.25	.08	.07	2.82	22.90	.28	.08	.07	2.57	24.85
Media, Travel, Leisure	.37	.06	.05	29.56	48.36	.38	.08	.06	1.26	53.93
Retail	.18	.05	.08	2.69	7.12	.20	.05	.08	5.99	6.68
Total	.24	.14	.06	4.88	18.02	.25	.08	.06	3.88	19.58

The other significant relationships found in the manufacturing industry are positive relationships linking the Reputation score and the Inventory Turnover in the Industrial Goods sector; and a negative relationship between the Environment Impact score and the Inventory Turnover in Pharmaceuticals. Worth mentioning is also a negative relationship between the Environment Impact score and the Profit Margin in the technology sector, and a positive relationship between the Environment Impact score and the Inventory Turnover in the Utilities sector. Table 3 also shows that these significant relationships either disappeared or the strength of those relationships decreased from year 2010 to 2011.

No significant relationships were found between the green indicators and organizational performance in sectors such as Basic Materials, General Industries, Oil and Gas, and Transport, Aerospace.

TABLE 3. Regression Analysis by Sector in Manufacturing Industry in 2010 and 2011

(Basic Materials, General Industries, Oil and Gas, and Transport, Aerospace are omitted as no significant relationships are found)

Industry Section		Year 2010					Year 2011				
		Debt Ratio	Profit Margin	Return on Assets	Market to Book Ratio	Inventory Turnover	Debt Ratio	Profit Margin	Return on Assets	Market to Book Ratio	Inventory Turnover
Consumer Products, Cars	Environment Impact Score			-.42 **	-.41 **						
	Green Policies and Performance Score			.44 **	.33 *						
	Reputation Score										
Food and Beverage	Environment Impact Score		.53 **					.47 **			
	Green Policies and Performance Score		-.40 **			.52 **		-.36 *			
	Reputation Score		.31 *			-.45 *					
Industrial Goods	Environment Impact Score										
	Green Policies and Performance Score										
	Reputation Score					.42 **					.41 **
Pharmaceuticals	Environment Impact Score					-.67 **					-.66 **
	Green Policies and Performance Score										
	Reputation Score										
Technology	Environment Impact Score		-.51**								
	Green Policies and Performance Score										
	Reputation Score										
Utilities	Environment Impact Score					.57 **					.55 **
	Green Policies and Performance Score										
	Reputation Score										

TABLE 4. Regression Analysis by Sector in Service Industry in 2010 and 2011

Industry Section		Year 2010					Year 2011				
		DR	PM	ROA	MTB	ITO	DR	PM	ROA	MTB	ITO
Bank & Insurance	Environment Impact Score					-.65 **					
	Green Policies and Performance Score										
	Reputation Score	.48**									
Financial Service	Environment Impact Score					-.71 **					
	Green Policies and Performance Score										
	Reputation Score					.76 **					
Health Care	Environment Impact Score		-.44 **			.63 **		-.34 **			.59 **
	Green Policies and Performance Score		.79 **	.57 **		-.72 **		.95 **	.79 **		-.73 **
	Reputation Score		-.51 **	-.57**				-.27 *	-.49**		
Media, Travel, Leisure	Environment Impact Score					-.28 *					
	Green Policies and Performance Score	-.34 *					-.46 **				
	Reputation Score					-.51 **					
Retail	Environment Impact Score			-.29 **					-.36 **	.36 **	
	Green Policies and Performance Score					-.55 **					-.46 **
	Reputation Score					.53 **					.59 **

Note: ** indicates a significant level at 0.05, * indicates a significant level at 0.10.

Table 3 reveals that out of five performance measurements, green operations likely have more impacts on profit margin and inventory turnover compared to other measurements in manufacturing industry.

Green Operations and Financial Performance by Sector in Service Industry

Table 4 shows that the green operations measures have greater impact on financial performance in the Health Care and Retail sector because these two sectors have more significant relationships between green indicators and financial performance measures. In the Health Care sector, the Environment Impact score has a negative impact on Profit Margin and a positive impact on Inventory Turnover in the year 2010, while the same relationships exists in the following year 2011 with a lower regression coefficient, indicating that the impact has decreased from the year 2010 to 2011. In addition, Table 4 also show that in the Health Care sector, Green Policies and Performance score has a positive impact on Profit Margin and Return on Asset, and a negative impact on Inventory Turnover in 2011. Again, the same relationships exist with a stronger impact in 2011. The Reputation score is negatively related to Profit Margin and Return on Assets in both 2010 and 2011. However in 2011, the impact of Reputation score has weakened.

In the Retail sector for the year 2010, the environmental impact score has a negative impact on Return on Assets, whereas Green Policies and Performance score has a negative impact on Inventory Turnover. Finally, the Reputation score has a positive impact on Inventory Turnover. The same impacts exist for the year 2011 with a higher regression coefficient.

In the Bank and Insurance sector, the Environment Impact score has a negative impact on Inventory Turnover and the Reputation score has a positive impact on Debt Ratio for the year 2010. These significant relationships disappear for the year 2011. In the Financial Service sector, the Environmental Impact score has a negative impact on Inventory Turnover and the Reputation score has a positive impact on Inventory Turnover. No significant relationships were found for the year 2011. Finally, in the Media, Travel, Leisure sector, the Environment Impact score has a negative impact on Inventory Turnover, and the Green Policies and Performance score has a negative impact on Debt Ratio for the 2010. For the year 2011, the only significant relationship found is the one between Green Policies and Performance score and Debt Ratio.

In summary, it can be concluded that green operations does have a significant impact on an organizational performance. However, this impact is mixed and varies by industry sector. The Reputation score has a positive impact on financial performance in the Bank & Insurance sector, while for the Financial Service and Retail sectors; however, it has a negative impact on Health Care, and Media, Travel, Leisure sector. The Environment impact score was found to negatively impact financial performance except in health care sector. The Green policy and performance score has a negative impact on financial performance in the Media, Travel, and Leisure, and Retail sector. Finally, Green policy and performance score has no impact in Bank & Insurance, and Financial Service, and a mixed impact on health care.

In addition, the results also indicate that a firm's green performance in one year not only impact an organization's financial performance in that particular year but also impact the year that

follows. However, the impact is degraded over the time except for Health Care and Retail sectors. It is also interesting to note that no new significant relationships appear in 2011.

CONCLUSION AND IMPLICATION

This study investigates the influence of green operations on organizational performance by sector for both the manufacturing and service industry for the top 500 publicly traded companies in the US. Green operations were measured by three indicators (Environmental Impact, Green Policies and Performance, and Green Reputation) while organizational performance were measured by Debt Ratio, Profit Margin, Return on Assets, Market to Book Ratio and Inventory Turnover. The results show that the impact of green operations on organizational performance varies by industry sector. For manufacturing firms, green operations have more impacts on performance in Consumer Products, Cars and Food and Beverage sectors, while for service companies, green operations have more impacts in Health Care and Retail sectors. The results also show that the impacts of green operations are mixed. Some green indicators are found to have positive impacts on organizational performance, while other green indicators have negative influence on the performance. In addition, it is also found that the impact of an organization's green operations initiatives in a given year on organizational performance decreases over the year in most sectors.

One limitation of this study is small sample size in each section that may impact the validity of the results. Future study can extend this study by increasing the sample size in each sector. Future studies may incorporate other contextual variables (such as firm size, organizational culture, environmental pressure, and nature of industry) so that the variation among industry sectors can be explained in further detail. Future study may also study the changes in green operation of a company from one year to another at Newsweek.com and how those changes impact its financial performance.

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