50TH ANNIVERSARY

**Northeast Decision Sciences Institute
Annual Conference Proceedings**

March 26-27, 2021 • VIRTUAL

PennState
Harrisburg

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The Pennsylvania State University
C119 Olmsted Building
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March 26, 2021

Dear NEDSI Members and Guests,

As the host institution of the annual meeting of the Northeast Decision Sciences Institute, I am honored to welcome you to the 50th meeting of this prestigious conference. Dr. Dinesh Pai, associate professor of supply chain management in the Penn State Harrisburg School of Business, and his team have put together an excellent program and we are pleased to be able to present it to you.

The theme of this year's conference, "Harnessing Analytics for Enhancing Healthcare and Business," illustrates the importance of decision sciences across disciplines in enhancing healthcare as an industry. While we are meeting in a virtual format, I encourage you to embrace this opportunity to learn, explore, network, share, and connect.

On behalf of the faculty, staff, and students at Penn State Harrisburg, I wish you a productive and successful meeting.

Sincerely,

John M. Mason, Jr., PhD PE
Chancellor

Welcome from the Program Chair

Dear Colleagues:

On behalf of the program committee, I take this opportunity to welcome you to the **50th Annual Conference of the Northeast Decision Sciences Institute**. Thank you for participating in this conference and supporting NEDSI during the challenging time of the ongoing pandemic. By participating in this conference, you have intertwined with the history of NEDSI: the 50th year of its glorious existence as well as its first virtual conference.

In line with the theme of NEDSI 2021 is 'Harnessing Analytics for Enhancing Healthcare & Business,' the program committee has put together a great conference with a variety of inter-disciplinary tracks, plenary sessions, workshops, panel discussions, and social hours. The theme serendipitously dovetails with COVID-19 challenges faced by organizations. As such, over the two days, the conference aims to discuss, deliberate, and provide actionable solutions to overcome many of the challenges.

We are delighted to report that the conference includes 217 accepted submissions by 360 authors from 171 different universities, government organizations and private enterprises, and 19 countries. The accepted submissions also include 26 student posters. Each submission underwent a blind review process, with ratings and feedback provided to authors. Full paper submissions that were nominated by the reviewers for awards underwent an additional review to decide the winners in several award categories. Congratulations to all winners! During the conference, the best Undergraduate Poster presentations will be determined, and award winners will be announced at the Awards Ceremony Saturday evening.

Please join us for the President's Reception and Virtual Happy hour Friday evening.

I regret to inform you that our colleague, friend, and past NEDSI President, Dr. Mark Davis from Bentley University, recently passed away. Please join us Saturday afternoon for the 'Remembering Dr. Mark Davis' session.

I hope you enjoy the conference and look forward to seeing you at future NEDSI conferences.

Dinesh R. Pai, Ph.D.
Program Chair, NEDSI 2021 Conference

About Decision Sciences Institute

The Decision Sciences Institute (DSI) is a professional organization of academicians and practitioners interested in the application of quantitative and behavioral methods to the problems of society.

Through national, international, and regional conferences; competitions; and publications, the Institute provides an international forum for presenting and sharing research in the study of decision processes across disciplines. The Institute also plays a vital role in the academic community by offering professional development activities and job placement services.

Five regional subdivisions in the United States, as well as regions representing Europe, Asia-Pacific and the Indian subcontinent, operate within the Institute (see regions). Each region has its own elected officers and representative on the board of directors and holds annual meetings.

The Institute, an independent non-profit educational organization, is located in Houston, Texas, where it receives extensive support from the C.T. Bauer College of Business at the University of Houston.

About Northeast Decision Sciences Institute

NEDSI is one of the five U.S. regions that comprise our professional society, the Decision Sciences Institute (DSI). Our region encompasses the Northeastern United States. NEDSI holds an annual regional meeting each spring that features presentations of original research papers, Ph.D. and new faculty development seminars, cutting edge research innovation in the fields of Accounting, Business Education, Finance, Human Resources, Management, Marketing, Analytics, Machine Learning, Artificial Intelligence, Information Systems, Organizational Behavior, Operations Management, Strategic Management, Supply Chain Management, among others. Awards for "Best Paper" in several categories are given each year.

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Workshop on 'Designing interactive courses on circular strategy'	Masterclass on 'Integrated Learning Approach aka Ed's principles'
26 March 2021	**27 March 2021**

The Blue Connection is a cross-functional business strategy simulation focused on Circular Economy. The simulation game challenges the participants to transform a linear supply chain into a circular value chain while increasing the Return on Material and Return on Investment of a (virtual) manufacturing company of e-bikes. The Blue Connection is versatile and can be used for courses of varying complexity at all levels of education or corporate training. During this session, you will learn how to get started with the business simulation game.

The Integrated Learning Approach seeks to provide a complete and coherent, yet practical framework to support the learner's journey. It aims at directly linking theoretical knowledge to development of skills through active participation in learning. During this Masterclass, participants will learn about the added value of having materials for each step of a student's learning cycle. Based on best practices, you will learn how to integrate theory, a business simulation, teaching cases and other supporting teaching materials in a course. The purpose of using a business simulation is twofold: it encourages experiential learning and a higher degree of learner engagement.

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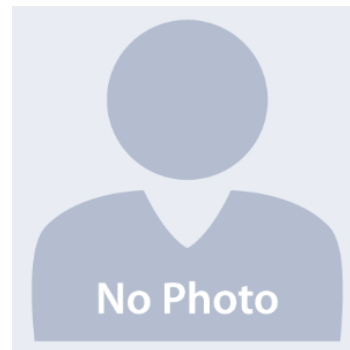
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New Jersey Institute of Technology

Cyber Security, IT, and Emerging Technologies (CIT)

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Big Data, Analytics, and Knowledge Management (BAK)

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DSS, Machine Learning, and Artificial Intelligence (DMA)

Chair: Nikhil Varma, Ph.D.
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Decision Making: Public Administration and Policy (DMP)	Education, Curriculum, and Cases (ECC)
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Healthcare Analytics and Services Management (HAS)

Chair: Balaram Rajan, Ph.D. California State University East Bay	Co-Chair: Fatma Pakdil, Ph.D. Eastern Connecticut State University

Human-Technology Interface (HTI)	Innovation and Creativity (IAC)
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Marketing and Consumer Behavior (MCB)	
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Strategy and Organizational Behavior (SOB)	Supply Chain Management and Logistics (SCM)
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Zhang, Xiao……………………………………………………..Saint Louis University

NEDSI 2021 Conference Keynote Speakers

Keynote 1 - Impact of COVID-19 on Healthcare Supply Chains

Mr. Richard Bagley, Senior Vice President, Chief Supply Chain Officer
PennState Health, Hershey, Pa.

As SVP and Chief Supply Chain Officer for PennState Health, Richard leads the PennState supply chain to deliver best in class solutions to the customers and patients we serve in central Pennsylvania. He is actively engaged in transforming the existing materials function. PennState health is a $2.5B IDN anchored by the PennState Milton Hershey Medical Center. Prior to his current role, he has also worked for Intermountain, 3M Health Information Systems and Siemens. He is a graduate from the University of Utah with a degree in computer science and also has an MBA degree from the University of Phoenix where he has taught 17 years.

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Keynote 2 - Harnessing Analytics for Enhancing Business Decision Making

Mr. Nick Divan, Vice President, Financial Planning & Analysis
D&H Distributing, Harrisburg, Pa.

Nick Divan is currently the Vice President of Financial Planning Analysis at D&H Distributing one of America's largest private companies in the distribution industry. Nick's career spans over 25 years where he has held various positions in IT distribution, banking, public accounting and healthcare. Nick's passion lies in assessing data challenges and driving positive changes in organizations by partnering with business leaders and more effectively using data to drive bottom line improvement. Nick is a graduate of the Wharton School with a degree in finance and accounting, has an MBA degree from SUNY at Buffalo and is a licensed CPA.

NEDSI 2021 Conference Best Paper Awards

Best Application of Theory Award

Simple Interaction Finding Technique (SIFT) – A Simple Methodology to Generate Novel Hypotheses from Complex Datasets

Murtaza Nasir [1], Nichalin Summerfield [1], Serhat Simsek [2], Asil Oztekin [1] (1. University of Massachusetts Lowell, 2. Montclair State University)

David M. Levine Best Paper Award in Innovative Teaching

The Healthcare Hackathon: An Undergraduate Experiential Immersion In Entrepreneurship & Healthcare

Michele Montecalvo [1], Eda Sanchez-Persampieri [2], Marie Segares [2] (1. Rutgers University, 2. St. Francis College)

Richard Briotta Best Paper Award in Knowledge Management/Strategy

A Knowledge Management Approach to Integration of Educational Analytics

Shouhong Wang [1], Laura Forker [1] (1. University of Massachusetts Dartmouth)

Bryant University Best Paper Award in Supply Chain Management and Logistics

Spatio-Temporal Effects on Decision Making in Negotiated Green Fleet Procurement

Marc Scott [1] (1. Georgia Southern University)

Best Ph.D. Student Paper Award

Simple Interaction Finding Technique (SIFT) – A Simple Methodology to Generate Novel Hypotheses from Complex Datasets

Murtaza Nasir [1], Nichalin Summerfield [1], Serhat Simsek [2], Asil Oztekin [1] (1. University of Massachusetts Lowell, 2. Montclair State University)

Best Overall Conference Paper Award

A New Ranking Method in the Data Envelopment Analysis Context for a Two-Stage Network Model

Jae-Dong Hong [1] (1. South Carolina State University)

NEDSI 2021 Conference Undergraduate/Masters Poster Participants

Session Chair: Dr. Jennifer Swanson *(Stonehill College)*

Analysis of Unemployment Rate and Mental Health Symptoms During the COVID-19 Pandemic

Miya Spinella [1], Keivan Sadeghzadeh [1] (1. University of Massachusetts Dartmouth)

The Effect of Socioeconomic Status on Mental Health Readmission Rate; An Investigation in the Commonwealth of Massachusetts

Yasaman Asayesh [1], Keivan Sadeghzadeh [1], Soheil Sibdari [1], Joohyun Chung [4] (1. University of Massachusetts Dartmouth, 2. University of Massachusetts Amherst)

The Impact of Self-Esteem on the Attitudes Toward Social Media Influencers

Kathryn Sweeney [1], Sharmin Attaran [1] (1. Bryant University)

COVID-19 and Its Impact on Social Entrepreneurship

Victoria Vitale [1] (1. Kean University)

Environmental, Social, and Governance Performance of Top-Rated Supply Chain Companies: A Quantitative Assessment Model

Noah Tellier [1], John K. Visich [1] (1. Bryant University)

Leadership in Energy and Environmental Design (LEED) in Education

Jonathan Hagenow [1], John K. Visich [1] (1. Bryant University)

Brain Tumor Classification using Graph Neural Networks

Daniel Babalola [1], Hien Nguyen [1] (1. Pennsylvania State University Harrisburg)

Changes in Food Conpsumtion After COVID-19

Natalia De LaFuente [1] (1. New Jersey City University)

Explainable Artificial Intelligence and Benefits for Business Applications

Jeannine Shantz [1], Chasity Nadeau [1] (1. Saint Joseph's University)

Mobilization of Healthy Foods to Urban Food Desert

Anthony Picciano [1], Natalia De LaFuente [1] (1. New Jersey City University)

The Effect of Positive Reading on the Development of College Students' Self-efficacy, Self-esteem, & Locus of Control

Mitchell Lanzl [1] (1. Kean Uni)

Artificial Intelligence in Marketing: Past, Present and Future

Leniqua'Domi Jenkins [1] (1. University of the District of Columbia)

Exploring Relationships between Cognitive Load and Student Performance in Online Learning Environments

Brea Ellis [1] (1. University of the District of Columbia)

Examining University Students' Multitasking Behavior with Online Learning

Terssa Kassahun [1] (1. University of the District of Columbia)

Beyond Leader-Member Exchange Theory (LMX): Developing a New Typology Model of Followers

Janell Laws [1], Justin Antonio [2] (1. Kean University, 2. Kean)

Cultural Intelligence and Leadership: The Impact on Organizational Performance

Sandra Orejarena [1], Jessica Fonseca [2] (1. Kean University, 2. Kean)

The Impact of COVID-19 on Consumer Behavior in Social Commerce

Zhangliang Pan [1], Zyasia Nash [1] (1. Kean University)

Cultural Intelligence and Leadership: The Impact on Organizational Performance

Jessica Fonseca [1], Sandra Orejarena [1] (1. Kean University)

Emotional Intelligence, Trust, Self-efficacy and Task Behavior: Longitudinal Study of Achievement Approach to Leadership Emergence

Justin Antonio [1], Janell Laws [1] (1. Kean University)

Critical Success Factor Model of Virtual Internship Program under COVID-19

Mitchell Lanzl [1], Jephte Philippe [1] (1. Kean University)

An Analysis of Successful Crowdfunding Campaigns: Kickstarter

William Riherd [1], Dafe Uvieghara [1], Alvaro Rodriguez [1], Caitlyn Kim [1] (1. Boston College)

Deptford, NJ Starbucks Process Analysis

Tyler Bell [1] (1. Rowan University)

Proposal of preventive care service considering the factors that prevent the elderly from going out

Tomoki Sanada [1], Aya Ishigaki [1] (1. Tokyo University of Science)

An Analysis of Length of Stay and Readmissions of AMI Patients: A Nationwide Analysis Using Statistical Process Control

Hannah Beazoglou [1], Fatma Pakdil [1] (1. Eastern Connecticut State University)

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Drivers of FDIs: New evidence in West African regions

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This paper examines the factors that attract Foreign Direct Investments (FDIs) in 16 West Africa regions from the period 1989 - 2018. The fixed and random effects models show that demand for the sourced countries' products (import size) is the major driver of FDI inflows in WAC. Other drivers revealed by the study are natural resources, how a country is open to trade, and the strength of the exchange rate. The study has given a different dimension on the factors that influence FDIs and has contributed to theory and practice in emerging countries perspective.

EXPANDING DATA ANALYSIS IN ACCOUNTING RESEARCH: VARIATION IN CRITICAL AUDIT MATTER MANDATED REPORTING

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Abstract:

More sophisticated and lower-cost methods of tracking business activities have led to expanded use of data analytics in business reporting and decision-making. What began with simple trend analysis and correlations has now expanded into textual analysis of business communications. This had led to the need for more sophisticated data extraction, cleaning and analysis tools. Many accounting researchers lack the expertise in using such tools, requiring instead collaborative work with technology experts to investigate and answer emerging questions in accounting and other business fields. We present, as an example, the use of data tools to evaluate the usefulness of auditors' reports about critical audit matters (CAM). The professional expertise of an experienced audit practitioner and researcher is combined with the technical expertise of an experienced data analytic researcher to investigate a vital issue for professional accountants, regulators and academicians.

Key words: critical audit matters, auditing, data extraction, big data, textual analysis

Introduction

More sophisticated and lower-cost methods of tracking business activities have led to an exponential growth in data capture within businesses and industries. Smaller firms are able to use complex accounting software to track ever-greater detail about their business activity. Larger firms are able to use data collection and analysis to respond quickly to changes in customer demands or more effectively manage costs. In turn, this has led to expanded use of data analytics in business reporting and decision-making.

The result is closer ties between various business disciplines, with academic programs incorporating decision science skills and concepts into more traditional business majors. One such discipline is financial accounting, which is focuses on communication of business results to outsiders. Big data analysis tools are being used to increase the efficiency of audit testing, looking for outliers and anomalies. They are being used by forensic accounting to identify fraudulent activity for legal cases. The accounting profession and related academic discipline themselves are rapidly changing as technology infuses and alters almost every aspect of the field.

The most recent report by the Association of International Certified Professional Accountants noted "increased demand for technology skills is shifting the accounting firm hiring model. This is leading to more non-accounting graduates being hired, particularly in the audit function." (2019)

Understandably, most uses of decision science tools in accounting have focused on the quantitative results: analyzing transactions for unusually large or small amounts, searching for amounts outside of expected ranges, finding duplicate or missing transactions, or noting trends that do not match projections or industry results. However, what began with simple trend analysis and correlations has now expanded into textual analysis of business communications.

Accounting practitioners are now turning data analysis on the qualitative information as more sophisticated textual analysis allows them to evaluate the explanations that accompany the qualitative results. Most accounting information released to the public is presented with extensive explanations. An annual 10 K of a public company can run to over 100 pages, with only a fraction of the data number-based. Quarterly financial reporting is generally shared with press releases and conference calls to allow the firms to put the quantitative data in context. As accounting is essentially the universal business communication tool, it is critical for accountants to use decision science tools to ensure that those communications convey useful and informative information.

Big data analytics have opened up to examination more of the information businesses release, such as press releases, earnings announcements, and Securities and Exchange Commission (SEC) filings. This had led to the need for more sophisticated data mining and extraction, cleaning, and analysis tools. As many accounting researchers studied and worked in earlier quantitative eras, they may lack the expertise in using such tools, requiring instead collaborative work with technology experts to investigate and answer emerging questions in accounting and other business fields.

We present, as an example of this collaboration, the use of data tools to evaluate the usefulness of auditors' reports about critical audit matters (CAM). This is one type of qualitative accounting information that shows the potential benefits of expanding textual analysis into more areas of financial reporting. Over time, the audit report has become a boilerplate text with a simple pass/fail assessment. Beginning for all large public companies audited after June 30, 2019 and all other public companies audited after December 15, 2020, the SEC has mandated reporting on CAM be included with the audit report. However, the new rules do not specifically

define what must be included and what is not relevant. Therefore, while most of the report is essentially identical for most firms, this new section *should* be unique to each firm. It should discuss matters that are specific to the one firm, not simply to an industry. Our purpose is to examine the additional reporting content to determine the level of uniqueness and relevance for individual companies. Such information is vital to the practitioners as it can help ensure that these reporting requirements have the greatest chance of succeeding in meeting the information needs of stakeholders. It can also inform best practices for the profession with regard to the CAM.

We find that this unique information approximately doubles the length of the audit report compared to the standard opinion report. We also find that the tone is more negative than positive and couched more in terms of potential issues rather than likely issues. Interestingly, the length is not tied to the tone of the material, but is tied to the use of Ernst and Young as auditor. The tone of the CAM is most associated with the use of more uncertain words, indicating that the ambiguity requires a greater number of negative words to convey its meaning. While the CAM appear to have been presented with a focus on potential negative outcomes for the client firms, there is a great variety of text reflecting the unique aspects of each firm.

The results of this study provide vital information to practitioners as it can help ensure that these reporting requirements have the greatest chance of succeeding in meeting the information needs of stakeholders. It can also inform best practices for the profession with regard to the CAM. Our study of the textual analysis can help inform auditor training and skill development. It can also provide an insight into new areas of joint research, combining the data extraction and analytic skills with the business understanding of accountants.

The next section discusses the background of PCAOB audit standards and disclosures, previous literature regarding the content and efficacy of these disclosures and the use of textual analysis in accounting research. Section 3 describes the research question development. Section 4 addresses the sample selection process and extraction tools used, including variable descriptions. Univariate and multivariate results of a sample OLS model and hypotheses are included in section 5. A discussion of the need for cross-discipline research as highlighted by the sample model is included in Section 6. Section 7 concludes.

Background and Hypothesis Development for CAM Study

PCAOB Audit Standard AS 3101

The PCAOB issued AS 3101 in 2017 to update the audit reports of public companies. While most provisions went into effect in 2017, one set of provisions was delayed until 2019. These provisions related to the communications of critical audit matters (CAM). CAM are matters that must already be communicated to the audit committee of the audit client firm. They related to material amounts and disclosures that "involved especially challenging, subjective, or complex auditor judgment." (Public Company Accounting Oversight Board (PCAOB) 2017, 1)

The new standard took over six years to finalize as the PCOAB sought to balance investor needs for more information regarding the audit and audit process with auditor concerns regarding expanding the role of auditors beyond their expertise. While major auditing firms have spent tens of millions of dollars on data analysis tools and training, the audit reports themselves have been proscribed down to the punctuation by auditing standards and legal review.

The majority of the provisions seek to make the audit report easier to read and understand. The CAM provisions, however, seek to provide additional information beyond the standard pass/fail opinion of the auditor's report. It is a part of the report where auditors are expected to customize

the disclosures to the client firm and the related audit processes. Auditors are not in the habit of creating unique reporting information. This new CAM reporting requirement will force firms to develop new communication skills.

To aid auditors in the transition to the expanded reporting requirements, the CAM provisions were delayed two years, expressly "to provide accounting firms, companies, and audit committees more time to prepare for implementation." (Public Company Accounting Oversight Board (PCAOB) 2017, 3) As a result, the CAM requirements went into effect for large, accelerated filers (LAF)[1] for fiscal years ending on or after June 30, 2019. All other required filers had until fiscal years ending on or after December 15, 2020. However, the new rules do not specifically define what must be included and what is not relevant. The decision has been left up to the auditor examining the company and preparing the report. This has led many auditing firms to look for ways to assess what the SEC is expecting. The concern is that these reports will fall into the same trap as the original opinion and become a boilerplate list of all the most common areas of concern for all companies.

Disclosures Other than AS 3101 Requirements

The basic structure, content and text of the audit report is carefully defined in the auditing standards set by the PCAOB. Appendix A provides a sample unqualified audit report as required by the PCAOB.[2] Variations to these audit reports can only add text, not replace or remove it. There are several types of additional text, commonly referred to as explanatory language, which may be included in the audit report. These include information about the use of other auditors,

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[1] Large, accelerated filers are defined by the SEC as public firms (1) with $700 million or more in public float on the last business day of the issuer's most recent second fiscal quarter, (2) that have filed at least one annual report (10K), and (3) are subject to SEC requirements for at least 12 months. (Securities and Exchange Commission 2020)
[2] Note that we focus our analysis on unqualified ("clean") opinions only. These are the only opinions released by public firms per SEC requirements and any variation in these is not related to the overall reliability of the underlying financial reporting. Throughout this paper, we use "audit report" and "audit opinion" to refer solely to unqualified opinions.

material changes in accounting methods used by the client firm, the restatement of prior financial statements or the adoption of a new accounting standard. Note that none of this explanatory language changes the auditor's opinion of the reasonableness of the financial statements. They are designed to merely highlight or emphasize a point that may help users to interpret the financial information referenced.

Previous literature on these disclosures includes examination of explanatory language regarding the audit process and financial reporting. Demek, Kaplan and Winn (2020) study the impact Rule 29 has on investors. This rule allows principal auditors to provide information about the use of other auditors in an appendix to the audit report. Such information is required by Rule 29 to be disclosed at the PCAOB website, but can be added to the audit report itself to improve transparency. They find that the more forthcoming the principal auditor is regarding the use of others (by voluntarily adding it to the audit report), the more positively the investors take the disclosure as a signal of overall audit quality.

Czerney, Schmidt and Thompson (2014) examine explanatory language for clues to future financial statement restatements. They find that the areas of the audit or financial statements discussed in the explanatory language corresponds to the areas requiring future restatements, indicating that auditors may be using the explanatory language to identify the higher risk areas of the audit. The use of this explanatory language has been increasing post-2000 and may be a means for auditors to address the uncertainties of an audit without having found specific misstatements. However, their follow-up research (Czerney, Schmidt, & Thompson, 2019) finds that investors do not respond to this explanatory language as a predictor of misstatement risk, missing out on 55% of the information contained in the explanatory language.

Other disclosure elements that are relevant here include the nature of disclosure behavior in general. Lin, Mao and Wang (2018) note that management voluntary disclosures are sticky, especially in terms of the decision to cease certain disclosures. This phenomenon may carry through to auditor disclosure behavior as well, influencing the manner in which auditors determine their CAM disclosures. It is not unreasonable to consider that audit firms, once they begin to define an issue as a CAM would be reluctant to remove it in future CAM. Other studies note the endogeneity of auditor and management disclosure as auditors examine both quantitative and qualitative management material prior to preparing the audit report and may influence the level of detail in management disclosures. (Legoria, Reichelt, & Soileau, 2018; Mayew, Sethuraman, & Venkatachalam, 2015) This mutual influence may lead to auditors matching the risks identified by management rather than providing unique information. Finally, Brown and Tucker (2011) note that management disclosures have tended to grow over time, resulting in less usefulness to stakeholders. This concern could be especially relevant to auditors as the CAM requirement is itself a response to reduced value and usefulness of the standard audit report. Combining the tendency for disclosures to grow with the stickiness phenomenon described above could lead to longer and more generic CAM disclosures.

Critical Audit Matters

As the AS 3101 reporting requirement is new, there is limited research on the topic. Most research to date has involved experiments to assess how hypothetical users would value the information. Some has been focused on the potential effect this could have on how jurors view auditors and audit reporting when a public company has a significant financial statement error. Brasel, Doxey, Grenier, and Reffett (2016) conducted an experiment during the time the requirement was under consideration on the effect of hypothetical CAM reporting on jurors in

cases of auditor liability. They focus on a hypothetical case of a company that had significantly misreported its financial position. The auditors had not found the error and the subjects were asked to participate as jurors to decide the level of negligence by the auditor. The experiment manipulated the type of reporting auditors provided about CAM. They find that the reporting of CAM may actually reduce the probability that auditors will be held liable for the financial statement error.

Gimbar, Hansser and Ozlanski (2016) conduct an experiment focused on the precision of the potential CAM on jurors' assessments of auditor negligence. Their concern is that identifying specific areas of financial reporting as judgment heavy will affect how the jurors view the auditors' task and expectations. The conclusion is that a lack of precision in the CAM can lead jurors to blame auditors more for a significant financial statement error.

Vinson, Robertson, and Cockrell (2019) conduct an experiment on changing the number or content of CAM on jurors' assessment of liability. In this study, subjected acted as jurors in evaluating a significant financial reporting error that caused losses to the hypothetical company's lender. This experiment manipulated the reporting of CAM by having some removed one year after having been reported. Their study suggests that once CAM are reported, any changes in subsequent years will increase auditor liability, as jurors believe the risks were known to the auditors.

Another line of research focuses on how the readers of the report actually take in and use the information. Sirois, Bedard, and Bera (2018) use an eye-tracking study to determine whether or to what extent readers of the report focus on the CAM. The researchers manipulated the reporting by changing the number and location of CAM. They find that readers are drawn to the

CAM especially in the audit report, but the more CAM reported the less readers use the other financial information in the report.

An experiment by Christensen, Glover and Wolfe (2014) examined nonprofessional readers' decisions to invest in a company based upon the existence or placement of the CAM. Study participants were more likely to change their investment decision if the auditor reported a CAM as opposed to the boilerplate audit report. Researchers also noted that participants' decision-making was influenced by auditor reporting of CAM more than company management reporting of the same CAM. Finally, the CAM have greater influence on participants when they are reported simply as a critical issue without follow-up resolution.

Dennis, Griffin and Zehms (2019) test the joint effects of management and auditor disclosure of CAM by comparing user perceptions of receiving the information from only one source or both. They find that the narrative structure of both disclosures can make using the information difficult. They also find that users are more concerned with the content of the disclosure if only the auditor includes it. This is seen as a signal that management is hiding something, but the auditor is trying to provide a check on that lack of transparency. Finally, it finds that having an auditor disclose a CAM can spur management also to discuss the issue in its own disclosures.

Finally, Chen, Jiang and Zhang (2019) develop a mathematical model to assess the benefits of disclosing information such as CAM on the efficiency of auditors and their potential liability if they do not find a significant error. The subject of liability as an incentive for auditors has been previously evaluated in other settings. Here, the authors focus on the efficiency of auditors in finding and reporting potential problems in the CAM. Their concern is that auditors will spend more time and effort on testing for potential problems if they fear being held accountable for not raising a concern, even if they find no financial reporting problem. The study finds that

reporting CAM only improves the auditor efforts when the public company has weak reporting quality and auditors assume stakeholders will look to them as insurance for a bad investment.

Textual Analysis

Textual analysis is a growing area of accounting research. As more information is available from management and external sources, and computing powers continue to expand, accountants are not limited to testing numerical data to identify risks or document trends. At least as far back as Botosan (1997) and Bryan (1997), researchers have studied the linguistic clues in various management reports using a variety of methods. Henry (2006) uses an event study of market reactions to earnings releases that incorporates verbal content and writing style. She finds that including verbal cues improves her model's ability to predict abnormal market returns by over 5%.

Li (2010) uses a machine-learning approach to analyzing the Management Discussion and Analysis (MD&A) portion of annual reports. This method allowed him to use 30,000 individual sentences from MD&As included in 10Ks between 1994 and 2007 as a training data set. With this set, he developed a machine-learning program to evaluate approximately 13 million sentences in the MD&As. His conclusions correlates the verbal tone of the disclosures to various firm characteristics and to future performance.

Research Question Development

Previous research showed that management used great variability in its communication about the results of business activity. (Cazier, Merkley, & Treu, 2020; Mayew, Sethuraman, & Venkatachalam, 2015; Brown and Tucker 2011) However as mentioned, auditors are not trained to do this. While during the course of an audit, accounting professionals do develop a great deal of unique information about their clients, this is primarily used to assess risks to the audit itself

or to notify management of potential risks, not to outside users. There is some emphasis-of-matter disclosure in the audit reports that can vary by audit firm and client. It is therefore an open question as to whether the mandated CAM reporting will provide the amount of unique information standard setters and the business community would like.

To complicate the issue, this requirement had only been mandated for LAFs, approximately 90% of which use one of the Big 4 largest accounting firms. (See Table 1, Panel C for details.) Within these firms, there is likely some standardization, lessening the expected variability of the CAM reports. For while auditors gather a great deal of unique information about clients, the limited number of firms and history of limited disclosure may preclude useful disclosure.

On the other side of the argument, audit firms are well aware of the intent of the new standard. As noted in the PCAOB's own staff guidance, "The purpose of critical audit matters (CAMs) is to provide audit-specific information that is meaningful to investors and other financial statement users about matters that required especially challenging, subjective, or complex auditor judgment – as one commenter put it, 'the things that keep the auditor up at night.' CAMs are determined from matters arising from the audit of the financial statements, and thus are rooted in the financial statements themselves." (Public Company Accounting Oversight Board (PCAOB), 2019)

With these competing pressures, it remains to be determined how unique these CAM are. Uniqueness can be measured in several ways: length of disclosure, tone of disclosure, usage of common words. Textual analysis can provide us with the information on these aspects of the CAM and help to determine the variation contained in them.

Sample Selection and Extraction Tools

Sample selection began with the master index files from the Security and Exchange

Commission's (SEC) EDGAR system. All such files through 2019 were accessed via the wrds

dataset. All master index files for 2020 were downloaded from the SEC's website and added to

the wrds dataset. We then pared these down to 10K reports filed between June 30, 2019 and

December 31, 2020, the initial year of the new standard, resulting in 14,548 files. We removed

filings for fiscal year ends prior to June 30, 2019 and filings that were later amended (keeping

the most current version of the filing). We then used Python to extract the audit reports from

each of these files into an Excel file for further analysis. As shown in Appendix A, the text is

very standardized, complete with headings, allowing us to search for specific content to extract.

Next, we extracted any unique language from the audit reports. This allowed us to sort CAM

reporting from other matters that may have been reported, such as a merger. This unique

information was added to the Excel file and the CAMS were sorted separately. Doing this

allowed us to use linguistic software to analyze all the unique content and the CAMs. We used

the LIWC2015 program to analyze the text of the CAMs and other unique content for length,

tone and style. Appendix B provides a list of the most common words used in the CAM reports.

As shown on the list, terms related to uncertainty top the list, followed by more financial and

accounting terms.

Financial data from Compustat was reviewed to ensure that the firms did not have significant

financial results that would have necessitated specialized reporting. The final sample includes

5,606 files. Of these, 2,122 files relate to firms designated as large, accelerated filers by the

SEC. These are the only ones required to add CAM language to the audit report. Table 1, Panel

A provides information on the sample selection process. Next, Table 1, Panel B provides a

breakdown of the reporting requirements of the final sample. As shown, about 38% of the sample are LAFs. Finally, Table 1, Panel C shows the audit firms used by the companies in the sample. While 90% of the LAF use one of the Big 4 firms, only about half of the entire sample use those firms. Thus, regardless of the results with the accelerated filers, the variation in the CAM reports may expand over time simply as more companies, using different audit firms, are required to report. This opens avenues for further study as technological text extraction can be refined and repeated in ways hand-collection of data cannot.

Descriptive Statistics and Empirical Results for CAM Study

As the primary objective of this paper is to show uses for new data analysis tools in the accounting realm, we focused on two areas: data extraction tools to gather and organize new datasets and testing using the linguistic software. Much work has been done in accounting research on the quantitative data included in the annual reports. For example, see Bharati, Crain, and Jategaonkar (2019) and Chung Hrazdil and Suwanyangyuan (2016) for quantitative analyses. Our focus is on using the qualitative data to find new information about the usefulness of the text of the reports. This can be expanded into other areas of financial reporting, providing both accounting practitioners and users of financial information a more complete understanding of the firms and industries in question. To this end, we focus most of our statistical analysis on the LIWC2015 textual analysis data, not traditional financial markers.

Descriptive Statistics and Correlations

The basic word counts of the CAMs and the counts of model variables is included in Table 2, Panel A. As shown, there is great variability in the length of the CAM reported and tone used in each. We find that firms reporting this extra, unique information used an average of 799 words to do so, about twice the length of the standard text of the audit report. The negative mean of the

tone is the result of the words being statistically more negative than positive (untabulated results with p-value = 0.00), reflecting the nature of the material covered. They also use statistically fewer strong-modal words compared to weak-modal words (untabulated results with p-value = 0.00). This means that more of the text is couched in terms of possibilities, not certainties or likelihoods.

Table 2, Panel B shows the correlations between the word counts, length, and audit firm. Interestingly, strong-modal words are negatively correlated with the length of the CAM, while weak-modal words are slightly positively correlated with the length of the CAM. This implies that more certainty in the tone of the CAM results in shorter CAM, while more uncertainty results in longer CAM. Of the Big 4 audit firms, Ernst and Young is most strongly correlated with the overall CAM word count, while PriceWaterhouseCoopers is most strongly correlated with sentence length. Deloitte and Touche is most strongly correlated with strong modal words, indicating a more intense disclosure with less uncertainty. KPMG is not strongly correlated with any of the textual variables. This lends credence to the idea that firms develop an internal standard to use with clients, so overall market variation may be increased by using a greater number of audit firms before it is increased within each firm.

Sample Model for Future Studies

We have included an incomplete regression model even though we are only using textual variables to show the future of this type of research in accounting and related fields. This is based on two hypotheses derived from our research question, stated in the null form:

H1: CAM disclosures for large accelerated filers will demonstrate limited variability in length.

H2: CAM disclosures for large accelerated filers will demonstrate limited variability in verbal tone.

To test our two hypotheses, we use univariate and multivariate analysis. In testing H1, univariate results show significant range (383 to 1,740) and standard deviation (353.83) in CAM word count (Table 2, Panel A), providing evidence that CAM for LAF do, in fact, demonstrate great variety in length. Additional analysis in multivariate testing may provide more evidence that CAM are not limited in word count, tone or the use of common words. To that end, we use the following model to test our H1:

$$Length = \beta_0 + \beta_1 Wps + \beta_2 Tone + \beta_3 Strong + \beta_4 Weak + \beta_5 EY + \beta_6 DT + \beta_7 KPMG + \beta_8 PWC + \varepsilon$$

$$(1)$$

Length is the total word count of the CAM. **Wps** is the LIWC2015 score for average words per sentence. This is often used as a measure of the complexity of the text. **Tone** is the LIWC2015 score for net tone, defined as the difference between the percentage of positive words and the percentage of negative words. Cazier, Merley, & Treu (2020) find that tone has an impact on readers' interpretation of the data, implying that variability in this could be a means of conveying unique information. **Strong** is the LIWC2015 score for what it terms strong-modal words. These convey greater certainty or impact, indicating the text is conveying more direct concerns, as opposed to more hypothetical concerns. Given the nature and PCAOB's stated goals for CAM, this provides a measure of the usefulness of the CAM. **Weak** is the LIWC2015 score for what it terms weak-modal words. These convey more uncertainty or possibilities, which often take more words, and more types of words, to explain. **EY**, **DT**, **KPMG**, and **PWC** are dichotomous variables noting whether the CAM was prepared by the particular audit firm. As these firms have resources to provide researched, standardized training on CAM, they are likely to issue CAM with similarities in style, tone or length.

For H2, the variation in tone is tested with the following model:

$$Tone = \beta_0 + \beta_1 Wps + \beta_2 Uncertain + \beta_3 Strong + \beta_4 Weak + \beta_5 EY + \beta_6 DT + \beta_7 KPMG + \beta_8 PWC + \varepsilon \qquad (2)$$

All variables as defined as above with Model 1, with the exception of ***Uncertain***. This is the LIWC2015 score for words denoting more contingent or imprecise language (Loughran & McDonald, 2011). It may account for variation in tone by changing the manner in which topics are explained.

Table 3 shows the regression and the variable descriptions. None of the variables is significantly associated with the length of the CAMs. This is not necessarily surprising. The R-squared of this regression is 21%. While textual analysis can be very valuable, it could be tied to quantitative information as well. Accounting research has developed expectations of what information is useful and how to measure that use for quantitative data. A merger of those methods with linguistic extraction and analysis likely would provide beneficial information on the new CAM standards and other disclosure topics.

Data Analysis in Accounting Research Revisited

It is clear that there are two growing trends in accounting: more information of a textual nature and exponential growth of the overall quantity of information available to analyze. It is critical that cross-discipline research develop new methods of gathering or extracting data to allow an understanding of this growing data environment. In our preliminary example study above, additional study may find that the length of the CAMs may be more related to the size of the firm or the length of the overall annual report. It is likely that the length may not be the most relevant variable. In this setting, the most important factor was uniqueness. The new CAM requirements are intended to provide information not found elsewhere. Other possible avenues of testing would include extracting other text from the annual report and comparing key words or phrases

to find content not described elsewhere. The key word listing in Appendix B provides more information about the type of content reported. Trend analysis of this listing may help determine how the CAM reports are evolving over time.

Additionally, combining qualitative and quantitative data require new approaches to research. Adding the skills of decision science experts to the financial understanding of accounting or other business disciplines can pave the way to better understanding of the usefulness of information and more rapid improvement in reporting to the business community.

Conclusion

This paper is intended to bring greater focus on the need to develop inter-disciplinary research in the business information environment. The business world is being inundated with data and decision scientists are in a position to help manage and analyze that data. However, an approach tied to specific business disciplines and their more pressing topics can help ensure that this expansion is both rapid and relevant. We provided a simple textual analysis of an accounting concern to demonstrate the need to work together to study an issue that accountants are not used to testing: words. While accounting research has a long history of *quantitative* research, the reality is that more information is coming in *qualitative* form. This requires tools and skills in data extraction and cleaning, parsing, and linguistic analysis and the ability to merge this information with existing quantitative data.

Our study of the newly required critical audit matter reporting by auditors showed that the limited guidance provided by standard setters was filled in part by audit firms themselves, with certain traits correlated with specific firms. We were able to discern the most common issues disclosed, including concern over estimates, valuation and testing. We noted distinct

characteristics of the tone and language used in the CAM reporting, with statistically significant trends to more negative and uncertain words, consistent with the word list topics.

We also discussed further expansion of this research to compare auditor reporting to management reporting, analysis of trends over time and across audit firms, and quantitative information about the companies. Developing these more robust research programs can help provide feedback to financial regulators, standard-setters, practitioners and business community members that is more relevant, timely and complete.

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Appendix A – Standard Audit Report with no Explanatory Language

Report of Independent Registered Public Accounting Firm

To the shareholders and the board of directors of X Company

Opinion on the Financial Statements

We have audited the accompanying balance sheets of X Company (the "Company") as of December 31, 20X2 and 20X1, the related statements of [titles of the financial statements, e.g., income, comprehensive income, stockholders' equity, and cash flows], for each of the three years in the period ended December 31, 20X2, and the related notes [and schedules] (collectively referred to as the "financial statements"). In our opinion, the financial statements present fairly, in all material respects, the financial position of the Company as of [at] December 31, 20X2 and 20X1, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 20X2, in conformity with [the applicable financial reporting framework].

Basis for Opinion

These financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's financial statements based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) ("PCAOB") and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical Audit Matters (if included)

[Signature]

We have served as the Company's auditor since [year].

[City and State or Country]

[Date][3]

---

[3] This text come directly from the PCAOB Release related to auditing standard AS 3101. (2017, A1-16)

Appendix B – Most Common Words in CAM

1. Evaluate
2. Estimate
3. Relate
4. Value
5. Use
6. Financial
7. Assumption
8. Procedures
9. Test
10. Rate
11. Fair
12. Significant
13. Communicated
14. Revenue
15. Consolidate
16. Determine
17. Control
18. Judgment
19. Tax
20. Asset
21. Account
22. Valuation
23. Opinion
24. Discount
25. Customer

Table 1: Sample Selection

Panel A: Full Sample Selection

10K filings from SEC from June 30, 2019 to June 29, 2020	14,548
Less: Filings related to FYE prior to AS 3101 period or duplicate / incomplete records	8,942
10K filings sample	5,606
Less: 10K filings not required to include CAM	3,484
10K filings from large, accelerated filers with CAM	2,122

Panel B: Sample Firms by Filing Type

Large, accelerated filer (LAF)	2,122
Accelerated filer	1,236
Smaller reporting accelerated filer	2
Non-accelerated filer	2,241
Smaller reporting filer	5
Not assigned	0
Total	5,606

Panel C: Sample Firms by Audit Firm

	Total sample	LAF only
Deliotte & Touche	708	432
Ernst & Young	908	603
KPMG	594	400
PricewaterhouseCoopers	612	465
Other firms	2,784	222
Total	5,606	2,122

Table 2: Descriptive Statistics and Correlations

Panel A: Descriptive Statistics

	Mean	Median	Minimum	Maximum
CAM Word Count	799.40	694.50	383.00	1,740.00
CAM Words per Sentence	36.40	35.87	26.52	53.67
CAM Positive Words	0.21	0.00	0.00	2.40
CAM Negative Words	1.66	1.57	0.81	2.61
CAM Strong Modal Words	0.03	0.00	0.00	0.52
CAM Weak Modal Words	0.13	0.13	0.00	0.45

Panel B: Correlation Table

	CAM Word Count	CAM Words per Sentence	CAM Positive Words	CAM Negative Words	CAM Strong Modal Words	CAM Weak Modal Words
CAM Word Count	1.00					
CAM Words per Sentence	(0.04)	1.00				
CAM Positive Words	0.04	(0.04)	1.00			
CAM Negative Words	0.08	(0.05)	(0.08)	1.00		
CAM Strong Modal Words	(0.23)	(0.26)	0.06	0.20	1.00	
CAM Weak Modal Words	0.04	(0.26)	(0.28)	0.22	(0.21)	1.00
ErnstYoung	0.33	(0.30)	0.33	(0.10)	(0.08)	0.17
DeloitteTouche	(0.23)	(0.12)	(0.02)	(0.02)	0.45	0.08
KPMG	0.03	(0.10)	0.11	0.14	0.02	(0.03)
PriceWaterhouseCoopers	(0.05)	0.40	(0.21)	0.11	(0.23)	(0.15)

Table 3: Regression Results

	Coefficients	*P-value*
Intercept	676.53	0.17
CAM Words per Sentence	(0.73)	0.95
CAM Positive Words	(95.09)	0.55
CAM Negative Words	139.94	0.28
CAM Strong Modal Words	(1,012.09)	0.21
CAM Weak Modal Words	(478.05)	0.42
ErnstYoung	396.57	0.11
DeloitteTouche	(35.98)	0.87
KPMG	47.35	0.83
PriceWaterhouseCoopers	(45.30)	0.80

R Square	0.21

CAM Words per Sentence is the average length of each sentence in each CAM field, based on linguistic definitions. *CAM Positive Words* are the percentage of positive-associated words in each CAM field that were included in a standard dictionary of business tonal words. *CAM Negative Words* are the percentage of negative-associated words in each CAM field that were included in a standard dictionary of business tonal words. *CAM Strong Modal Words* are the percentage of words in each CAM field representing certainty or necessity as included in a standard dictionary of business tonal words. *CAM Weak Modal Words* are the percentage of words in each CAM field representing uncertainty or possibility as included in a standard dictionary of business tonal words. *ErnstYoung* is a dichotomous variable set to 1 if the audit firm that prepared the CAM was Ernst and Young, 0 otherwise. *DeloitteTouche* is a dichotomous variable set to 1 if the audit firm that prepared the CAM was Deloitte and Touche, 0 otherwise. *KPMG* is a dichotomous variable set to 1 if the audit firm that prepared the CAM was KPMG, 0 otherwise. *PriceWaterhouseCoopers* is a dichotomous variable set to 1 if the audit firm that prepared the CAM was PriceWaterhouseCoopers, 0 otherwise.

NEDSI Conference 2021

FUTURES FOR WATER H2O, A SIGN OF ENVIRONMENTAL AND FINANCIAL RISKS WITHOUT DATA REPORTED BY COMPANIES

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ABSTRACT

In the United States the opening of the Index Veles Water in 2020 is calling our attention of the importance of environmental risk in this nation and around the world. Wall Street is selling Futures of the Water, as a commodity like oil and gold. This fact is talking about the necessity to recognize the urgent action for protecting the environment and the water which is a vital liquid. However, some companies do not report data regarding their environmental and financial impact. Pressure made by investors to companies to disclose financial information regarding environmental and financial risk such as water is a red light for all.

Key words: Futures for water, environmental risk, financial risk, data.

FUTURES FOR WATER H2O, A SIGN OF ENVIRONMENTAL AND FINANCIAL RISKS WITHOUT DATA REPORTED BY COMPANIES

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Introduction

The United Nations in its Agenda 2030, Goal 6 dedicated to water is alerting this issue, about 2.2 billion people in 2017 in the world lack safely managed drinking water. This is a result of the growing population that require water for basic use, economic development, land use and climate change. But the deterioration of the freshwater ecosystem in the world is affected by several factors (Corcoran et al., 2010) such as the pollution of water (wastewater) by developing nations and the excessive use of water by developed nations (Bogardi, et al.,2020). That situation impacts the quality and quantity of water as natural resource.

Considering this scenario of contaminated water not only in one nation but in the whole world, that issue requires a fast action from countries as is stated by the United Nations, 2030 Agenda, Goal 6.

The water and its protection require to realize its importance as a basic component in life and the view of water as vital liquid, instead of utilitarian purpose that the Futures for Water H2O is highlighting. In addition, it will be better for the future of the world to educate people regarding the sustainable development of the water and the whole ecosystems.

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PASS-THROUGH EFFECT OF OIL ON LATIN AMERICAN EMERGING STOCKS IN A PRE AND DURING COVID- 19:

AN EVIDENCE THROUGH WAVELETS AND VAR APPROACH

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Abstract

An evidence of wide range of possible connections between oil price and LATAM stock markets is analyzed through Coherent Wavelet analysis which can best be applied to the identification of patterns in a time series. A mixture of time varying parameter VAR model is used to study the impact of oil prices shocks on the LATAM stock returns. The standard deviations of the demand side structural shocks during the pandemic have remained high. Pass-through effects of oil to stocks vary at different time frames. The contribution of oil market specific demand price has shown fundamental linkages rather than pure contagion. The effect of oil prices innovations on stock markets returns depends on timing.

Keywords: Wavelets, VAR, oil pass-through, stock markets.

Introduction

The oil price volatility has an increasing influence on the economic growth. Research studies have analyzed the impact of non anticipated fluctuations of international crude oil prices of developed economies [Barsky and Kilian 2004; Kilian 2008; Hamilton 2009[a]]. Volatility in the oil prices is assumed to be passing through to other goods prices in both direct and indirect ways. Research studies on Oil pass through in the economies have shown that investment expenditures have responded to energy Price shocks [Edelstein & Kilian, 2007]. The effects of changes in crude oil prices on inflation use aggregate measures of inflation or a very simple disaggregation (energy/non-energy) who conclude that there is mainly a direct effect through the energy component, while indirect and second-round effects are commonly less important (ECB 2010). Research on disaggreagated European data analyzed the effects of crude oil price shocks on inflation at disaggregate level for the euro area and its four main economies (France, Germany, Italy and Spain), through the objective of comparing the magnitude and timing of such effects across countries and assessing the impact on competitiveness among them [Castro et al., 2017]. However its impact in the stock markets have been argued to be in opposite directions [Federal Reserve Bank of Cleveland].

A panel data analysis of LATAM markets with a random effects model, using the world stock market index Morgan Stanley Capital International World Index, domestic money market rates, and currency exchange rates as control variables for monthly observations from 2000-2015 suggests that, after controlling for the individual countries non-observed characteristics, oil prices explain positively monthly returns of the stock markets (Santillan et al., 2017).

The paper is organized as follows. A literature review of work on the effect of oil prices on stock returns is presented in Section 2. Section 3 presents the research motivation. The research methodology and data are presented in Section 4. Section 5 discusses empirical results on the dynamics of oil price shocks and stock market and presents robustness results. Finally, section 6 concludes and presents the future research plans.

Review of literature

The Crude oil price movements had a major impact on the World economies, while oil price shocks have implications to international stock market returns in terms of asset allocation and portfolio risk management. There are different kinds of conclusions that have addressed oil-stock relationships. The studies can be divided into three strands of literature, first one finds a negative relationship between oil shock and stock returns (Kaul & Jones, 1996; Kilian & Park, 2009; Kling, 1985); a second, show positive linkages between oil and stock markets (El-Sharif et al., 2005; Narayan & Narayan, 2010). A third strand of the literature reports insignificant relationships (Apergis & Miller, 2009; Henriques & Sadorsky, 2008).

Narayan and Sharma (2011) investigated the oil price and 560 U.S. firm returns and show that oil price affects firm's returns differently depending on their sectoral location. Moreover, the authors find that among 14 sectors only five sectors that oil price affects firm returns based on different regimes. Elyasiani, Mansur, and Odusami (2011) study the impact of oil returns and oil return volatility on excess stock returns and return volatilities of thirteen U.S. industries. The results support strong evidence that oil price fluctuations constitute a systematic asset price risk at the industry level. More precisely, nine sectors exhibit statistically significant relationships between oil-futures return distribution and industry excess return. While the majority of the earlier studies focused on mainly western nations, Perry and Lederman (1998) studied the contagion and spillover effects from the Asian crises to Latin American exchange markets to observe if the

previous findings can be replicated in different contexts. Contrary to earlier studies, their investigation reveals that the Asian crises have a significant effect on all the principal exchange markets.

Most studies on the oil prices and stock markets dynamics have been based on econometric methodologies as Vector Autoregressions (VAR) [Kang et al. 2015], Vector Error Correction Models (VECM) [Hammadache, 2012] or the GARCH approach [Alsalman, 2016]. But increasing research has been done based on the wavelet approach which allows for the time scale and frequency analysis of time series [Akoum et al., 2012; Martín-Barragán, 2013; Reboredo & Castro, 2014; Thenmozhi& Srinivasan, 2015; Owusu et al., 2018]. In particular, the wavelet coherency approach allows to identify direction, causality, and timing ofoccurrences between the interactions of time series.

Studies within the developed and emerging markets exploits a novel Corporate Emerging Markets Bond Indices (CEMBIs) database processed with a VAR-CCC model to clarify the nature of such relationships, and makes an objective interpretation of their characteristics.

The major changes in the global oil market were studied by Hamilton (2013) since the early 1970s with fluctuations in the real price of oil, movement in the sources of demand for oil, and shifts in oil production due to geopolitical events, changes in economic motivations, technologies, and resources. Similar work by Baumeister and Peersman (2013a) demonstrated that the volatility of the real price of crude oil has been higher since 1986 and that the volatility of global oil production has trended downwards over the last thirty-five years. Blanchard and Gali (2009) argued that there has been a change in the causal relationship between oil price and the economy, in that increases in oil price are linked with smaller movements in output and inflation in recent years than in the 1970s. Blanchard and Riggi (2013) document that these changes are due to more efficient use of oil, lower real wage rigidity, and better monetary policy.

(Kang et al, 2015) investigated in changes with variance of the structural shocks in the crude oil market over time and in the transmission of oil market shocks to the U.S. stock market over time with time varying parameter VAR (Vector Autoregression) model. The oil price shocks have changed over time and have changing effects on the real economy. The structural form VAR model is based on that in Kilian and Park (2009), the first paper to recognize that in examination

of the connection between crude oil prices and the stock market it is important to identify global influences that might drive both.

Kilian and Park (2009) show that increased global real economic activity is associated with rising oil price and a rising U.S. stock market, and that oil price increases driven by oil-market specific demand shocks, identified by controlling for global demand for commodities and supply disruptions, cause the U.S. stock market to fall.

Research work of Aloui et al. (2013) find positive conditional dependence between crude oil price and stock markets in the transition economies of Central and Eastern Europe. Jiménez-Rodríguez and Sanchez (2005) argue that the negative effects for oil importing countries are reinforced because of intensive trade connections. Aloui et al. (2013) considered the effects of oil price shocks on stock returns in emerging markets classified as heavily oil dependent, moderately oil-dependent, and net-oil exporting.

Motivation of the research

This research work is a motivation of work of Santillan et al and Kilian Park and is applied to understand the pass on through oil prices and its effect on stock returns in the Emerging Stock returns in LATAM Markets.

This study is based on panel data model with the effect of oil prices to stock returns with an application of wavelet coherence analysis where oil and stock time series are decomposed into sub time series. A Vector Auto Regression model is applied to decompose series in a way to identify the pass-through effect in different time horizons and impact of oil shocks to stock returns by the impulse-response functions.

This research work aims to contribute to the literatura in LATAM markets with emerging stock returns with respect to pre covid and during covid to provide the following objectives.

Main objectives

This research work tends to answer the following questions as to identify the time series interactions of oil and stock markets that may vary in different time frames, how the spread over time behaves, the contagion effects and the fundamental sources. It answers to:

- At what times of the year the interactions of oil and stock markets differ? (local correlation)

- In which periods of time occur these differences? (timing)

- How fast do interactions spread over time? (pure contagion or fundamental linkages)

- Do oil pass-through to stock markets? (decomposed VAR)

- How long does it last the impact of oil shocks to stock returns at different time frames? (decomposed impulse-response functions).

Methodology and data

Wavelet analysis

The wavelet draws the movements of index returns over two frequencies bands; low frequency movements when the wavelet transform stretches into a long wavelet function and high frequency movements when it compresses into a short wavelet function (Aguiar-Conraria & Soares, 2011). The wavelet approach has the property of concentrating energy in time to provide an analysis of temporality, non-stationarity and volatility changes over time (Wei et al., 1998; Rua & Nunes, 2009). Wavelet approach performs the estimation of the spectral characteristics of a time series as a function of time, revealing how the different periodic components of the time series change over time (Aguiar-Conraria, Azevedo, & Soares, 2008). It stretches to isolate slow and persistent movements. It also allows us to describe the local behavior of heterogeneous markets participants. Indeed, some participants have an investment horizon of several minutes or hours to several days (e.g., short-term movements of the stock markets) while others are interested with the investment horizon of several weeks or months (e.g., medium-term movements of the stock markets) or an investment horizon of several years (e.g., long-term movements of the stock markets). Wavelet analysis shed more lights on the spillover effects across international stock markets and commodity markets, revealing the potential presence of contagion. On the other hand, the wavelet is useful for a risk management and portfolio diversification.

Methodology.

Fig. 1 shows the methodolgy applied to analyze the oil pass-through to stock returns basedon a hybrid approach in which data is decomposedintodifferent time-scales, then vector auto regressions are applied on pair wise decomposed series and finally the impulse-response functions are estimated to detect the impacto of oil shocks into stock returns.

Fig. 1. The Wavelet-VAR approach.
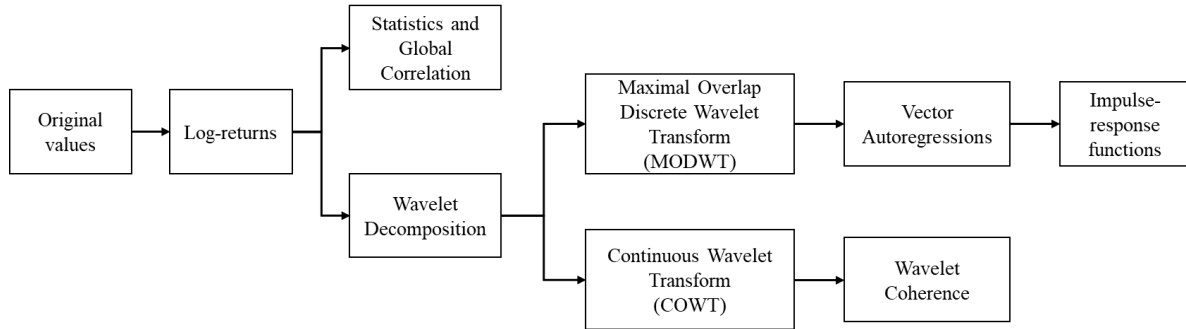
The wavelet based approach considers a process of decomposition into multiple frequency-time scales of a time series, so the analysis called multiresolution decomposition, where each resolution level is referred to a time-scale. This approach has its basis onthe Fourier series analysis which the sine-cosine functions only capture the time series frequencies. Instead, the wavelet analysis allows to decompose the time series into its frequency components at different time scales, where by means of a filtering process it is possible to separate high frequencies from low frequencies. In the first case, high frequencies mostly occur in very short time intervals, whereas the second case indicates that low frequencies may occur in long time intervals. Expression (2) represents the decomposition of a time series *f(t)* into its components occuring in different resolution levels:

$$f(t) = \sum_k s_{j,k}\phi_{j,k}(t) + \sum_k d_{j,k}\phi_{j,k}(t) + \sum_k d_{j-1,k}\psi_{j-1,k}(t) + \cdots + \sum_k d_{1,k}\psi_{1,k}(t), \quad (2)$$

where $\phi(t)$ and $\psi(t)$ are the father and mother wavelet functions, respectively. The father wavelet function allows to approximate the smooth component of the time series, meanwhile the mother

wavelet function approximates the detail components. On the other hand, $s_{j,k}$ are the smooth coefficients and $d_{j,k} \ldots d_{l,k}$ are the detail coefficients, where j and k are the scaling and translation parameters, obtained from the wavelet transform. Based on Daubechies (1988), expressions (3) and (4) define the discretized form of the father and mother wavelets:

$$\phi_{j,k}(t) = 2^{-\frac{j}{2}}\phi\big(2^{-j}t - k\big), \tag{3}$$

$$\psi_{j,k}(t) = 2^{-\frac{j}{2}}\psi\big(2^{-j}t - k\big). \tag{4}$$

An example of a mother wavelet is the Mexican hat function given in expresion (5):

$$\psi(t) = (1 - t^2)e^{\frac{t^2}{2}}. \tag{5}$$

Then, the general decomposed form of a time serie $f(t)$ may be represented in terms of its smooth (S_J) and detailed (D_J) series, as in expression (6):

$$f(t) = S_J(t) + D_J(t) + D_{J-1}(t) + \cdots + D_1(t). \tag{6}$$

The interaction analysis among stock index returns is performed under the wavelet correlation and coherence. The wavelet correlation is estimated by the Maximal Overlap Discrete Wavelet Transform (MODWT) which holds the main characteristic to analyze and discretize a time series $f(t)$ on a scale-based additive decomposition as shown in expression (2), with the advantage that at each scale the wavelet coefficients $s_{j,k}$ and $d_{j,k}$ have the same length as the original time series. In that context, using as mother wavelet the Least Asymmetric Daubechies function, the wavelet correlation unbiased estimator is performed as shown in expression (7):

$$\tilde{\rho}_{X,Y}(\lambda_j) = \frac{\gamma_{X,Y}(\lambda_j)}{\nu_X(\lambda_j)\nu_Y(\lambda_j)}, \tag{7}$$

where $\gamma_{X,Y}$ is the covariance between time series X and Y at scale λ_j, $v^2{}_X$ and $v^2{}_Y$ are the variances of X and Y, respectively, at scale λ_j. Finally, $\lambda_j=2^{j-1}$ stands for the time-frame at j-scale; for example, if original data comes from a daily frame, then at 1-scale it will be obtained the decomposed correlation ocurring at a $\lambda_1=1$ day window, $\lambda_2=2$ day window, and succesively at J-level.

On the other hand, wavelet coherence is performed under the Continuous Wavelet Transform (CWT), which based on Graps (1995) is represented as in expression (8):

$$CWT_f(j,k) = \int_{-\infty}^{\infty} f(t)\frac{1}{\sqrt{j}}\overline{\psi\left(\frac{t-k}{j}\right)}dt, j > 0, b \in \mathbb{R}, \tag{8}$$

Where $\overline{\psi(t)}$ stands for the complex conjugate of the mother wavelet, j the scaling factor and k the translation factor (see expression 2). In that context, Torrence and Compo (1998) defined the cross wavelet transform (XWT) of two time series $X(t)$ and $Y(t)$ as in expression (9):

$$W_{X,Y} = W_X W_Y^*, \tag{9}$$

Where W represents the CWT of the time series (see expression 8) and * denotes the complex conjugation. Given the XWT, Torrence and Webster (1999) define the wavelet coherence of two time series which closely matches the correlation coefficient on local basis as follows:

$$R_n^2(s) = \frac{\left|S\left(s^{-1}W_n^{XY}(s)\right)\right|^2}{S\left(s^{-1}\left|W_n^X(s)\right|^2\right)\cdot S\left(s^{-1}\left|W_n^Y(s)\right|^2\right)}, \tag{10}$$

Where S is a smoothing operator. By such means, Grinsted et al. (2004) argue that the wavelet coherence is a powerful tool to analyze linkages between two time series. In addition, Aloui and Hkiri (2014) consider its importance for detecting stock market co-movements.

Finally, all estimations were performed in R version 4.0.2.

Data

The dataset consists of 514 daily closing prices from January 2, 2019 to December 31, 2020 of Latin American stock markets which belong to the MSCI Latam index such as Argentina, Brasil, Colombia, Chile, Mexico and Peru, and the West Texas Intermediate future crude oil prices. Daily prices were transformed to log-returns as shown in expression (11):

$$Ret_t = log\left(\frac{P_t}{P_{t-1}}\right), \tag{11}$$

Where P_t and P_{t-1} are the current and previous stock index values and WTI prices, respectively.

Descriptive statistics of log-returns are shown in Table 1 where the maximum and mínimum returns are observed on the WTI oil and Brasil-MERVAL prices, respectively. Indeed, WTI as shown by the standard deviation recorded the highest volatility, which is explained when future prices plunged to negative zone in April 2020 and then boosted to levels greater than $30 USD/barrel in les than a month. However, WTI shows the better risk-return trade-off among the equity indexes as shown by the Coefficient of Variation.

Table 1. Descriptive statistics of oil and stock returns.

	MXX	BVSP	COLCAP	BVL	MERVAL	IGPA	WTI
Min	-6.86%	-17.34%	-17.69%	-11.64%	-61.11%	-14.84%	-32.61%
Max	4.63%	12.21%	11.72%	4.77%	9.31%	7.37%	475.92%
Mean	0.0005%	0.0295%	0.0001%	0.0067%	0.0272%	-0.0540%	1.2446%
Var	0.00015	0.00047	0.00030	0.00015	0.00162	0.00025	0.05024
Std. Dev.	1.23%	2.16%	1.74%	1.22%	4.02%	1.59%	22.41%
Coef.	2274.70	73.13	12687.34	181.87	148.05	-29.40	18.01

Var.							
Skew	-0.5941	-2.2449	-2.8370	-2.4554	-7.1499	-2.3536	19.0178
Kurtosis	3.9378	20.6328	36.5045	20.4076	103.2620	23.6512	392.0653

Descriptive statistics of log-returns are shown in Table 1 where the maximum and mínimum returns are observed on the WTI oil and Brasil-MERVAL prices, respectively. Indeed, WTI as shown by the standard deviation recorded the highest volatility, which is explained when future prices plunged to negative zone in April 2020 and then boosted to levels greater than $30 USD/barrel in les than a month. However, WTI shows the better risk-return trade-off among the equity indexes as shown by the Coefficient of Variation.

Fig. 2. Global correlation between oil and stock market returns
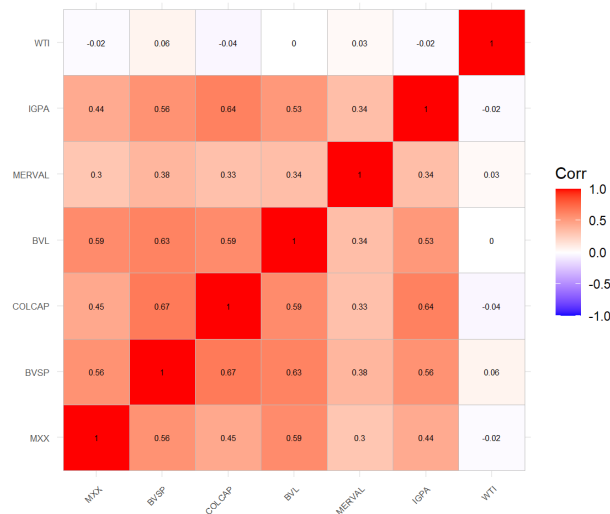
The global correlation between oil and stock returns shows a weak level of association, and in some cases a negative interaction which would support previous findings. These results would suggest the possibility of a diversification investment strategy considering the oil market as an asset that could work as a hedging instrument. In the macroeconomic perspective it could be stated that oil prices have not fully pass-through to stock markets even during the Covid-19 era.

Results

Wavelet Coherence among stock exchanges

Fig. 3 shows the wavelet coherence analysis of the Mexican-IPC against the other LATAM stock markets (see Appendix for complete estimations). In most of the cases it is observed that the dynamic co-movement is from low to medium degree of interaction at low scales (high frequencies). Red zones at low scales (high frequencies) mirror excess of co-movement which may occur before and during the Covid-19 crisis.

However, at high scales (low frequencies) all cases show strong degrees of association which is interpreted as fundamental linkages. Even this type of co-movementthat has been happening in the long run before the Covid-19 crisis, more concentrated red zones at medium scales are found around March 2020 when most of the economies were shut down.

In a particular example, Mexico-IPC against Brasil-Bovespa, it is observed that interactions differ at different times, before September 2019 in most of the time frames there were low relationships between the stock markets. After this date an increasing co-movement has been occuring but at window times greater than 64 days. Since not all market participants operate on the same time horizons, benefits of diversification would not have been collected in a long-term strategy as that of short-term.

Fig. 3. Wavelet coherence among LATAM Stock Markets.

Mexico IPC vs. Peru BVL

Mexico IPC vs. Argentine MERVAL

Mexico IPC vs. Chile IGPA
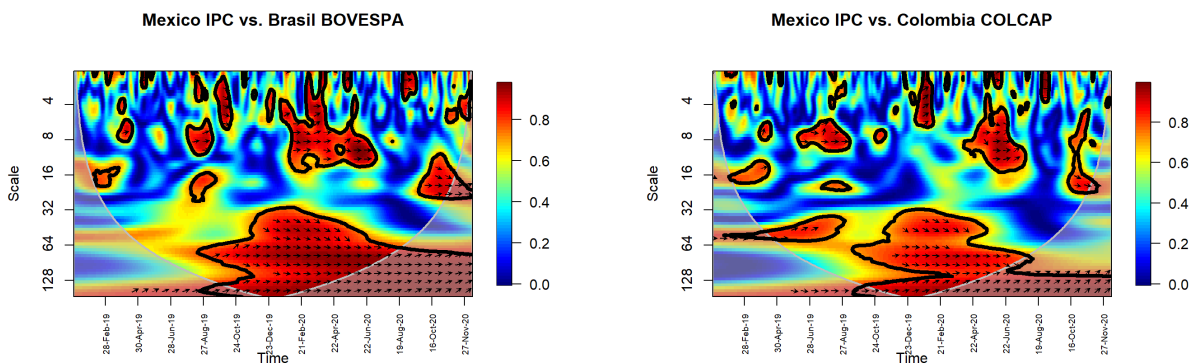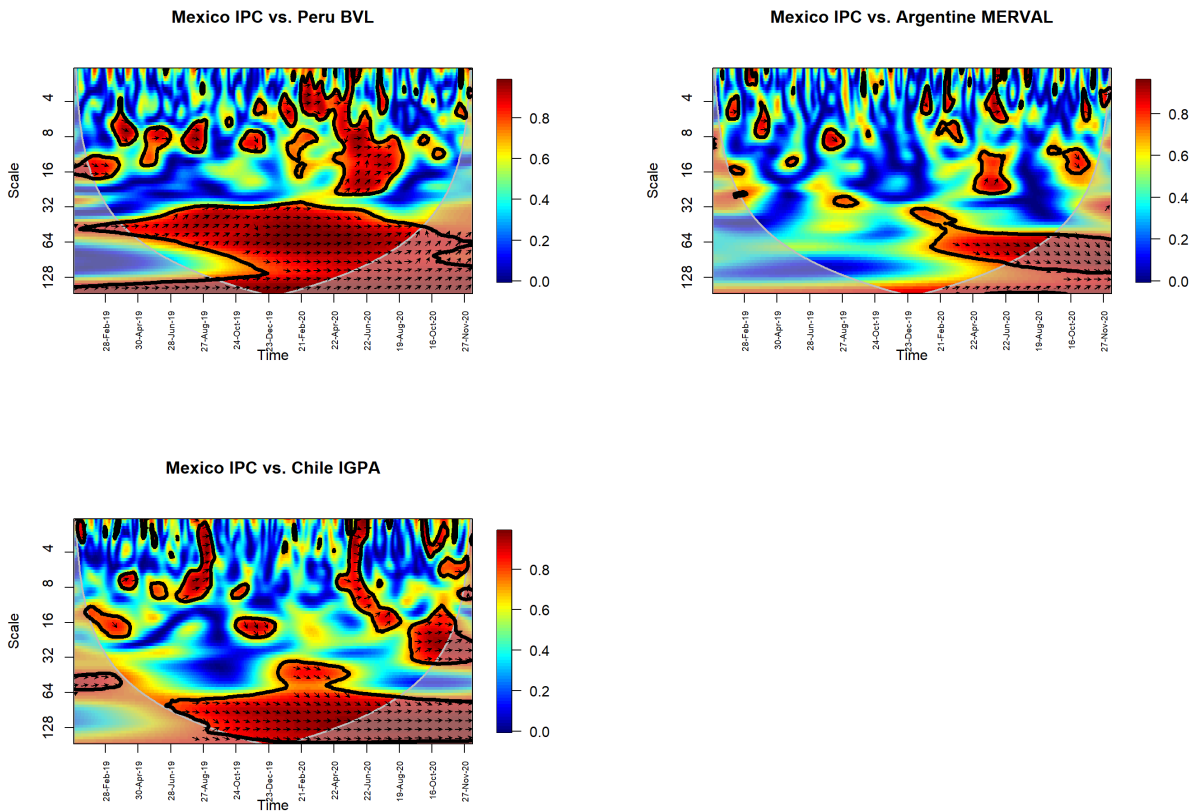
As another example, the pair Brasil-Peru (seeAppendix) shows strong interaction at medium and high scales around March 2020, which after June 2020 moved back to its normal long run interdependence. A same pattern is found between Mexico and Colombia.

On the contrary, all the pairs related toArgentine does only show excess of co-movement which got stronger after March 2020 but it has not lasted more than six months. An exception is found between Brasil-Argentine which up to November 2020 has continued co-moving, but which can still mirrors a pure contagion.

Wavelet coherence between oil and stock returns.

The global correlation showed a weaker level of association between oil and stock market returns. However, if the correlation structure is decomposed into different time-scales it is found that both markets hold interdependence since at high scales (low frequencies) the degree of

interaction is greater than low and medium scales. Fig. 4 depicts the wavelet coherence among oil and stock returns at different time-scales.

Fig. 4. Wavelet Coherence among oil and stock returns.
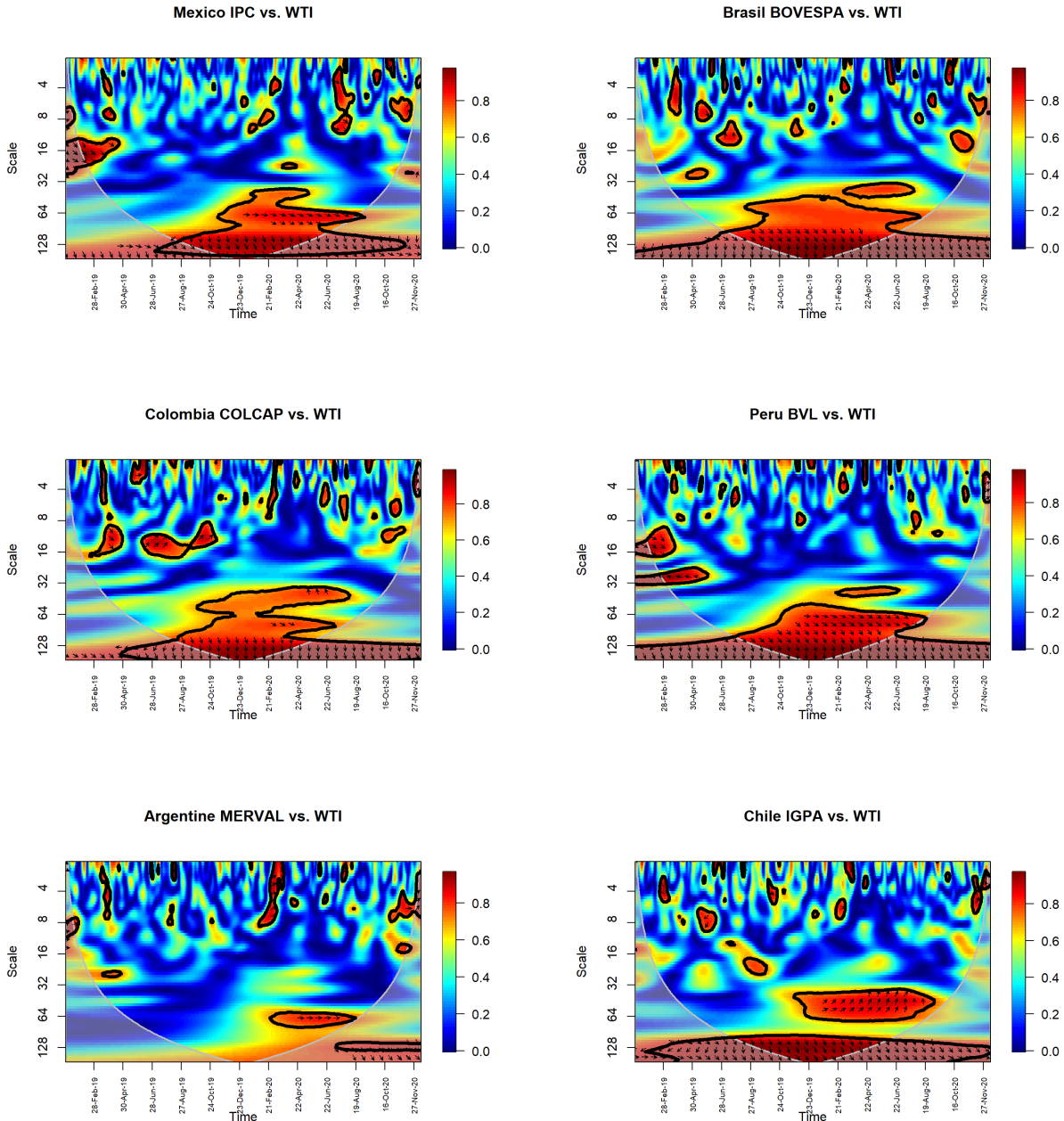
In the pre and post Covid-19 crisis it has been observed a dynamic co-movement described as "fast and furious". On one hand, at high scales the pattern is better described as interdependence

where the coherence shows greater concentration around March and April 2020 when most economies were shut down and when oil future prices plunged belowzero. On the other hand, the interaction wasviolent and relatively fast which lasted by August 2020, then it got back to its normal co-movement which has been observed before the Covid-19 crisis. The exception is in Argentine, where no fundamental linkages between the stock and oil markets can be supported by the wavelet coherence, just contagion between markets is better described.

A previous study by (Santillán, Calderón & Venegas; 2017) found a positive relationship between oil prices and the stock markets of Argentina, Brazil, Chile, Colombia, Mexico and Peru. They considered a data panel analysis with monthly prices from 2000 to 2015. They argue that "it does not matter if countries ar exporters or importers of oil, in the region as a whole, an increase of oil prices has a positive effect on the stock markets' returns".

In that sense, (Santillán et al.) results partially converge with the findings in this Research. First, the global correlation in the period of study would signal no positive relationship between stock and oil markets returns. But when the correlation structure is decomposed in different time-scales, it is found that the positive relationship holds in the long run which is described as a fundamental linkage between the markets. However, at low scales or short period of times, the interdependence does not longer hold and the pattern that better charatcerizes the relationship is that of excess of co-movement.

Furthermore, Santillán et al. (2017) argue that *"the empirical analysis of the relationship between oil prices and the stock market remains a field open to novel methodological proposals"*. Then, the importance of the Research findings are that based on the wavelet coherence approach it is possible to break down the correlation structure between the stock and oil markets returns to better understand the dynamics co-movement along time and across time-frames in a pre and post crisis as that of the Covid-19 era. These findings may help investment managers to identify the time-frame when the interaction should be considered as pure contagion or spillovers in such a way to better manage their holding positions and risk exposure.

The wavelet coherence results may answer the question regarding the time in which interactions occur, which showed that correlation may differ at different time frames. Weaker interactions between oil and stock returns have been occuring up to window times of 64 days. After that time, the joint behavior strenghtens. In addition, these stronger interactions have ocurred in most of the

cases since August 2019. Even during the post Covid-19 era there is not shown greater levels of associations when oil prices plunged below zero. If ocurred, it was in very short window times that dissipated quickly. Since stronger interactions have occured long term window times, then the relationship between oil and stock returns is explained the most by fundamental linkages.

Decomposed Vector Autoregressions (VAR)

Expression (12) represents a first lagVector Autoregressionoftwo variables, VAR(1):

$$Y_{1,t} = \alpha_1 + \beta_{11,1}Y_{1,t-1} + \beta_{12,1}Y_{2,t-1} + \varepsilon_{1,t},$$
$$Y_{2,t} = \alpha_2 + \beta_{21,1}Y_{1,t-1} + \beta_{22,1}Y_{2,t-1} + \varepsilon_{2,t}$$

(12)

The decomposed-VAR(1) system would be represented by expression (13):

$$Y_{1,j} = \alpha_1 + \beta_{11,1}Y_{1,j-1} + \beta_{12,1}Y_{2,j-1} + \varepsilon_{1,j},$$
$$Y_{2,j} = \alpha_2 + \beta_{21,1}Y_{1,j-1} + \beta_{22,1}Y_{2,j-1} + \varepsilon_{2,j}$$

(13)

Where $Y_{1,j}$ and $Y_{2,j}$ are thedetailcoefficients at j-scaleof time series Y_1 and Y_2, respectively.

Table 3 shows VAR(2) estimations on the Mexico-IPC and WTI oil relationship at seven level of resolutions (see Appendix for whole estimations). Results showed that at low scales (high frequencies) the Mexico-IPC is no sensitive to oil Price changes. However, as time frame (level of resolution) increases, so does sensitiveness. It could be stated that at high frequencies within time frames lesser than 4-days, there is no evidence of a passing-through effect from oil prices to the stock market. But from time frames greater than 8 days start showing a pass-through effect. These results could be supported by an indirect effect of oil prices to the stock market when market participants adjust their portfolio asset holdings over time as companies maye xpect lower earnings caused by an increase in production or operational costs since oil Price increases are expected to pass-through into domestic prices.

Table 2. Estimation results for equation MXX:

MXX = const +MXX(-1) + WTI(-1) + MXX(-2) + WTI(-2)

Level(j)	Time frame (days)	Variable				
		Const	MXX(-1)	WTI(-1)	MXX(-2)	WTI(-2)
d1	1-2	5.399E-06	-1.019E+00	-1.896E-03	-6.275E-01	-1.814E-03
		(0.026)	(-29.193)	(0.827)	(-17.87)	(-0.797)
d2	2-4	6.898E-06	6.346E-01	1.619E-03	-8.359E-01	-3.087E-03
		(0.059)	(25.541)	(1.202)	(-33.550)	(-2.299)
d3	4-8	-2.985E-06	1.559E+00	-1.657E-03	-9.713E-01	1.373E-03
		(-0.131)	(141.844)	(-3.335)	(-88.213)	(2.77)
d4	8-16	-2.097E-07	1.884E+00	-6.461E-04	-9.829E-01	9.159E-04
		(-0.066)	(347.267)	(-2.954)	(-182.451)	(4.162)
d5	16-32	5.105E-08	1.985E+00	-4.482E-04	-1.007E+00	5.182E-04
		(0.082)	(736.78)	(-3.649)	(-372.271)	(4.233)
d6	32-64	1.76E-09	2.02E+00	-9.40E-04	-1.02E+00	8.48E-04
		(0.012)	(942.797)	(-8.618)	(-474.420)	(7.867)
d7	64-128	-3.778E-09	2.005E+00	3.121E-04	-1.006E+00	-3.351E-04
		(-0.135)	(1517.574)	(4.675)	(-751.369)	(-5.073)

*_t-values in parenthesis_

It should be noticed that the Mexican stock market is smaller than those of the United States of America. Also, in the Mexican stock Exchange are no listed oil producer companies that could weigh on the market capitalization. So, this could also support a lower sensitiveness of the stock market to oil prices in the short term. But from the medium to the long-run fundamental linkages are thus explaining the dynamic interaction.

On the contrary, Colombia showed a pass-through effect in the first scale (1-2 days window frame) which then the stock market sensitiveness to oil prices decreases in the second and third scales. After, as the window frame increases the pass-through effect comes back. This could be explained on market participants' trading horizons where those who operate in very short run-terms adjust quickly their asset holdings. But those whose investment horizons are within time frames between 2 and 8 days may not have great exposure to oil linkages. Even so, stock market's sensitiveness increases as time frame is higher than 8 days which could be explained by the indirect exposure of oil fundamental linkages to market participants' asset holdings.

The decomposed-VAR results may answer the pass-through effect of oil on stock markets. Since results have shown weak sensitiveness in very short time frames (1 to 8 days) compared to medium-to-long term, then the existence of a pass-through effect may be explained by fundamental linkages. The importance of these results may help investment strategies to exploit risk diversification opportunities based on direct and indirect transmission mechanism of oil to stock market and among stock markets at different time frames.

Impulse Response Function

Fig. 5 plots the impulse-response functions of oil Price one-standard deviation (shock) to stock returns of Mexico-IPC (see Appendix for complete estimations). In a time-frame of 1-2 days, a shock in oil prices has an initial negative effect on stock returns which takes about 20 days to dissipate. In contrast to level 2, the response dies in about 60 days. At level 3, the response decreases in about 80 days but surges again since 100 days. Since this level of resolution, the stock market response to the oil impulse is never dissipated, which may be explained by indirect fundamental linkages.

So the question to be answered is if stock markets would respond to oil shocks. Results show that response varies across time frames. A market participant whose investment horizon ranges within 1 and 2 days would respond inmmedately to an oil shock where its reaction would lasted in about 20 days. In this sense it could be stated that a pure contagion has been occured since the spread over time was fast and furious. However, market participants whose investment horizons

are greater than 32 days react in a lower pace where decisions may rely more on fundamental factors and the shock effect would lasted longer.

Fig. 5. Impulse-response of oil shocks to Mexican-IPC returns.

D1 resolution level: 1 – 2 days
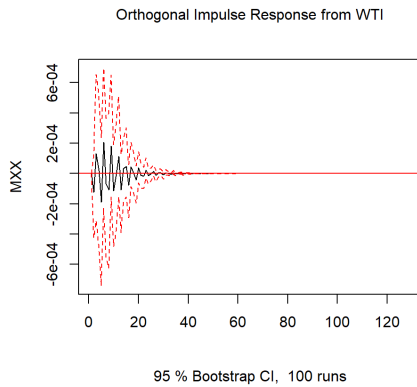
D2 resolution level: 2 – 4 days
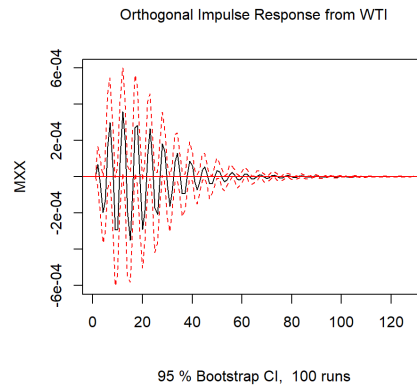
D3 resolution level: 4 – 8 days
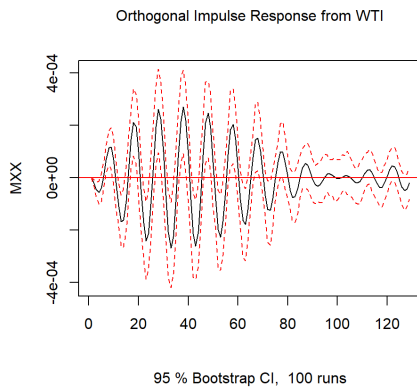
D4 resolution level: 8 – 16 days
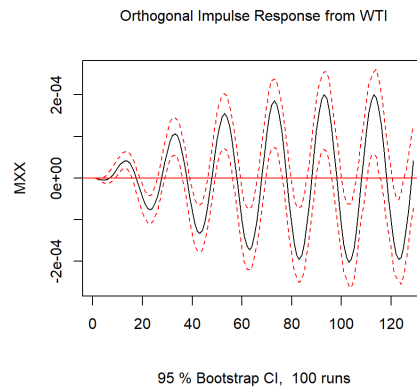
D5 resolution level: 16 – 32 days

D6 resolution level: 32 – 64 days

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs
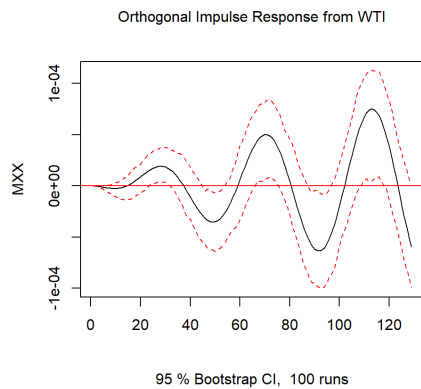
D7 resolution level: 64 – 128 days   S7 Smooth scale

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs
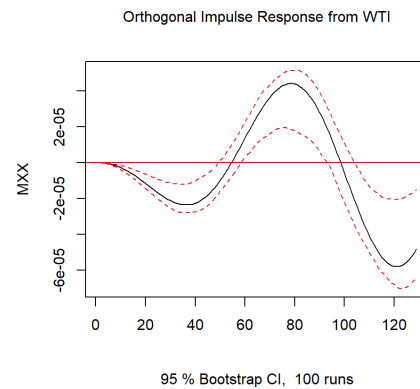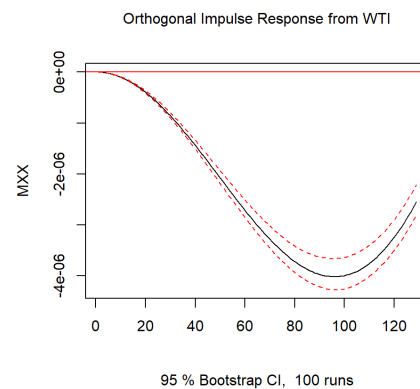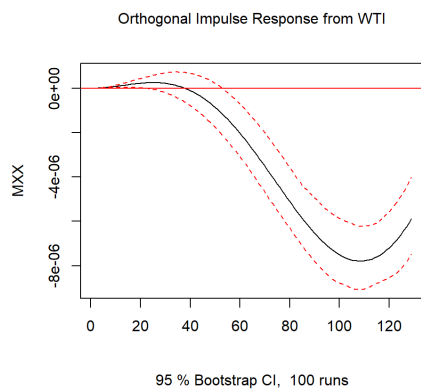
Discussion and conclusions

Wavelets are filtering functions which allow to capture at the same time oscillatory and smoothness properties of signals. The filtering process performed by wavelets is known as multiresolution decomposition (MRD) where time series are decomposed into high frequencies which occur at short time-frames and low frequencies which occur at long time-frames. Since the first application of wavelets in economics to analyze the interaction among macroeconomic variables (Ramsey & Lampart, 1998), substantial research has been done in economic analysis based on wavelets such as the Phillips curve analysis (Gallegati et al., 2006), Monetary Policy (Aguiar-Conraria et al., 2008), and International Portfolio Diversification (Rúa & Nunes, 2009).

The denoising process by wavelets has allowed to discover hidden patterns (Graps, 1995) that traditional time series anlysis cannot perform among economic variables which has resulted to

staking out some principles in economics and finance. As an exmaple, Rúa and Nunes (2009) highlight investors' investment horizons who may exploit diversification opportunities when timing plays an important role in asset correlations across time. Since then interactions has been distinguished in two types: the first one when co-movement is rapid and furious named as pure contagion. The second one, when co-movement stays in the long-run which has been called as spillovers (Gallegati, 2012).

The importance to distinguish types of co-movements allowed to discover in this research hidden patterns in the relationship between stock markets and crude oil prices. If the type of relationship is characterized as an instant association which dissipates almost immediately, then a pass through effect from oil to stock markets coud be described as pure contagion. On the other hand, if the pass through has remained in long time-frames and across time, then fundamental linkages are driving the relationship between stock markets and oil prices.

This research work based on a hybrid approach of both coherence wavelet analysis and vector auto regression model helps to understand the important connection between the oil and stock market returns which has improved in understanding of the potential relationships in emerging markets as those from Latin America. Evidence showed that oil price stock return relationships have more structural shifts with time varying volatility and may be of a non-linear type over a period of time. Assessing the fact and source of time variation is crucial since it explains innovations in the variance-covariance matrix which are observed in the correlations that may vary at different time spans. In that sense instead of considering a global correlation it could be stated a term structure of correlation.

This resarch examined the effects of oil price shocks on stock market real return using a mixture innovation time-varying parameter VAR model. We investigate the impact of oil price shocks on the emerging markets of LATAM stock exchanges. It is found that oil price shocks contain information to forecasting real stock returns. It is found that coefficients and the nature of shocks have changed over time.

 Maximum and mínimum returns are observed on the WTI oil and Brasil-MERVAL prices, respectively. WTI as shown by the standard deviation recorded the highest volatility. They are supported and explained when future prices plunged to negative zone in April 2020 and then

boosted to levels greater than $30 USD/barrel in less than a month. WTI shows the better risk-return trade-off among the equity indexes as also indicated by Coefficient of Variation Matrix.

The global correlation between oil and stock returns show a weak level of association, and in some cases are negative interactions which would support previous findings. These results would suggest the possibility of a diversification investment strategy considering the oil market as an asset that could work as a hedging instrument. In the macroeconomic perspective it could be stated that oil prices have not fully pass-through to stock markets even during the Covid-19 era.

Mexican-IPC against the other LATAM stock markets observed the dynamic co-movement from low to medium degree of interaction at low scales (high frequencies). Wavelet coherence red zones at low scales (high frequencies) mirror excess of co-movement which may occur before and during the Covid-19 crisis. Since all market participants do not operate on the same time horizons so benefits of diversification strategies are not collected in a long term as compared to that of small term.

Mexican stock market is small as compared to USA and Mexican Exchange is not listed with oil producer companies that could weigh on the market capitalization. This can be support to lower sensitiveness of the stock market to oil prices in the short term. But from the medium to the long run fundamental linkages explain the dynamic interaction.

Main findings in this study could answer the research questions:

- In most of the cases, low interactions between oil and stock returns have been observed at time frames lesser than 64 days. At some time frames it was observed high-comovements but dissipated rapidly. In all cases, interactions between oil and stock returns have been high at time frames greater than 128 days.
- Oil and stock markets have co-moved in the long run across time even before Covid-19 Era. This co-movement that passes through across time is explained by fundamental linkages. Interactions increased around the beginning of Covid-19 but the timing was short. If any degree of association has remained it is explained by fundamental factors that are driving oil and stock markets. But this pattern is hidden in the global correlation since it showed a negative relationship.

- Then interactions that may occur in short periods of time dissipate rapidly (pure contagion). But a long-run relationship lasts more time since the linkage is due to fundamental factors (spillovers).

- Hence, oil pass-through to stock markets varies across time. In short periods of time it couldn't be found evidence of a pass-through effect. However, in longer times it could be confirmed a pass-through effect from oil to stock markets.

- The pass-through effect in shorter time-frames could last no longer than 20 days. But in longer time-frames the impact could last more than 128 days.

- All above could happen since market participants have different investment horizons. Those whose horizons are short-timing may respond rapidly and furiously to any shock, but may get back to their "path" in a shorter time. However, those market participants whose horizons are long-timing would not adjust their positions until more information arises that may allow them to reallocate they assets gradually over time.

In that way, the argument stated by (Santillán; 2017) could be modified as *"it does not matter if countries are exporters or importers of oil, in the region as a whole, the effect of oil prices innovations on stock markets returns depends on timing"*.

This Research has shown that positive effects do last to traspass in the long run, meanwhile in short periods of time the traspass is rapid.

Future research

This research work is limited with emerging markets stock returns in LATAM exchanges with a time period of two years and relating with few industries. This work can be extended in future to Asian markets with an extended period of time with a comparison over other regions as well.

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Appendix

A. 1 Wavelet coherencies among stock markets
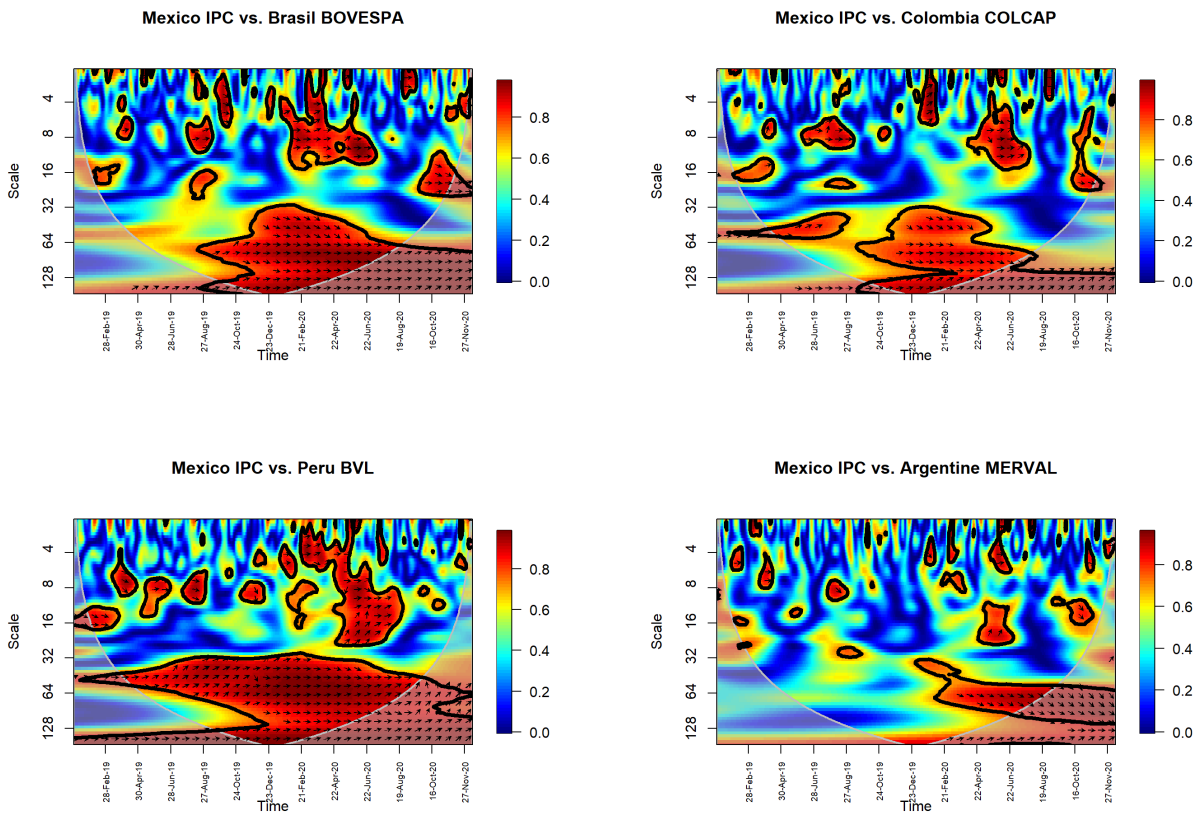
Mexico IPC vs. Chile IGPA
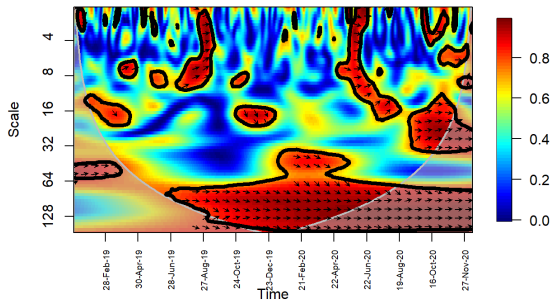
Brasil BVSP vs. Colombia COLCAP
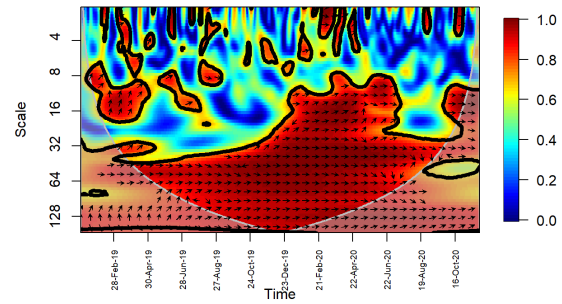
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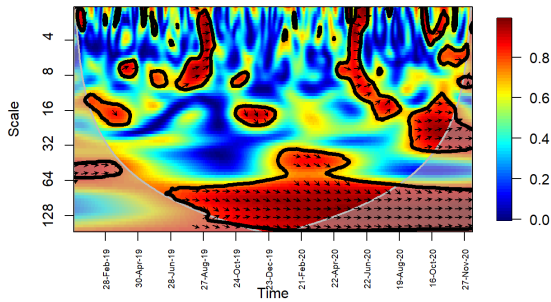
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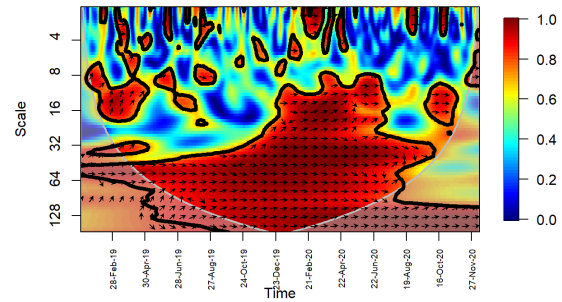
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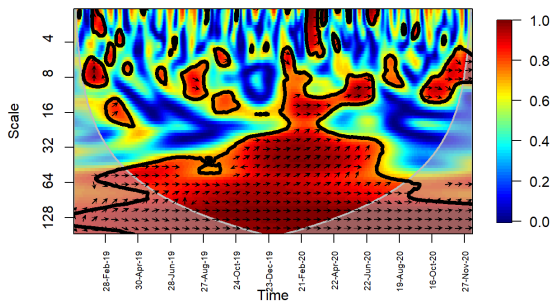
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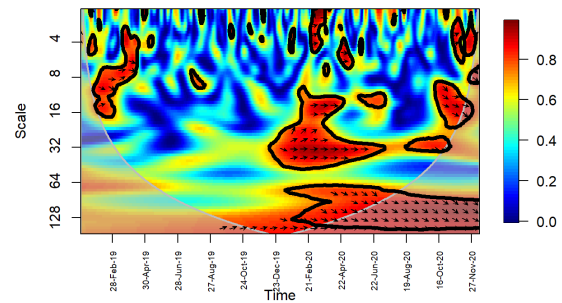
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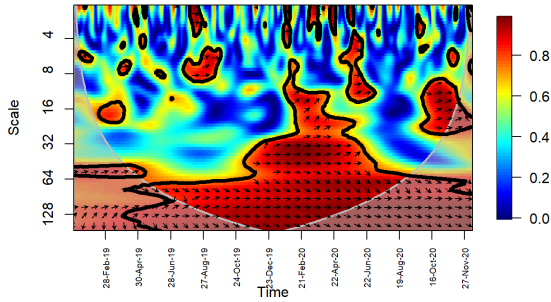
Colombia COLCAP vs. Peru BVL
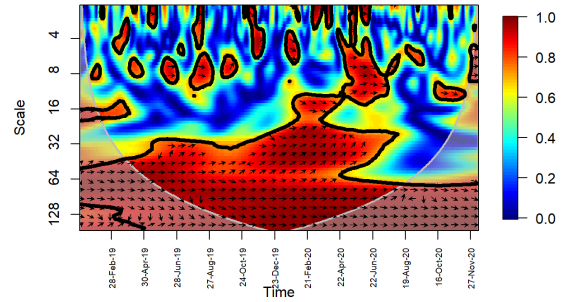
Colombia COLCAP vs. Argentine MERVAL

Colombia COLCAP vs. Chile IGPA

Peru BVL vs. Argentine MERVAL

Peru BVL vs. Chile IGPA

Argentine MERVAL vs. Chile IGPA

A.2 Impulse response functions

D1 Level

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

D2 Level

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

D3 Level

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

D4 Level

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

D5 Level

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

D6 Level

Orthogonal Impulse Response from WTI

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

D7 Level

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

MERVAL

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

IGPA

95 % Bootstrap CI, 100 runs

S7 Coarse Scale

Orthogonal Impulse Response from WTI

MXX

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

BVSP

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

COLCAP

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

BVL

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

Orthogonal Impulse Response from WTI

95 % Bootstrap CI, 100 runs

A.3 Vector Autoregression (VAR) estimations

Estimation results for equation BVSP-Brasil:

BVSP = const +BVSP(-1) + WTI(-1) + BVSP(-2) + WTI(-2)

Level(j)	Time Frame (days)	Variable				
		Const	BVSP(-1)	WTI(-1)	BVSP(-2)	WTI(-2)
d1	1-2	-7.235E-06	-1.286E00	-3.305E-03	-7.026E-01	4.959E-03
		(-0.021)	(-40.583)	(-0.866)	(-22.075)	(1.306)
d2	2-4	4.536E-06	5.789E-01	4.983E-03	-7.939E-01	-9.274E-03
		(0.031)	(22.823)	(2.891)	(-31.318)	(-5.394)
d3	4-8	-1.738E-06	1.614E00	-3.548E-03	-9.704E-01	2.087E-03
		(-0.052)	(133.129)	(-4.814)	(-79.404)	(2.856)
d4	8-16	9.137E-08	1.907E00	-1.479E-03	-9.947E-01	1.052E-03
		(0.014)	(274.016)	(-3.429)	(-142.312)	(2.452)
d5	16-32	3.780E-08	2.015E00	2.149E-03	-1.044E00	-1.326E-03

		(0.045)	(884.019)	(9.184)	(-435.823)	(-5.910)
d6	32-64	-1.854E-08	2.037E00	-2.464E-03	-1.041E00	2.247E-03
		(-0.101)	(970.182)	(-16.451)	(-493.436)	(15.258)
d7	64-128	-1.275E-09	2.004E00	-5.517E-04	-1.006E00	5.271E-04
		(0-021)	(1376.863)	(-2.254)	(-674.835)	(2.164)

* t-values in parenthesis

Estimation results for equation COLCAP-Colombia:

COLCAP = const +COLCAP(-1) + WTI(-1) + COLCAP(-2) + WTI(-2)

Level*(j)*	Time Frame (days)	Variable				
		Const	COLCAP(-1)	WTI(-1)	COLCAP(-2)	WTI(-2)
d1	1-2	-5.719E-06	-1.248E00	-7.876E-03	-6.861E-01	-5.386E-04
		(-0.024)	(-38.526)	(-3.028)	(-21.244)	(-0.206)
d2	2-4	1.912E-06	7.305E-01	1.830E-03	-8.715E-01	-2.820E-03
		(0.017)	(33.599)	(1.424)	(-40.067)	(-2.194)
d3	4-8	-2.707E-06	1.675E00	-8.687E-05	-9.744E-01	-7.987E-04
		(-0.086)	(150.892)	(-0.125)	(-87-269)	(-1.153)
d4	8-16	4.193E-07	1.918E00	-3.611E-03	-1.008E00	2.531E-03
		(0.054)	(317.295)	(-7.064)	(-164.228)	(5.029)
d5	16-32	4.560E-08	2.017E00	4.329E-03	-1.048E00	-3.376E-03
		(0.044)	(814.496)	(13.914)	(-400.773)	(-11.298)

Level(j)	Time Frame (days)					
d6	32-64	-2.410E-08	2.019E00	-1.959E-03	-1.025E00	1.894E-03
		(-0.131)	(1033.33)	(-14.825)	(-521.239)	(14.405)
d7	64-128	3.772E-09	2.002E00	1.320E-03	-1.003E00	-1.337E-03
		(0.10)	(1666..97)	(13.29)	(-827.71)	(-13.57)

* t-values in parenthesis

Estimation results for equation BVL-Peru:

BVL = const +BVL(-1) + WTI(-1) + BVL(-2) + WTI(-2)

Level(j)	Time Frame (days)	Variable				
		Const	BVL(-1)	WTI(-1)	BVL(-2)	WTI(-2)
d1	1-2	1.064E-05	-1.198E00	-2.740E-03	-6.056E-01	-1.694E-03
		(0.052)	(-33.902)	(-1.225)	(-17.144)	(-0.757)
d2	2-4	-2.485E-06	6.090E-01	2.113E-03	-8.566E-01	-2.740E-01
		(-0.207)	(26.533)	(1.973)	(-37.206)	(-2.568)
d3	4-8	-1.037E-06	1.638E00	-2.799E-04	-9.701E-01	-5.483E-04
		(-0.054)	(137.684)	(-0.664)	(-81.235)	(-1.305)
d4	8-16	2.006E-07	1.875E00	-1.690E-03	-9.790E-01	1.552E-03
		(-0.057)	(290.549)	(-7.448)	(-151.592)	(6.844)
d5	16-32	6.367E-08	1.997E00	-1.206E-03	-1.019E00	1.359E-03
		(0.107)	(764.747)	(-9.667)	(-386.152)	(11.002)
d6	32-64	-1.760E-08	2.008E00	-5.502E-04	-1.013E00	4.830E-04

		(-0.095)	(804.322)	(-3.663)	(-402.910)	(3.241)
d7	64-128	7.684E-10	2.005E00	8.673E-04	-1.006E00	-8.964E-04
		(0.022)	(1248.041)	(5.276)	(-610.118)	(-5.521)

* t-values in parenthesis

Estimation results for equation MERVAL-Argentina:

MERVAL = const + MERVAL(-1) + WTI(-1) + MERVAL(-2) + WTI(-2)

Level(j)	Time Frame (days)	Variable				
		Const	MERVAL(-1)	WTI(-1)	MERVAL(-2)	WTI(-2)
d1	1-2	2.337E-05	-1.183E00	-8.480E-03	-6.669E-01	-1.523E-03
		(0.035)	(-35.747)	(-1.157)	(-20.166)	(-0.208)
d2	2-4	-1.011E-05	6.546E-01	2.659E-03	-8.676E-01	-5.572E-03
		(-0.032)	(29.861)	(0.729)	(-39.609)	(-1.528)
d3	4-8	-4.458E-06	1.609E00	-8.937E-04	-9.557E-01	7.427E-04
		(-0.065)	(123.049)	(-0.598)	(-73.108)	(0.498)
d4	8-16	-1.843E-07	1.895E00	-3.248E-03	-9.852E-01	2.698E-03
		(-0.015)	(286.303)	(-4.024)	(-148.718)	(3.345)
d5	16-32	1.154E-07	1.980E00	-1.677E-03	-1.004E00	2.167E-03
		(0.047)	(633.691)	(-3.972)	(-319.553)	(5.519)
d6	32-64	-9.727E-10	1.999E00	-1.242E-03	-1.004E00	1.193E-03
		(-0.002)	(1090.660)	(-4.209)	(-547.759)	(4.047)

d7	64-128	-1.677E-09	2.005E00	-2.034E-03	-1.008E00	1.987E-03
		(-0.043)	(5048.433)	(-25.877)	(-2508.326)	(25.382)

* t-values in parenthesis

Estimation results for equation IGPA-Chile:

IGPA = const + IGPA(-1) + WTI(-1) + IGPA(-2) + WTI(-2)

Level*(j)*	Time Frame (days)	Variable				
		Const	IGPA(-1)	WTI(-1)	IGPA(-2)	WTI(-2)
d1	1-2	-1.547E-06	-1.212E00	-2.668E-03	-6.123E-01	4.929E-03
		(-0.006)	(-34.535)	(-1.003)	(-17.366)	(1.865)
d2	2-4	1.566E-06	6.837E-01	2.066E-03	-8.638E-01	-3.621E-03
		(0.013)	(30.731)	(1.542)	(-38.799)	(-2.704)
d3	4-8	-2.274E-07	1.651E00	3.093E-04	-9.658E-01	-5.894E-04
		(-0.008)	(135.071)	(0.494)	(-78.842)	(-0.942)
d4	8-16	-2.760E-07	1.926E00	6.734E-05	-1.019E00	-1.295E-03
		(-0.050)	(392.478)	(0.169)	(-202.673)	(-3.331)
d5	16-32	5.924E-08	2.018E00	1.218E-03	-1.045E00	-5.018E-04
		(0.065)	(655.803)	(4.552)	(-323.973)	(-1.963)
d6	32-64	-2.539E-09	2.015E00	-1.763E-03	-1.020E00	1.729E-03
		(-0.017)	(1352.589)	(-20.409)	(-684.287)	(20.048)
d7	64-128	5.389E-10	1.991E00	5.805E-04	-9.924E-01	-5.714E-04

| | (0.017) | (1738.319) | (7.014) | (-860.146) | (-6.886) |

* *t-values in parenthesis*

Big Data, Analytics, and Knowledge Management

ANALYTICAL MODELS AND BITCOIN PRICE AT TIMES OF UNCERTAINTY

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Abstract: The decentralized nature of cryptocurrencies makes them appealing choices for some investors around the world in times of uncertainty. The COVID-19 threat has been instrumental in causing a huge uncertainty in financial markets around the world initially. In this study, we examine the recent changes in the price of Bitcoin and explore the relationship between various financial factors and the price of Bitcoin. In particular, we explore the nature of the relationship between the Bitcoin price and different market indexes such as the S&P 500, Dow Jones Industrial Average, Russell 2000, Nikkei 225, and the price of commodities such as Gold before and after the COVID-19 pandemic. To address the issue of uncertainty due to the volatility of stock markets and its effect on the Bitcoin price, we examine the relationship between the popular measure of the stock market's expectation of volatility based on the S&P 500 index (VIX) and Bitcoin price before and after the COVID 19 pandemic by using Regression Analysis. Different time periods such as weekly and monthly data are used in this study.

Key Words: Cryptocurrency, Volatility, and Market Indexes.

I. Introduction:

A significant upward trend in the price of Bitcoin lately has renewed interest in the study of cryptocurrencies in general and Bitcoin in particular. Bitcoin was initially introduced to the world of finance by Satoshi Nakamoto, in 2009. Currently, Bitcoin is the most famous cryptocurrency in the world. Cryptocurrencies are virtual currencies that can operate independently without utilizing the traditional financial institutions and governmental agencies but still can be used for exchange and speculation similar to any physical currency in the world. There are several characteristics of cryptocurrencies that are appealing to investors and speculators. The most significant aspect of cryptocurrencies is their ability to be used in different financial transactions without need for a central player to oversee and approve such transactions. As a result, peer-to-peer transactions do not need a central player. Instead they would be verified by peers in the Bitcoin network who keep permanent records of all the transactions in the Blockchain. To understand the role of Blockchain in this process it would be useful to think of Blockchain as a distributed database that keeps track of all the records anonymously. The anonymous peers in the network would be able to verify all the transactions and confirm their legitimacy. This process makes it impossible to commit an error. This anonymous peer evaluation is another appealing aspect of cryptocurrencies. While the world is still trying to figure out the role cryptocurrency plays as an asset class, there are several theories as to how should perform in certain economic environments. On theory is cryptocurrencies should serve as a good alternative to gold. However, in practice due to speculation, volatility, and the presence other viable alternatives this issue has not materialized during the last several years. More importantly, at least currently, many central banks are not opened to the idea to use cryptocurrency as a store of value, like gold. Despite all these, cryptocurrency remains as a lucrative business around the world.

Bitcoin is still by far the most popular cryptocurrency, despite its rapid relative decline since 2015. In 2015, Bitcoin had 86% of the market share of the cryptocurrency market while in 2020 its market share was reduced to 66%. In a huge boost to the usage of Bitcoin, PayPal (one of the most famous payment systems in the world) announced on October 23, 2020 that its users in the US can buy, sell and hold Bitcoin and a small number of other cryptocurrencies directly through PayPal using their Cash or Cash Plus account [1]. Furthermore, PayPal announced that it will

enable Bitcoin and these other cryptocurrencies as a funding source for purchases in 2021. This allows the users to utilize their cryptocurrency holdings to make purchases in the PayPal network which consists of more than 26 million merchants. It must be noted that there are several other cryptocurrencies such as Bitcoin Cash, Ethereum, Ripple, and Litecoin that are competing with Bitcoin for the cryptocurrency market share with some degree of success [2]. However, in this study, we exclusively concentrate on the Bitcoin performance since it is by far the most common cryptocurrency.

In times of uncertainty, investors more than ever seek to manage their risk by investing in a well-diversified portfolio. The COVID-19 virus has been one of the most devastating health care threats in many decades. Although initially, its presence was restricted to China, it soon became clear that this virus can spread with an amazing speed around the world. Indeed, just a few months after it was first detected in China, we observed that the virus was spreading around the world exponentially and soon became a worldwide pandemic. To fully understand the magnitude and effect of this pandemic, we take a closer look at some available data. As of January 31, 2021, according to the Johns Hopkins University database which collects world wide data [3], the number of infected individuals exceeded 103 million with a death toll of over 2.2 million. In the United State alone, As of January 31, 2021, the number of infected patients is well over 26 million infected cases with the death toll of over 441,000 individuals [3]. Obviously, such a devastating pandemic has great consequences on the world economy in general and the US economy in particular. According to the world bank data [4], the US economy is the largest economy in the world. The initial estimate of the effect of this pandemic on the world economy is enormous. In the USA alone, using the year-over-year data, the economy contracted 3.5% in 2020. Indeed, for the year 2020, the COVID-19 virus inflicted the worst economic freeze since the end of World War II [5]. Furthermore, the economic decline we have seen during the COVID-19 crisis is the first decline we have seen since the 2009 financial crisis. Continuation of the COVID-19 pandemic is causing an economic uncertainty around the world in general and in the United States in particular. Although the development of several vaccines around the world was good news to reduce the uncertainty, the slow pace of vaccinations has offset the initial optimism. This continued uncertainty inevitably will impact the economic recovery. Indeed, it is expected to slow down the economic recovery in the foreseeable future. Consequently, in this environment, it is natural that the investors seek different alternatives to manage the uncertainty

which they are facing. A well-diversified portfolio at the time of uncertainty such as now can mitigate the risk.

To address the issue of uncertainty due the COVID-19 pandemic, we examine the volatility of stock markets and its effect on the Bitcoin price. In particular, we examine the relationship between major stock indexes, Gold, popular measure of the stock market's expectation of volatility based on the S&P 500 index (VIX) and Bitcoin price before and after the COVID-19 pandemic. Different time periods such as weekly and monthly data are used in this study.

II.   Literature Review:

Since the creation of Bitcoin in 2009, we have seen many research articles addressing different aspects of cryptocurrency in general and Bitcoin in particular. Some of this research concentrated on the price formation of Bitcoin while others address the volatility of Bitcoin's price. In 2014, *Ciaian etal*. [6] studied the relationship between the price of Bitcoin and the demand and supply fundamentals of this cryptocurrency. In addition, they examined the relationship between different global financial indicators such as oil price, the Dow Jones Industrial Average index and Bitcoin's attractiveness for investors (i.e. the volume of daily Bitcoin views on Wikipedia). Furthermore, they studied the impact of each of the variables on Bitcoin's price individually, as well as the interaction of these factors on the price of the cryptocurrency. They conclude that Bitcoin market fundamentals and Bitcoin's attractiveness for investors have a significant impact on Bitcoin price. However, the authors did not find evidence that the financial variables have an effect on Bitcoin's price. In 2017, *Julio Estrada* [7] examined the Bitcoin price volatility and concluded that there exists a bidirectional *Granger-causality* relationship [8] between Bitcoin's realized volatility and the VIX at the 5% significance level. In 2019, *Aalborg etal*. [9] attempted to use different variables such as return, volatility, trading volume, transaction volume, change in the number of unique Bitcoin addresses, the VIX index and Google searches for Bitcoin to predict the price of Bitcoin. However, they concluded that the trading volume of Bitcoin can be predicted from Google searches for Bitcoin. However, none of the considered variables can predict Bitcoin returns.

III.   Data Set:

For this study weekly and monthly data was collected. Weekly data was collected from **September 15, 2014 to Jan 11, 2021** while monthly data was obtained from **Sept 15, 2014 to Jan 31, 2021**. The data downloaded was for Bitcoin price, market indexes such as the S&P 500, Dow Jones Industrial Average, Russell 2000, Nikkei 225, and the price of commodities such as Gold (GC F-2) before and after the COVID-19 pandemic. In addition, VIX values were downloaded for the stated dates. Yahoo Finance was used for downloading our data. After the data was downloaded, it was decided that some parts of the data may not be relevant to this study. So only the date and closing values were kept for each variable.

IV.   Methodology:

To gain some insight about our data, preliminary data analysis was performed. First, different analytical measures such as measures of central tendency, variation and shape were calculated for the whole data set (weekly and monthly).

Different Measures of Central Tendency, Variation and Shape for Weekly Data							
	Weekly Bitcoin Close	*Weekly S&P 500 Close*	*Weekly DJIA Close*	*Weekly RUT 2*	*Weekly GC-F-2 Close*	*Weekly N225 Close*	*Weekly VIX Close*
Mean	5204.51	2563.64	22423.52	1403.58	1349.12	20374.50	17.20
Standard Error	311.28	25.84	228.52	11.60	12.16	142.19	0.43
Median	3998.98	2549.33	23062.40	1412.32	1278.50	20407.08	14.74
Standard Deviation	5663.26	470.07	4157.64	211.10	221.27	2586.89	7.80
Kurtosis	8.36	-0.61	-1.37	-0.15	1.15	-0.16	11.27
Skewness	2.13	0.49	0.06	0.27	1.43	0.11	2.74
Minimum	210.34	1864.78	15973.84	971.99	1056.20	14532.51	9.14
Maximum	39187.33	3824.68	31097.97	2123.20	2038.00	28519.18	66.04
Count	331	331	331	331	331	331	331
Coefficient of Variation	108.81%	18.34%	18.54%	15.04%	16.40%	12.70%	45.36%

Different Measures of Central Tendency, Variation and Shape for Monthly Data							
	Monthly BitCoin Close	*Monthly S&P 500 Close*	*Monthly DJIA Close*	*Monthly RUT Close*	*Monthly GC-F Close*	*Monthly N225 Closing*	*Monthly VIX Close*
Mean	5527.81	2579.66	22521.00	1412.04	1351.08	20512.15	17.84
Standard Error	714.47	54.48	473.87	24.32	25.80	294.43	0.89
Median	4061.34	2579.93	23352.35	1420.25	1280.00	20574.20	15.36
Standard Deviation	6228.57	474.98	4131.12	212.00	224.89	2566.79	7.75
Kurtosis	7.13	-0.54	-1.38	0.30	1.10	0.21	5.97
Skewness	2.17	0.50	0.02	0.44	1.39	0.32	2.15
Minimum	217.46	1920.03	16284.70	1033.90	1060.30	15575.92	9.51
Maximum	34316.39	3756.07	30606.48	2073.64	1967.60	27663.39	53.54
Count	76	76	76	76	76	76	76
Coefficient of Variation	112.68%	18.41%	18.34%	15.01%	16.65%	12.51%	43.43%

The above results show that the measure of Skewness and Kurtosis of Bitcoin are consistent with the fat-tailed distribution. In addition, the high value of the coefficient of variation of Bitcoin reveals very high variation (as a measure of uncertainty) compared to the rest of our data (in both the weekly and monthly data sets).

At this time, we divided our data into two sets; before February 1, 2020 and after February 1, 2020. We use Feb 1, 2020 as the date that it became clear that the COVID-19 virus is a very serious health issue which can impact the world economy if it is not contained immediately. It can be argued that the COVID-19 virus started to infect individuals on a massive scale in March 2020 in the USA. However, in some European and Asian countries the COVID-19 virus was infecting individuals on a massive scale much earlier. In addition, the psychological impact of COVID-19 started to impact the global market in February 2020.

After dividing the data into two periods, for both periods, different analytical measures were calculated for weekly data. The result is provided below. Although the coefficient of variation has reduced after the COVID 19, the measures of Kurtosis and Skewness of Bitcoin remain high after the COVID-19.

Different Measures of Central Tendency, Variation and Shape for Weekly Data Before COVIA 19							
	Weekly Bitcoin Close	*Weekly S&P 500 Close*	*Weekly DJIA Close*	*Weekly RUT 2*	*Weekly GC-F-2 Close*	*Weekly N225 Close*	*Weekly VIX Close*
Mean	3852.23	2443.19	21627.37	1379.53	1268.14	19940.69	14.96
Standard Error	237.45	22.49	230.19	11.49	6.37	138.14	0.25
Median	2041.20	2415.82	21080.28	1388.84	1254.30	20014.77	13.89
Standard Deviation	3980.34	377.06	3858.62	192.61	106.85	2315.64	4.14
Kurtosis	0.08	-1.15	-1.48	-1.21	0.90	-0.90	1.59
Skewness	0.92	0.32	0.19	-0.06	0.83	-0.22	1.29
Minimum	210.34	1864.78	15973.84	971.99	1056.20	14532.51	9.14
Maximum	19140.80	3329.62	29348.10	1740.75	1594.00	24120.04	30.11
Count	281.00	281.00	281.00	281.00	281.00	281.00	281.00
Coefficient of Variation	103.33%	15.43%	17.84%	13.96%	8.43%	11.61%	27.64%

Different Measures of Central Tendency, Variation and Shape for Weekly Data After COVIA 19							
	Weekly Bitcoin Close	*Weekly S&P 500 Close*	*Weekly DJIA Close*	*Weekly RUT 2*	*Weekly GC-F-2 Close*	*Weekly N225 Close*	*Weekly VIX Close*
Mean	12804.28	3240.56	26897.92	1538.69	1804.26	22812.52	29.76
Standard Error	1058.72	49.99	381.37	36.38	17.60	381.65	1.57
Median	10198.51	3308.96	27303.72	1519.17	1819.80	22901.48	26.63
Standard Deviation	7486.28	353.47	2696.71	257.26	124.47	2698.70	11.08
Kurtosis	5.15	-0.08	0.20	-0.07	-0.51	-0.01	3.45
Skewness	2.27	-0.51	-0.65	0.34	-0.38	0.00	1.75
Minimum	5392.31	2304.92	19173.98	1013.89	1495.60	16552.83	13.68
Maximum	39187.33	3824.68	31097.97	2123.20	2038.00	28519.18	66.04
Count	50	50	50	50	50	50	50
Coefficient of Variation	58.47%	10.91%	10.03%	16.72%	6.90%	11.83%	37.22%

For our monthly data we also divide our data into two parts; before the COVID-19 pandemic and after the COVID-19 pandemic. The result is provided below:

Different Measures of Central Tendency, Variation and Shape for Monthly Data Before Covid 19							
	Monthly BitCoin Close	Monthly S&P 500 Close	Monthly DJIA Close	Monthly RUT Close	Monthly GC-F Close	Monthly N225 Closing	Monthly VIX Close
Mean	3864.07	2452.53	21708.72	1384.10	1267.33	20030.47	15.28
Standard Error	482.36	47.18	483.16	23.70	13.64	279.69	0.48
Median	2383.63	2417.60	21179.14	1393.56	1266.80	20024.10	14.12
Standard Deviation	3858.84	377.45	3865.29	189.62	109.14	2237.50	3.84
Kurtosis	-0.80	-1.19	-1.54	-1.25	0.87	-1.02	1.54
Skewness	0.70	0.31	0.16	-0.06	0.76	-0.16	1.14
Minimum	217.46	1920.03	16284.70	1033.90	1060.30	15575.92	9.51
Maximum	14156.40	3230.78	28538.44	1740.75	1582.90	24120.04	28.43
Count	64	64	64	64	64	64	64
Coefficient of Variation	99.86%	15.39%	17.81%	13.70%	8.61%	11.17%	25.16%

Different Measures of Central Tendency, Variation and Shape for Monthly Data After Covid 19							
	Monthly BitCoin Close	Monthly S&P 500 Close	Monthly DJIA Close	Monthly RUT Close	Monthly GC-F Close	Monthly N225 Closing	Monthly VIX Close
Mean	14401.05	3257.68	26853.14	1561.03	1797.75	23081.07	31.45
Standard Error	2536.92	102.77	734.80	77.33	38.89	800.98	2.65
Median	11055.54	3270.54	26464.96	1494.06	1820.15	22632.64	28.97
Standard Deviation	8788.16	356.02	2545.44	267.87	134.73	2774.69	9.18
Kurtosis	1.55	-0.53	-0.26	0.12	-0.67	-0.52	1.94
Skewness	1.59	-0.25	-0.22	0.75	-0.57	0.55	1.29
Minimum	6438.64	2584.59	21917.16	1153.10	1564.10	18917.01	20.57
Maximum	34316.39	3756.07	30606.48	2073.64	1967.60	27663.39	53.54
Count	12	12	12	12	12	12	12
Coefficient of Variation	61.02%	10.93%	9.48%	17.16%	7.49%	12.02%	29.19%

At this time, Regression Analysis is used to examine the relationship among our variables and to predict the monthly price of Bitcoin. To account for the effect of the COVID-19 pandemic a dummy variable was introduced. In order to construct our regression model, all the monthly indexes used (S&P 500 = X1, DJIA= X2, Russell 2000 = X3, Gold =X4, Nikkei 225 = X5) plus VIX = X6. For the period before the COVID-19 pandemic we assign zero and for the period after the COVID 19 pandemic we assign 1 to our dummy variable. To construct our regression model, the statistical package for the social sciences (SPSS) was utilized. The step-wise regression method reveals that the monthly S&P 500 = X1 and the dummy variable which represents the COVID 19 pandemic effect (X7) were not statistically significant at $\alpha = .05$.

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		

7	(Constant)	-42517.588	2722.903		-15.615	.000
	Monthly N225 Close = X5	.679	.297	.280	2.288	.025
	Monthly GC-F Close = X4	11.364	2.180	.410	5.214	.000
	Monthly RUSSELL Close = X3	22.483	4.556	.765	4.935	.000
	Monthly DJIA Close = X2	-.687	.214	-.455	-3.203	.002
	Monthly VIX Close = X6	138.602	49.460	.172	2.802	.007

a. Dependent Variable: Monthly Bitcoin Close = Pm

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
7	COVID Effect = X7	-.146[h]	-1.054	.296	-.126	.101
	Monthly S&P 500 Close = X1	-.382[h]	-.708	.481	-.085	.007

h. Predictors in the Model: (Constant), Monthly N225 Close = X5, Monthly GC-F Close = X4, Monthly RUSSELL Close = X3, Monthly DJIA Close = X2, Monthly VIX Close = X6

Based on the above information, the regression model for predicting the monthly price of Bitcoin is provided below:

$$Pm = -43,517.588 - 0.687(X2) + 22.483(X3) + 11.364(X4) + 0.679(X5) + 138.602(X6)$$

The regression model above provides the effect of three of our indexes, gold and VIX (Monthly DJIA Close = X2, Monthly RUSSELL Close = X3, Monthly GC-F Close = X4, Monthly N225 Close = X5, and VIX = X6 on the monthly price of Bitcoin (Pm). For example, a one-unit increase in the monthly value VIX would increase the price of monthly Bitcoin (Pm) by $138.602 (as long as other factors in our model remain constant).

For the weekly data, a similar approach was used. The step-wise regression method indicates that DJIA = X2 and the dummy variable which represents the COVID 19 pandemic effect (X7) were not statistically significant at $\alpha = .05$.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-39518.547	2019.103		-19.572	.000
	Weekly S&P 500 Close = X1	-5.210	1.660	-.432	-3.139	.002
	Weekly RUSSELL 2000 Close = X3	18.311	2.671	.683	6.855	.000
	Weekly GC-F-2 Close = X4	12.623	1.817	.493	6.947	.000
	Weekly N225 Close = X5	.661	.149	.302	4.431	.000
	Weekly VIX Close = X6	109.266	25.301	.151	4.319	.000

a. Dependent Variable: Weekly Bitcoin Close = Pw

Excluded Variables[a]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
5	Weekly DJIA Close	-.054[f]	-.285	.776	-.016	.017
	COVID 19	-.039[f]	-.605	.545	-.034	.147

f. Predictors in the Model: (Constant), Weekly S&P 500 Close = X1, Weekly N225 Close = X5, Weekly GC-F-2 Close= X4, Weekly RUSSELL 2000 = X3, Weekly VIX Close = X6

Based on the above information, the regression model for predicting the weekly price of Bitcoin is provided below:

$$Pw = -39,518 - 5.21\,(x1) + 18.311\,(X3) + 12.623\,(X4) + 0.661\,(X5) + 109.266\,(X6)$$

The regression model above provides the effect of three of our indexes (Weekly S&P 500 Close = X1, Weekly RUSSELL Close = X3, Weekly GC-F Close = X4, Weekly N225 Close = X5, and Weekly VIX = X6 on the Weekly price of Bitcoin (Pm). For example, a one-unit increase in the weekly value of VIX would increase the price of weekly Bitcoin (Pw) by $109.266 (as long as other factors in our model remain constant).

V.   Summary:

Our results for both monthly and weekly data reveal that two of our indexes (Russell 2000 and Nikkei 225) plus Gold and VIX were always statistically significant at $\alpha = .05$ for predicting the price of Bitcoin. Meanwhile, the COVID-19 pandemic was not statistically a significant factor in predicting the price of Bitcoin in the period under study. The monthly and weekly effects of S&P 500 and DJIA were not consistent. Furthermore, introducing the COVID 19 pandemic to our model did not improve our model statistically. We believe this result should be examined in more detail in future studies.

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HOW INFORMATION TECHNOLOGY – IT – CONTRIBUTES TO THE PERFORMANCE OF BUSINESS PROCESSES: A STUDY CASE IN A BRAZILIAN CONTACT CENTER INDUSTRY UNDER THE INFLUENCE OF ENVIRONMENTAL TURBULENCE

ABSTRACT

The Coronavirus / Sars-CoV-2 Pandemic changed the world from night to day bringing with it lots of impacts for all economies and jobs around the world. In a scenario which is much more virtual every day, IT units update their system of resources to deal with the exchange in business processes and daily technological releases. Based on the dynamic capabilities found on literature, this study investigates how IT capabilities (DITCS), gathering with organizational memory and improvisational capabilities, contributes for the performance of business processes (BPER) under the influence of environmental turbulence. The studies about the influence of IT capabilities on improvisational remains limited to the development of new products. Furthermore, there is another context with others IT systems, such as emerging architectures that are promising by denoting a gap for further investigation regarding these effects. This effects can be positive or negative that the improvisational capability and also the dynamic capabilities of IT can exercise to obtain performance of business processes. Based on a vast literature investigation, it was made a study case research at a large Brazilian company specialized in the industry of contact center. To accomplish this, data collect for evidences was required in this article. The results based on researches demonstrate that IT features – IT dynamic capabilities, organizational memory and improvisational capability – must be applied simultaneously and in parallel in order to maximize business process performance of the organizations.

Keywords: IT dynamic capabilities, organizational memory, improvisation capability, turbulence, business processes improvements.

1. INTRODUCTION

By the last past years, organizations are resorting to the dynamic capabilities of IT to respond in at an environment unpredictable and turbulent, in order to increase agility that will help increases competitive development as well (Mikalef & Pateli, 2017; Pavlou & Sawy, 2010; Tallon, Queiroz, Coltman, & Sharma, 2019). At a turbulent environmental the level of uncertain is measured by the unpredictability and defined by dynamism dimensions, therefore, in environments which are high levels of change coming from the external, there are more difficulties to companies predict future events (Mikalef, Krogstie, Pappas, & Pavlou, 2020; Yoshikuni & Albertin, 2018).

According to the ultimate research made by McKinsey Consulting, data indicates that, within the time of eight weeks, there was a five years advance in adopting digital category by part of the consumers and companies (Baig, Hall, Jenkins, Lamarre, & McCarthy, 2020). This was noticed because the coronavirus emerges and spread, which caused serious impacts for all economy and jobs around the globe. The organizations are changing, in high speed in concerning of decisions to be make, and simultaneously, improving productivity by using technologic and databases in different ways as they accelerate the scope and the innovation scale (Smet, Pacthod, Relyea, & Sternfels, 2020). Swiftly companies are adapting to create more visibility, agility, efficiency and connection with their final costumers (Sneader & Sternfels, 2020).

Thereon, to deal with unexpected events in a quickly and creative way, organizations need more and more to get reliable in their capacity of managerial improvisation (Levallet & Chan, 2018). As resources of improvisation become more comprehended, is possible to project IT functionalities that dedicates to improve the specific dimensions of the improvisational resources (Pavlou & Sawy, 2010). As well they can compare it with the development of the organizational memory to identify the roll they have been participating on technology (D. Nevo et al., 2012).

Differently from the strategic planning, strategic improvisation applies to conditions which there is no time to project a strategy and executing it (Levallet & Chan, 2018). Before a contingency scenario, the capability of improvisation can be considered the faster and also more creative alternative to managed the environment (Levallet & Chan, 2015), in other words,

to allow that organizations become capable of setting up spontaneously their previous capabilities.

The influence of IT capacities on improvisation remains limited on developing new products, furthermore, there is another context with others IT systems, such as emerging IT architectures that are promising to digital competition (Levallet & Chan, 2015; Pavlou & Sawy, 2010) , such as the improvisation based on IT strategy that can also be explored (Moeini, Rahrovani, & Chan, 2019).

Accordingly, we notice a gap for further investigations in despite of the effects, positive or negative ones, and the capacity of improvisation, inhabited by the organizational memory e by its IT dynamic capacities can obtain the development of business processes (Levallet & Chan, 2016). To illustrated, it was required an exploratory case study in an organizational level in a private Brazilian company that is inserted in huge turbulent sector and scenery, characterized by the need of technological resources and high improvisational level.

2. LITERATURE REVIEW

2.1 DITC – Dynamic Information Technology Capability

 Otherwise the academic comprehension has advanced continually in the last two decades (Wilden, Devinney, & Dowling, 2016), their functions applied by the DITC remained, at least, less understood (Benitez, Ray, & Henseler, 2018; Pavlou & El Sawy, 2006).

In turbulent environments characterized by changes in preferences of the customers, changes in the limit industry as by fast evolution technologies and also by the emerging ways of global competition, the organizations are under pressure to build their dynamics of capabilities that improve their potential digital technologies, in order to facilitate various business activities (Li & Chan, 2019; Queiroz, Tallon, Sharma, & Coltman, 2018).

Li and Chan (2019) defined DITC as a dynamic concept capability of first order. In other words, is the capability of an IT unit to acquire, deploy, integrate, reconfigure and transform the organization's IT resources to reach the business objectives, allowing IT units to appropriate the value of their infrastructure due to growing interdependence between organizations.

DITC concept has origins from the hierarchical capabilities that categorizes by ordinary capabilities (order zero) and dynamics (first order). In this case, are the resources that an IT unit deploy and offers support to IT capabilities [1]. Such capabilities allow to understand how IT units can use the three main DITC components (dynamic capacity of the digital platform, dynamic capacity of IT management and dynamic capacity of IT knowledge management) to extend, modify or create common IT capacity - those that allow the company to "come alive" in the short term and support the fulfillment of its strategic objectives (Bharadwaj, 2000; Li & Chan, 2019; Winter, 2003).

2.2 Improvisational Capability

The capacity to improvise deals with the abilities learned how to spontaneously reconfigure existing resources in real time, in order to create new operational resources that better correspond to new environmental situations (Pavlou & Sawy, 2010). The companies face new situations in turbulent environments, improvisation is probably a repeated activity that is improved with practice (Kung & Kung, 2019; Pavlou & Sawy, 2010; Winter, 2003). Therefore, improvisation capacity is a purpose that aims to reconfigure existing operational capacities, acting outside of previous practices to address new events (Weick, 1993, 1999).

The main objective of improvisation is to solve problems in a creative way, either through a good combination for new environmental situations or based on the realities of the moment (Du, Wu, Liu, & Hackney, 2019; Kung & Kung, 2019).

Unlike dynamic capabilities that emphasize flexibility and discipline, or the "planned opportunity" logic (Eisenhardt & Martin, 2000), improvisation capabilities require creativity, intuition, and are based on "spontaneous response logic" to recombine resources in real time, in order to create new operational capabilities that address new environmental situations (Pavlou & El Sawy, 2007; Pavlou & Sawy, 2010).

Increasingly, researchers in strategy, IT and management are beginning to see improvisation as a new management technique and guidance for the renewal of organizational

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[1] Tangible resources that comprise the physical components of the IT infrastructure, the human resources of IT, including their technical and managerial skills and the intangible resources enabled by IT, such as knowledge assets, guidance and synergy for the customer (Bharadwaj, 2000).

strategy, proposing that organizations can develop improvisation abilities through practice (MM Crossan, 1998; Kung & Kung, 2019).

2.3 Organizational Memory

Organizational memory (OM) is defined as acquired knowledge that is learned from previous experience - such as past events, promises, objectives, assumptions and behaviors - and that can be used in present decisions (Walsh & Ungson, 1991; Wang, Ahmed, & Rafiq, 2008). Organizational memory is not simply the sum of the memories of members of the organization, as it may involve the interaction of other people, or even reside outside the consciousness of specific individuals (Moorman & Miner, 1997). This information is stored, as a result of the implementation of the decisions to which they refer, through singular memories and shared interpretations, in such a way that organizational memory is presented as an instance of collective memory, which depends on knowledge distributed especially by through processes, individuals and devices of the organization, thus allowing the improvement of central competence, increased learning, lower transaction costs and greater autonomy (Stein & Zwass, 1995; Walsh & Ungson, 1991).

Although scholars disagree on whether organizations store information in memory as individuals (Moorman & Miner, 1998a), there is a consensus that organizations have frames of reference, routines, structures and other physical artifacts that reflect the presence of stored knowledge, emphasizing improving existing knowledge, as well as developing new knowledge (Kyriakopoulos, 2011; K. Lee et al., 2017). Organizational memory has been associated with better decision making and the development of new products (Kmieciak, 2019).

From a technology standpoint, organizational memory can assist in building a knowledge repository, such as a shared database or knowledge base, to capture and store knowledge so that others can easily access it (Lin, 2015).

The content of organizational memory refers to the meaning of the information stored collectively (Walsh & Ungson, 1991), consisting of two types of knowledge: procedural and declarative (Cohen, 1991; Moorman & Miner, 1998a), which will help companies to build their learning capacities, while enhancing the positive role of organizational memory and minimizing its possible negative effects (Aryati, 2017; K. Lee, Kim, & Joshi, 2017).

2.4 Business Process Performance

According to Davenport (1993), a business process is the specific ordering of work activities over time and space, with beginning and an end, as well as clearly identified inputs and outputs. Business processes are fundamental for converting investments in IT into performance (Ferraris, Monge, & Mueller, 2018).

Information technology increasingly permeates organizational boundaries, connecting several companies through digital networks and applications that aim to merge their business processes (Li & Chan, 2019; Queiroz et al., 2018; Tallon et al., 2019). Thus, it is possible to say that it is in the process (for example, a better way of doing things), and not in the product, that IT has a real impact (Melville, Kraemer, & Vijay, 2004). As stated by Smith and Fingar (2003), "IT doesn't matter, but business processes do".

Resource-based theory highlights the link between the type of IT and the nature of business processes (Melville et al., 2004). A number of studies have argued that the primary effects of IT occur at the process level and that these effects can be aggregated at the organization level (Melville et al., 2004; Setia, Venkatesh, & Supreet, 2013; Sunil Mithas, Ramasubbu, & Sambamurthy, 2011), suggesting that the impacts of IT at the process level are important to understand how IT resources relate to the company's performance (Queiroz et al., 2018).

Business process performance (BPER) denotes a range of measures associated with improving operational efficiency in specific business processes and is arranged in three dimensions: 1) cost - which reflects the perspective oriented to efficiency; 2) time - which is to respond to changing conditions quickly and flexibly; and 3) quality - which includes customer orientation and the possibility of differentiating the company's value proposition through a specific business process (Ferraris et al., 2018; Melville et al., 2004; Ray, Muhanna, & Barney, 2005).

3. Development of Propositions

3.1 Dynamic IT Capabilities and Improvisational Capabilities

The dynamic capability of the digital platform creates new avenues for creating value, improves operational efficiency, provides access to external capabilities and resources, and

allows for more participatory forms of engagement (eg, open innovation) (Li & Chan, 2019; Nan & Tanriverdi, 2017; Ray et al., 2005), enabling greater IT flexibility when organizations are pressured to adopt new technologies, transform or even end existing systems (Queiroz et al., 2018; Rai, Constantinides, & Sarker, 2019). When the act of improvising promotes the need to spontaneously reconfigure existing capacities to create new operational resources (Pavlou & Sawy, 2010), a flexible IT infrastructure plays a key role in the improvisation capacity (Levallet & Chan, 2016).

The flexibility of the IT infrastructure, characterized by scalable, adaptable, modular and compatible IT systems, aims to easily scale and reconfigure existing IT infrastructure components to meet different business objectives and technology requirements (G. Kim, Shin, Kim, & Lee, 2011; Li & Chan, 2019), so that information can be collected, analyzed and shared much more efficiently and quickly throughout the organization (Tallon, 2010; Tallon et al., 2019), in addition to presenting a potential to generate opportunities and introduce new forms of value creation that competitors will find it difficult to imitate immediately (Kung & Kung, 2019; JN Lee, Park, Straub, & Koo, 2019).

Dynamic IT management capabilities allow IT units to regularly update their service portfolios to support new features and practices, such as establishing new online distribution channels, automating and reconfiguring collaborative business networks (Yeow, Soh, & Hansen, 2018). Whether through incremental adjustments or radical changes, the ability of an IT unit to effectively adjust how IT is managed allows the organization to make good adoption decisions that implement IT solutions at lower costs, which quickly apply the benefits of new assimilated technologies and take advantage of emerging process improvements (Bharadwaj & Grover, 2016; Li & Chan, 2019; Sunil Mithas et al., 2011). Such characteristics contribute to the capacity for improvisation when it requires creativity and spontaneous intuition to recombine resources in real time, in order to create new operational capacities that address new environmental situations (Eisenhardt & Martin, 2000; El Sawy, Malhotra, Park, & Pavlou , 2010).

Improvisation is an important source of learning. People act to make events meaningful and situations understandable and, in the process, deepen their knowledge through more learning, making professionals reflective (Cunha & Clegg, 2019; Du et al., 2019). Thus, the dynamic capacity of IT knowledge management can contribute as a facilitator in the creation, transfer and retention of IT knowledge throughout the organization.

Thus, the study proposes to investigate the contribution of information technology capabilities (DITC) to the generation of improvisation capacity with the following proposition:

P1: Information technology (DITC) capabilities contribute to the generation of improvisation capabilities.

3.2 Organizational Memory and Improvisation Capacity

Organizational memory represents one of the main determinants of the nature of improv results (Moorman & Miner, 1998a). There is considerable evidence to suggest that decision makers adopt strategies based on the recognition of characteristics of past problems to solve current adversities (Mendonça, 2007). The effectiveness of organizational improvisation depends on the processing of stored knowledge, which is called organizational memory (Antunes & Pinheiro, 2020; Moorman & Miner, 1998b).

Filieri and Willison (2016) note the importance of the origin and reuse of knowledge in the product development process. They point out that new products are generally a modification of existing products, which is why "R&D personnel often recover and reuse existing problem solving in prototyping new products" (p. 147). In addition, the information stored must be of high quality, accurate and sufficient, because, if an employee has easy access to adequate knowledge, he can effectively reuse the knowledge for recurring problems or for routine activities that will appear in the improvisation process (Kmieciak, 2019).

Given that organizational memory focuses on project histories, content repositories, knowledge directories and data storage functionalities that allow access to knowledge and memory from previous projects, Pavlou and Sawy (2010) argue that organizational memory can prevent the skills of improvisation that focus on responding to new situations, acting out of previous knowledge. In addition, Vera and Crossan (2005) state that past knowledge can restrict improvisation, forcing people to trust past practices that may not be related to the new situation in question.

This is due to the fact that the memory of failures, called the skill trap or routine rigidity, can prevent employees from taking risks and taking daring actions (Moorman & Miner, 1997). In addition, employees may be reluctant to change procedures and ways of doing things tried and tested, repeating old ways and habits of acting (Kmieciak, 2019). Therefore, organizations need to learn to forget the knowledge that must be discarded (for example, bad habits from the

past or learned from a partner), and not to forget the knowledge that is valuable and must be retained (Martin de Holan, Phillips, & Lawrence, 2004).

In contrast, Levallet and Chan (2015) postulate that, in order to be able to strategically improvise, companies need to quickly identify and evaluate business opportunities. In this sense, access to information online is essential because it provides managers with the means to have a clear and real-time understanding of their resources and capabilities (Eisenhardt & Martin, 2000). Organizational memory represents all information and knowledge held by an organization, especially factual information, routines and procedures, which can be used to make current decisions (Miner, Bassoff, Moorman, & Miner, 2001).

Organizational memory is important for all forms of organizational innovation, but it is particularly important for organizational improvisation, due to the convergence of composition and performance (Moorman & Miner, 1998a). According to Antunes and Pinheiro (2020), procedural memory should enhance improvisation, efficiency and speed, reducing its novelties; declarative memory, however, should increase the effectiveness of organizational correlation and novelty, while reducing its speed.

That said, the work proposes to investigate the contribution of organizational memory to the generation of improvisation capacity with the following proposition:

P2: Organizational memory contributes to the generation of improvisation capacity.

3.3 Improvisational Capability and Improvement of Business Performance Process

The performance of the business process (BPER) is manifested through activities that transform inputs into outputs (Melville et al., 2004; Tallon et al., 2019). In this sense, the ability to improvise can simultaneously create and execute a new solution, obtained through the unplanned recombination of available resources, aiming at maintaining or improving the efficiency of the process (Kung & Kung, 2019).

Performance denotes a range of measures associated with improving the operational efficiency of business processes, such as, for example, protecting customers, transforming products and / or delivering these products or services to customers (Yoshikuni & Albertin, 2020). These activities are related to innovation, operations and after-sales support (Kaplan & Norton, 2000) and can benefit from the ability to improvise when planned routines or operations are unable to respond to unexpected and specific situations (Miner et al., 2001; Vera,

Nemanich, Vélez-Castrillón, & Werner, 2016), or when there is a need to create something new through a creative process, in order to solve a problem or gain a competitive advantage (Vera & Crossan, 2005). High levels of innovation capacity, that is, investing heavily in task automation and data integration, indicate that business processes are largely supported by IT with a focus on process automation (Ferraris et al., 2018).

Improvisation relates to sustaining and innovating capabilities, such as experience and organizational knowledge (Kamoche, Cunha, & Cunha, 2017), and gives meaning to these challenges, while providing immediate decisions under uncertainty (Brown & Eisenhardt, 1997; Vera & Crossan, 2005). Therefore, at the heart of a process performance, is the ability to execute the action using only the materials and resources available, under severe time restrictions (Cunha & Clegg, 2019; Kamoche et al., 2017; Mendonça, 2007; Pina and Cunha, Vieira da Cunha, & Kamoche, 1999).

Currently, many studies are viewing organizational improvisation as a business process, rather than an ad hoc course of action, because some organizations have routinized processes to stimulate and implement improvisation, and others have developed improvisation as an organizational capability (M. Crossan, 2005; Du et al., 2019).

Given the importance of business processes, their quality is a critical predictor of a company's ability to provide products and services efficiently (Mikalef & Pateli, 2017). Thus, the easier it is for an organization to recombine / restructure its resources, the greater its performance; likewise, the faster the organization can formulate and implement a new and creative solution to respond to an unexpected event, the better its performance will be (Hu et al., 2020; Kung & Kung, 2019).

Thus, the study proposes to investigate the contribution of improvisation to the achievement of business process performance with the following proposition:

P3: The ability to improvise contributes to the achievement of business process performance.

3.4 Environmental turbulence, Improvisational Capacity and Performance of Business Processes

The need for improvisation capacity is more apparent and affects the speed of business in highly turbulent environments (Pavlou & Sawy, 2010; Rui, 2020). As argued by Chakravarty

et. al. (2013), environmental dynamism moderates more than just a relationship; it probably affects the enabling and facilitating functions of IT competencies in complex ways.

As all industries face challenges created by increasingly uncertain environments, organizations adopt and merge emerging information technologies into the structure of their products, services and business processes, indicating that business and IT strategies are converging (Kung & Kung, 2019; Mikalef et al., 2020; Tallon et al., 2019).

The importance of the ability to improvise is evident in the modern digital age, because there is rarely time to plan the best way to react to unexpected disorders in this type of environment (Levallet & Chan, 2015; Queiroz et al., 2018). When an unpredictable event occurs, companies must react quickly to solve a problem or seize an opportunity and thus gain a competitive advantage (Kung & Kung, 2019; Wilden et al., 2016). When the future is difficult to predict, it is important to monitor the environment closely and remain flexible (Miner et al., 2001).

For example, in the case study on improvisation in innovation in information technology in China, Hu et al. (2020) found that, in general, the impact of organizational improvisation on companies gradually diminished. The reason for this is that the turbulent environment found in the company's initial development stage requires organizations to be able to respond to demands in a timely manner. This requires the construction of improvisation capacities, mainly for the development of scarce resources, thus providing a range of opportunities for the application of information technology in order to improve processes and organizational performance (Melville et al., 2004).

The search for an effective improvisation process in turbulent environments can also be seen in the case study of Du et al., (2019) - Effective organizational improvisation in the development of information systems: perceptions of the development of the Tencent messaging system. The authors proposed the creation of a step-by-step process in order to drive effective improvisation to respond to the changing business environment and, thus, obtain better results in innovation, agility and performance improvement (Du et al., 2019).

Thus, the study intends to investigate the contribution of environmental turbulence to the generation of improvisation capacity and to obtain business process performance with the following proposition:

P4: How the environmental turbulence activates a capacity for improvisation to achieve the performance of the business process.

4. INTEGRATED RESEARCH MODEL

Integrating the four propositions, our research model (Figure 1), describes the constructs DITC (Dynamic Information Technology Capability) and Organizational Memory as enabling the Improvisation Capacity, which in turn integrated the Environmental Turbulence Influence Business Process Performance.
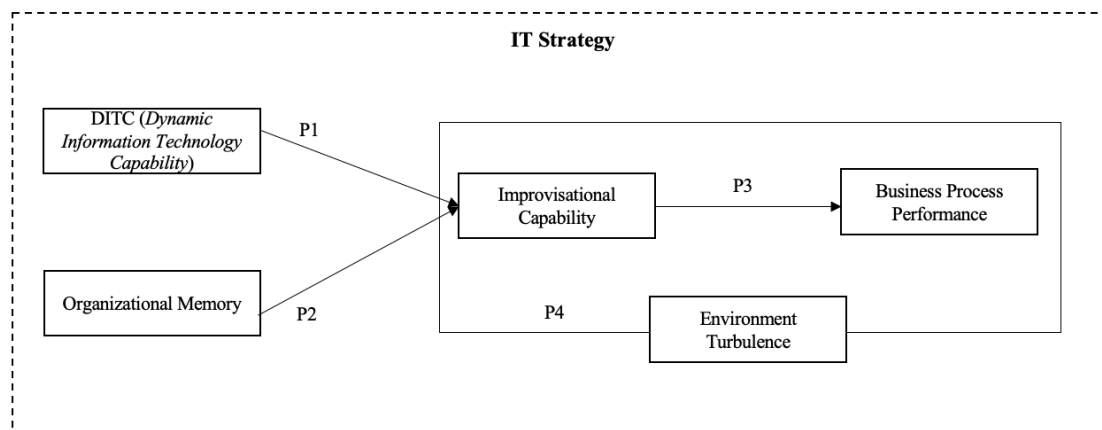
Figure 1 – Research Model

5. METHODS

5.1 Research

In the research, a single case study, of the exploratory type, was carried out, using semi-structured interviews in order to develop relevant hypotheses and proposals for further investigation (Yin, 2016). Still according to Yin (2016), the case study is applicable to address questions of the "what", "how" or "why" questions, made about a real and contemporary phenomenon that one wishes to understand in depth and over which the investigator has little or no control.

In research on qualitative approaches, data are collected through poorly structured techniques and through interpretative analyzes, in order to contemplate the discovery (Vergara, 2005). The study sought to respond to the traditional concerns of a case study: conducting research rigorously, avoiding confusion with teaching cases, knowing how to reach general

conclusions when desired, and carefully managing the level of effort, understanding the competitive advantage of research (Yin, 2016).

5.2 Selection for the Case Study

The case selected for the study was that of a large private Brazilian company in the contact center sector, which has more than 1,000 employees and annual sales exceeding R $ 60,000,000.00.

Faced with a turbulent scenario arising from the pandemic (covid-19), companies had to adapt in record time to a reality never lived before (InforChannel, 2020), especially when the business continuity plans of customer service organizations and the contact center generally did not include the ability for employees to work remotely (Blood Steve & Drew, 2020). Customers began to demand more. The demand for flexible, safe and scalable technologies has come to have a relevant weight, as well as the need for constant innovation and improvisation to respond to the impacts of the pandemic. The companies looked for other ways that could enhance new experiences for customers. For example, there has been an increase in the interest of companies for digital customer service tools - such as chatbots and artificial intelligence (AI) - for multichannel strategies (omnichannel), in addition to an increase in the use of RPAs (Robotic Process Automation) to help improve processes (CallCenterInf, nd; Ventura, 2020).

5.3 Databases

To collect the data, in-depth interviews were conducted (Eisenhardt, 1989; Yin, 2016). Interviews are an appropriate method for collecting data when the objective is to seek respondents' opinions and experiences and find out what people are thinking (Myers, 2009). The interview is also a flexible technique, because, in addition to clarifying the meaning of the questions, it can be easily adapted to the people and circumstances in which it is conducted; however, it depends on the interviewee's motivation, which can provide false answers for conscious or unconscious reasons to the participants (Gil, 2009). In case studies, it is common to conduct interviews with people who have had practical experiences with the researched problem (Filho; Filho, 2015). Due to the conditions imposed by the pandemic, the interviews were conducted by videoconference. In total, 5 hours of audio were recorded, and the duration of the interviews ranged between 25 and 50 minutes. All content was transcribed for further analysis.

The participants were selected jointly with the directors and managers of the company, always looking for people who were involved with technology, either running (IT area) or demanding (business areas). All participants signed an informed consent form prior to the interviews.

In all, 9 professionals were interviewed, who occupy different positions in the organization, from IT analyst to CEO. In order to create a more comfortable environment for respondents, personal data remained confidential, with personal information hidden. The organization's name was also masked (Company X). Below, the details of the interviews are presented:

Interviewee	Position	Company Time	Area of Performance	Date of the Interview
I1	IT Manager	5 years	IT - Infrastructure	10/23/2020
I2	Operation Manager	7 years	Business	10/26/2020
I3	Operation Supervisor	3 years and 3 months	Business	10/26/2020
I4	IT Coordinator	2 years and 3 months	IT - Infrastructure	10/27/2020
I5	IT Analyst	1 year e 8 months	IT - Infrastructure	10/27/2020
I6	Planning manager	8 years	Strategy	10/28/2020
I7	Operation Superintendent	13 years	Business	10/28/2020
I8	CEO	10 years	Business	10/29/2020
I9	Development Manager	2 years and 9 months	IT Development	10/29/2020

Table 1 – interviewed for research // Author´s elaboration source based on Interviews

5.4 Data analysis

Data analysis is the most complex and difficult stage of research (Eisenhardt, 1989). For Yin (2016, p. 137), "data analysis consists of examining, categorizing, classifying in tables, testing or, otherwise, recombining quantitative and qualitative evidence to address the initial propositions of a study".

It is a permanent process involving continuous reflection on the data. The analysis involves collecting open data, based on asking open questions and developing an analysis of the information provided by the participants (Creswell, 2010). The results obtained in the analysis of the data must contemplate both what is adherent to the existing theories and what is conflicting (Eisenhardt, 1989).

After completing the interviews, all 9 recordings were transcribed in full. Subsequently, we performed the analysis of the raw results of the interviews, using the classification process. The information was grouped in tables that allowed to explore and investigate the scenario of Company X through the triangulation between the data in the academic literature, the company's public documents and the data collected in the interviews.

6. RESULTS AND ANALYSIS

In this section, we describe our findings about DITC, organizational memory, improvisation capacity and performance of business processes in the studied company based on the developed proposals. As a tool to support the content analysis of the interviews, we chose to use the MAXQDATA Analytics Pro software.

At the beginning of the interviews, all participants indicated how they viewed the IT strategy of Company X. This question aimed to meet what Chan and Levallet (2015) proposed, that is, before leaders decide to invest in resources and IT capabilities, it is advisable to carefully reflect on the context of the organization to determine the potential benefit of improvisation in conjunction with its IT strategy.

Interviewee	Strategy			
	Innovative	Conservative	Undefined	Ambidextrous
I1				x
I2				x
I3	x			
I4				x
I5				x
I6				x
I7				x
I8				x
I9	x			

Table 2 – interviewers for the Research // Author's elaboration based on interviews

According to the responses of the interviewees [2], the direction for a type of ambidextrous strategy was evident, when the best of conservative and innovative strategies is used in order to find a balance between novelty and caution (Leidner, Lo, & Preston, 2011). This statement can be seen in the words of the CEO of Company X.

"[...] it needs a certain stability to maintain the business, but also, at the same time, we always need to bring new things, both from the market, and internally developing things [...] new products, new solutions for that we also stay one step ahead of our competitors in our business" (I8).

P1 - Information technology (DITC) capabilities contribute to the generation of improvisation capabilities.

Discoveries in the IT literature suggest that improvisation benefits from IT capabilities (Pavlou & Sawy, 2010). For example, having a flexible IT structure plays a key role in the ability to improvise (Levallet & Chan, 2016). As the development manager said:

"Due to the time, we started to work with more flexibility [...] The integration of the systems themselves and the cloud solution part was paramount. This decision, at the time, in

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[2] We used the letter "I" follow up by the person interviewed number to identify and differentiate between one another answers. For example, "Interview n.8" = "I8".

having used the cloud structure itself gave us the structure, the ability to make a more fluid integration" (I9).

The IT manager also sees Company X's IT flexibility as an important feature for problem solving. "[...] We did manage to have the flexibility to face the changes as they happen" (I1). For example, when deploying a new tool to facilitate home office service.

[...] "Slack provided security, because we have a record, we have a control [...] The purpose of the tool is to speed up communication with the company and, with that, we will have a greater speed for decision making, for corrections, in short ... It is a tool that unites employees in a closer way and streamlines processes." (I1).

Below, it can be seen a real example that shows how the flexibility of Company X's IT structure was used to easily reconfigure components to meet different business objectives and technology requirements (G. Kim et al., 2011).

"[...] we needed a more powerful firewall, with more resources and hardware, I couldn't get it up quickly. Suddenly, we saw that our antivirus software has a function, a content filter, that it could do, if not the same, even better than the firewall itself and still at no cost [...] this type of resource that you were not using, because there was no need, from the moment there was a realization that it is flexible." (I1).

Still within the context of flexibility, the capacity of IT platforms can create new ways to create value, to improve operational efficiency, enabling greater IT flexibility when organizations are pressured to adopt new technologies, to transform or even to terminate existing systems (Li & Chan, 2019; Queiroz et al., 2018; Rai et al., 2019). In the study, it was possible to notice the creation of new platforms that were reconfigured to meet business requirements, maintaining and even updating the portfolio of IT products and services.

"[...] before, it was 100% by phone and, today, a platform called "Fast Zap" was created. This platform helps 100% of the operational areas. Before, we had the issue of digital service, but we expected the customer to stimulate us, and not today. Through the "Fast Zap", we were able to make an asset for this client [...] the client, he can receive a ticket via WhatsApp; he can negotiate via WhatsApp" (I2).

In the operations manager's view (I2) above, it is possible to see that, in addition to reconfiguring and updating the portfolio, through effective IT management, it was possible to establish new online distribution / communication channels (Yeow et al., 2018).

"[...] the "Fast Zap" is a platform that we use daily; so, every day we carry out actions. Operationally, this is very important; we select the audience and that's it. This platform is even used today by all the company's customers". (I2).

In addition, the implementation of a new platform has enabled the creation of value that competitors will find difficult to imitate immediately.

"[...] this is a platform developed internally by us. We even commented on this in the committees with the end customer, it was a platform that greatly leveraged our results." (I3).

It is also possible to observe that automations were created (Yeow et al., 2018), that is, through incremental adjustments or radical changes, the ability of IT to effectively adjust how IT is managed has allowed the organization to make good adoption decisions, as well as implementing IT solutions (Bharadwaj & Grover, 2016; Li & Chan, 2019).

To support a solid knowledge base, IT units must take steps to prevent loss of knowledge (S. H. Kim, Mukhopadhyay, & Kraut, 2016). Having a consistent and robust knowledge base was important for Company X's IT team to implement solutions and tools efficiently.

"[...]. I arrived by documenting, structuring the processes, and the pandemic even helped that, too, because we saw that, really, there were many flaws in certain process points, and I went there, studied, and we improved these processes. This knowledge base was so useful that we were able to implement these various tools here in the company." (I4).

Not least, Company X was able to deploy knowledge base solutions to reuse in the future.

"[...] the base can and should be improved, for example: "Search the channel for such a keyword", the person places the keyword there, type one, for example, "VPN access, how to do it?"; she will find a document there; you can attach this document, it is inside the base of Slack. You can have specific channels; for example, a support channel, just for people to check, consult, as if it really were a knowledge base". (I1).

And, in addition, organizational leaders also need to have an IT infrastructure that facilitates access or sharing of this information in real time (Levallet & Chan, 2016).

"[...] when BI was implemented, we were able to take all the data into the BI. This was fundamental for us in the strategy area to be able to have the information online 24 hours a day and, thus, to execute the action taking more quickly. We analyze and already reap the success or the error and we already execute it immediately, without wasting time". (I6).

P2 - Organizational memory contributes to the generation of improvisation capacity.

To strategically improvise, companies need to quickly identify and evaluate business opportunities (Levallet & Chan, 2015), providing real-time information and quickly identifying and evaluating business opportunities (Eisenhardt & Martin, 2000).

"[...] IT was able, through new servers, to support all the information we have in the company, which is a lot of telephony information, and to put this in a format, online to facilitate the analysis and execution of strategies." (I6).

The memory acquired by the IT team at Company X was instrumental in solving problems that had never existed before and that occurred during the pandemic. The example below is observed in the change of on-site employees to home office, as portrayed by one of the professionals in the technology area.

"[...] what we already knew about the environment, including from previous tests that had been done, problems that we had already faced before. All of this helped to make this migration faster" (I4).

Organizational memory helped Company X take advantage of the entire IT ecosystem, such as business intelligence systems, knowledge management and collaborative systems, to provide organizational leaders with useful information quickly.

"[...] we can create a useful information channel, in which people can answer, for example, satisfaction surveys and surveys. The company will have the feedback practically in real time; you can hold meetings online; conferences; be presenting, exposing your Power Point screen to the people attending the conference." (I1)

Below, the planning manager exemplifies the implementation of an improvement in a tool that was only possible due to the knowledge accumulated in previous projects.

"[...]. We created a digital agent robot that validates that it really is the customer and only transfers the confirmed customer to operation. So, with that, we reduced the transfer by almost 80% (eighty percent) of the calls. We managed to be more assertive, and bring better performance. This was only possible with the experience we had. We changed the whole process for the robot to validate the CPF first and only then transfer to the operation." (I6)

Although, when it comes to memory, there are studies that refer to the memory of failures, called the competence trap or routine rigidity, which can prevent employees from taking risks and daring actions (Moorman & Miner, 1997), this characteristic was not observed

at Company X; on the contrary, the organization provided a culture of challenge to the status quo and processes that were not working, in search of innovations and improvisations that would generate some kind of competitive differential in the face of an adverse scenario.

"[...] our focus, our culture is always this: if we have a problem, we need to provide a solution and it has to be the best solution for that problem. So, I think this is already the mindset of our IT; for example, they are not there to solve the same problems every day, every day. They are there to create better ways of doing that, so that those problems don't happen again". (I8)

Risk appetite is part of the business and people are challenged to contribute in some way to the final result (Martin de Holan et al., 2004). This characteristic can be seen in the statement below.

"[...] we take the business risk extremely. Customers make it very clear just the following: the goal is "X", you have to achieve it. There are some rules that have to be followed, but we always have to be innovative and sometimes risky. We have many successes and many mistakes as well. What I use a lot is to make mistakes quickly. So, when there was a pandemic, we had to think: If you are going to make a mistake, make a quick mistake and if necessary, make some adjustments". (I6)

In fact, Company X's organizational memory represents all the information and knowledge retained by the organization, especially factual information, routines and procedures, which can be used to make current decisions (Miner et al., 2001).

P3: The ability to improvise contributes to the achievement of business process performance.

The performance of the business process (BPER) manifests itself through activities that transform as inputs as a result (Melville et al., 2004; Tallon et al., 2019).

Company X was able to improve the performance of its products and operations with products and services created through improvisation processes, since there was no pre-planned action requiring rapid action. As the CEO said, it was necessary to create new solutions to support the organization's processes.

"[...] we had to learn fast, seek solutions that we didn't have yet; we had about 80% (eighty percent) of the solutions, but twenty, we had to create to sustain this change" (I8).

For example, the WhatsApp service platform, called "Fast Zap", contributed to improving the customer service process more quickly and more conveniently, in addition to being available 24 hours, as commented by the development manager.

"[...] The "Fast Zap" for messaging helped us a lot. This was one of the products that we created during this pandemic and it was a very rapid development" (I9).

Improvisation leads to support and innovation of capabilities, such as experience and organizational knowledge (Kamoche et al., 2017), and gives meaning to these challenges, while providing immediate decisions under uncertainty and denotes a range of measures associated with improving the operational efficiency of business processes, such as, for example, protecting customers, transforming products and / or delivering these products or services to customers (Yoshikuni & Albertin, 2020).

"[...] if I didn't have the option to call a customer on WhatsApp, if I didn't have the option of the customer entering the weekend platform to get a ticket, if IT didn't have the speed to assemble one machine at an employee's home, perhaps today, my performance would be poor. I would have had totally negative impacts on the portfolios, and that would have a very negative impact on the company "(I2).

Company X has developed improvisation as an organizational capacity.

"[...] Company X already has a habit of working with innovations [...] it was very cool when we saw people innovating, studying, looking for alternatives, looking at the market [...] IT was adapting, innovating and creating different things for Company X" (I3).

Given the importance of business processes, their quality is a critical predictor of a company's ability to provide products and services efficiently (Mikalef & Pateli, 2017). And, through constant improvisation, it was possible to increase the performance of the processes.

"[...] we have considerably improved the efficiency of the processes, impacting even on the final performance. Today, we ended up having a reduction in capacity without dropping performance". (I6).

The faster the organization can formulate and implement a new and creative solution to respond to an unexpected event, the better its performance (Hu et al., 2020; Kung & Kung, 2019), as assessed by the operational supervisor:

"[....] because, if IT had not acted quickly, effectively and efficiently, we would not have been able to leverage or maintain any results" (I3).

P4 - How the environmental turbulence activates a capacity for improvisation to achieve the performance of the business process.

The need for improvisation capacity is more apparent and affects the speed of business in highly turbulent environments (Pavlou & Sawy, 2010; Rui, 2020), such as what was observed in the pandemic (Sars-CoV-2).

"[...] The pandemic almost completely affected the business, as much as the processes, such as the way we deal with our resources. Our people, our employees, we had to reinvent ourselves." (I3)

"[...] We had to adapt, in record time [...] Our IT had to adapt, very quickly to make all these necessary changes and modifications" (I6).

The turbulent environment brought about by the pandemic meant that Company X benefited from detection and reconfiguration activities to align its technological capabilities to the needs of its Clients.

"[...] It was an accelerator; he made it as if everyone left his square; everyone had to develop and seek new ideas, new solutions for what you were already doing" (I7).

And in that sense, once again, environmental dynamism moderated not only a relationship, but probably affected the enabling and facilitating functions of IT competencies in complex ways.

"[...] We had people who had an internet problem, who had no possibility of working from home, because they had no access to the internet, and the IT area was able to purchase 4g modems in record time". (I2)

During this turbulent period of pandemic, Company X constantly sought innovation and improvisation as a foundation for the business, since the demand for IT in the organization is very high, as the planning manager said:

"[...] at my point in view, 90% (ninety percent) is needed from technology" (I2).

Although there was fear, the improvisation was successful at Company X, ensuring the performance of operations.

"[...] the company's technology area managed to change, very quickly and with quality. At first, I had doubts, if we would be able to provide the service with quality. TI was able to make this change without losing performance". (I2).

Companies adopt and merge emerging information technologies into the structure of their products, services and business processes. This was visible in the products that emerged during the pandemic, such as the "Fast Zap" and that, since then, started to be part of the processes of Company X. What did not exist before, is now part of a new normal.

"[...] today, operationally, we have no intention of stopping using it; on the contrary, even after the pandemic has passed, the idea is to intensify the use of this platform even more, because it worked very well; customers are increasingly digital, and that was very important" (I2).

In the words of the operational superintendent (I7), it is clear that the agility of IT management and improvisation was fundamental to meet the business needs during the pandemic:

"[...] it was very agile and very efficient. I think that was the essential point so that we could continue to deliver performance to our client". (I7).

Even more so when the Client started demanding more, as pointed out by the planning manager:

"[...] we had to accelerate to a format to better serve the client and the time the client wants to be served" (I6).

The importance of the ability to improvise is evident in the modern digital age because there is rarely time to plan the best way to react to unexpected disorders in this type of environment (Levallet & Chan, 2015; Queiroz et al., 2018).

"[...] before, we only had telephone assistance; we had no way of reaching the customer in other ways. So, through the IT development area, the ability to reinvent itself, we were able to adapt and create new forms". (I2)

Technological changes in a market imply unpredictability, ignorance or an inability to understand technological developments or changes in the external environment, especially when the Client requires more quality of processes. For example, with the implementation of the home office, Company X eliminated the physical barrier to growth in its operations and, thus, increased the service capacity. As the CEO comments:

"[...] for sure, there is a pre- and post-pandemic [3] world. In the post-pandemic there is no single structure. It becomes more malleable; you can be in an area, in an operation, in a 100% (one hundred percent) Home or hybrid sector or in the company. Now there are more options and we already understand that, with the evolution of the internet and with things happening. Now, with the arrival of 5G, physical location increasingly matters less. Your technology hub and your speed matter" (I8)

7. CONCLUSIONS

In conclusion, based on the interviews and data of a large Brazilian company in the contact center sector, we found great support to support our propositions that dynamic IT capabilities in conjunction with organizational memory are important enablers that shape improvisation capabilities. In turbulent environments, improvisation skills are essential to obtain performance in business processes. This section discusses and emphasize the limitations of our study, as well as its implications for researchers and practitioners.

7.1 Theoretical Contributions

The study makes several contributions to SI. The call from El Sawy (2010) was followed, seeking to better understand how IT capabilities, improvisation capabilities and organizational memory are interrelated in organizations that have characteristics of high IT dependency, considering a time of environmental turbulence.

At first, the work complements the statement by Li and Chan (2019) about the importance of studying how information technology capabilities (DITCS) can be influenced and leveraged to facilitate detection and reconfiguration capabilities at the company level. The study showed that, in a highly turbulent environment, as in this case, impacted by the Coronavirus (Covid-19 / Sars-CoV-2) pandemic, the use of dynamic IT capabilities played a central role for the organization to be able to readjust its processes in order to meet the new requirements IT and business. Through a flexible and integrated IT structure, the organization was able to migrate most of its employees to the home office without losing the quality and performance of operations. Still in relation to what was proposed by Li and Chan (2019), the study adopted a DITCS view based on practice.

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[3] Adaption of Language in order to accomplish a more understandable message.

Secondly, the study extends the research of Pavlou and Sawy (2010), who examined the improvisation capabilities in NPD (new product development), investigating other functional contexts, with other types of IT systems, as well as IT architectures promising emerging markets for digital competition.

Contrary to what Pavlou and Sawy (2010) discussed and argued, that organizational memory systems do not facilitate improvisation capabilities in highly turbulent environments, the study showed exactly the opposite. In the face of an adverse scenario, memory capacity was important for teams to be able to improvise. For example, through memory, the organization improvised new firewall functions using antivirus, which served to mitigate information security risks for employees who were working in the home office.

Regarding to performance, our study focused on the efficiency of business processes. The application of the constructs presented above (information technology capabilities, organizational memory, improvisation capacity and turbulence) allowed the company to be more efficient in its business processes. A clear example concerns the elimination of physical barriers to the implementation or growth of operations. Due to an adverse and turbulent scenario (pandemic), the organization needed to improvise the practice of the home office, thus showing a quick ability to reconfigure its resources. For this, knowledge from previous projects and organizational memory was used, which consequently generated a new business model. A more dynamic, scalable and performance model for both the company and the customer.

7.2 Practical Contributions

In turbulent environments, a company's strategic capabilities must continue to evolve to maintain competitive advantage. The fact that IT is an integral part of contemporary business and the ability of an IT unit to collaborate with business partners to extract value from IT, can be decisive for the performance of the company and its long-term processes. The survey provides useful insights for business professionals in the contact center industry. Other sectors can also benefit from these discoveries.

The ability to improvise can be seen as an alternative to strategic planning when there is no time to plan effectively, for example, when there is an unexpected disruption in the sector. Companies need to have strong IT capabilities to respond effectively to changes and to quickly adjust their strategies, as having flexible and standardized IT allows organizations to scale their operations quickly. In addition, having an IT strategy definition will help managers better define which IT capabilities and investments will be prioritized.

The study encourages organizational leaders to challenge the status quo and promote an improvisation-oriented culture. Although it is often still seen as a pejorative characteristic, still occasionally treated as "stuff", through the case study it was possible to perceive that improvisation capacity is essential for companies to survive in dynamic environments. Especially, when time is a determining factor. Even though improvisation is considered useful in only a few contexts, the study showed that improvisation capabilities can be effective and complementary to dynamic IT capabilities in severe turbulence.

Leaders also need to get used to encouraging their employees to take risks. When it is difficult to anticipate and there is no time to plan, having professionals who are not afraid to change or reinvent existing processes is likely to help the organization maintain business continuity. In addition, knowledge needs to be preserved and shared; thus, it is important that managers focus on the development of organizational memory.

7.3 Limitations and Future Studies

Like any research, the present study has some deficits that could be improved in the future. First, it focuses on just one company in a specific industry (contact center). Therefore, it is evident that the conclusions cannot simply be extended to organizations of other sectors and sizes. In addition, as it is a single case study, the work carries a limitation inherent to this type of research, which is the impossibility of generalizing the results obtained (Yin, 2016). Although the case study is an appropriate methodology for such research, it is recognized that all methodologies have their limitations. Even if the selection of the interviewees was made carefully, together with the direction of the organization, a total of 9 interviews were carried out, thus limiting the results to the quality of the responses.

8. Final Considerations

The case study was punctual and chosen, which can also corroborate with some type of bias, regarding the subject mentioned in the article.

Thus, it is indicated that, in the future, a longitudinal study is carried out in a new context, with cross-validation of the results and with a sample that covers other companies as well. In addition, it is also recommended to use other methodologies to complement the approach adopted.

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A NEW RANKING METHOD IN THE DATA ENVELOPMENT ANALYSIS CONTEXT FOR A TWO-STAGE NETWORK MODEL

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ABSTRACT

This paper proposes an innovative procedure for transforming the two-stage network (TSN) data envelopment analysis (DEA) model into a single-stage DEA model. The TSN-DEA models' critical issue is that the efficiency score depends on the reference set of the decision-making units (DMUs) to be rated. As a result, the TSN-DEA ranking methods for the two-stage process are so limited. For the single-stage DEA model, several popular DEA-based ranking methods may be applied. Through a numerical example, the procedure for the proposed method is shown to demonstrate its outstanding performance.

KEYWORDS

Two-stage network, Data envelopment analysis, Decision-making unit, Cross efficiency, Super Efficiency

INTRODUCTION

Various authors have proposed several approaches in modeling decision-making units (DMUs) with a two-stage network (TSN) structure, as shown in Cook et al. (2010). As Monfared and Safi (2013) and Chen et al. (2018) state, the single-stage DEA model considers a DMU as a 'black box' and neglects intervening processes, i.e., different series or parallel functions. They continue to say that the black box approach provides no insights regarding the inter-relationships among the components' inefficiencies and cannot provide specific process guidance to DMU managers to improve DMUs' efficiency. Kao (2017) introduces several traditional TSN DEA models: the centralized model, frontier projection, leader-follower model, and VRS (Variable Returns-to Scale) model. Most TSN-DEA models are based on the centralized model. Liang et al. (2008) show that the two-stage process can be viewed as one where the stages jointly

determine a set of optimal weights on the intermediate factors to maximize their efficiency scores. It is called a CRS (Constant Returns-to-Scale) two-stage centralized model. The TSN-DEA model's most critical weakness lies in its inconsistent centralized efficiency score (ES), which depends on the DMUs under evaluation in the reference sets. The TSN-DEA models frequently allow the previously lower-ranked DMU to overtake the top-ranked DMU to become a new #1 DMU if some lower-ranking DMUs are not evaluated together. No literature has explicitly and seriously discussed this critical weakness of the TSN-DEA models based on the centralized model.

On the contrary, the efficient DMUs with a perfect efficiency score (ES) of 1 for the single-stage conventional DEA (C-DEA) model will always have an ES of 1, regardless of the existence of inefficient DMUs in the reference sets (see Zhu, 2014). In other words, the efficient DMUs' ES in the C-DEA model would not change whether inefficient DMUs are evaluated along with efficient DMUs or not. Under C-DEA, each DMU is evaluated to maximize its own efficiency. Thus, to maximize the self-efficiency, the C-DEA model ignores its unfavorable inputs or outputs. As a result, the C-DEA method is known to show insufficient discriminating power by frequently rating too many efficient DMUs with an ES of 1 out of all DMUs under evaluation

To remedy this deficiency, Sexton et al. (1986) propose a cross-evaluation concept to do the peer evaluation, rather than the DEA's pure self-evaluation. Doyle and Green (1994) suggest a cross-evaluation matrix for ranking the units by applying the cross-efficiency DEA (CE-DEA) model. Generally, the CE evaluation can provide a full ranking for the DMUs. But, as Doyle and Green (1994) find, the non-uniqueness of CE scores and non-consistent rankings have been critical issues for applying the CE-DEA. To compensate for CE-DEA's weakness, the concept of the super-efficiency (SE) DEA model was introduced. When a DMU under evaluation is excluded in the DEA models' reference set, the resulting model is called a SE-DEA model. The SE-DEA model has significance for discriminating among efficient DMUs. Charnes et al. (1992) use the SE model to study the efficiency classification's sensitivity. Anderson and Peterson (1993) propose the SE model for especially ranking the efficient DMUs. But the critical issue of using the model is that the adjacent DMUs decide the super efficiency score (SES) of an efficient DMU, so it would be unreasonable for DMUs to be ranked by the SESs.

Li and Reeves (1999) propose a multiple criteria DEA (MC-DEA) model under multiple objective linear programming models. There are three performance measures in MC-DEA, efficiency score, the sum of slack variables, and the maximum quantity among all slack variables. The efficiency score can be interpreted as the relative efficiency of DMU_k when each DMU is given a chance to achieve the best practice for using the original inputs and producing original outputs. With an efficiency score, we can measure how efficiently DMU_k produces or generates the outputs using given inputs, comparing with all other DMUs. The MC-DEA model involves a broader definition of relative efficiency than the classical one introduced by Charnes et al. (1978). In other words, several different efficiency measures are defined under the same constraints, and each efficiency measure performs as a criterion to be optimized. They (1999) claim that efficiency criteria, which are more restrictive than the C-DEA, will yield fewer efficient DMUs and allow less flexibility for input/output weight distribution. However, if several DMUs under evaluation turn out to be efficient, the question of how to rank them remains unanswered.

RANKING METHOD

By applying the multi-objective programming (MOP) model to the MC-DEA, three performance measures are generated. Note that the efficiency score can be considered an output, whereas the other two inputs. Thus, applying MC-DEA to DMUs using the MOP model transforms DMUs with a two-stage process into DMUs with a single-process with two inputs and one output. We call this procedure the **transformed two-stage network** (**T-TSN**) DEA method. The proposed **T-TSN** DEA approach enables each DMU's efficiency to be more accurately evaluated so that DMUs are more consistently ranked. See Hong (2020) for the detailed procedure. The first approach to ranking the transformed DMUs is similar to the one that Li and Reeves (1999) propose. That is, DMUs are ranked based on the average centralized efficiency score. The second and third approaches apply the two most popular DEA-based ranking methods, cross-efficiency (CE) and super- efficiency (SE) DEA, for the transformed DMUs. The CE-DEA method, which consists of two phases, was proposed to rank DMUs with the central idea of using DEA to do peer evaluation rather than pure self-evaluation. The weights or multipliers arising from the first phase are applied to all DMUs to get the cross-efficiency score (CES) for each DMU in the second phase. As mentioned before, especially the CE-DEA method of ranking the

DMUs with many inputs and outputs shows inconsistent results. But with transformed DMUs with just two inputs and a single output, the CE-DEA method would generate more robust or consistent rankings.

CASE STUDY

This study considers the numerical example illustrated by several authors, such as Hwang and Kao (2006), Kao and Hwang (2008), Kao (2009), Chen et al. (2009), Kao and Liu (2019), and Lim and Zhu (2019), where there are twenty-four (24) DMUs as shown in Table 1. In Taiwan, the popular non-life insurance industry has an operation with a network structure. It has two processes in its operation, the insurance service itself and capital investment. For the former, clients are attracted to pay direct written premiums, and reinsurance premiums are received from other insurance companies. For the latter, the premiums are invested in a portfolio to earn the profit. This problem has been studied as a TSN problem, in which insurance service is the first stage and capital investment the second. The inputs of the first stage considered are:

   Insurance expenses (X1): expenses incurred in the service of insurance.

   Investment expenses (X2): expenses associated with the investment.

The intermediate products are premiums, and there are two types:

   Direct written premiums (Z1): premiums received from insured clients.

   Reinsurance premiums (Z2): premiums received from ceding companies.

The outputs of the second stage are:

   Underwriting profit (Y1): profit earned from the insurance business.

   Investment profit (Y2): profit earned from the investment portfolio.

The efficiency at stage 1 measures the performance in marketing the service of insurance, while the efficiency at stage 2 measures the performance in generating profit from the premiums.

We compare the efficiency scores, $\theta_\omega^{cen.}$ and $\bar{\theta}_\omega^{cen.}$, which are generated by TSN-DEA and T-TSN DEA, and report them along with the corresponding rankings in Table 1. As several authors already show, the top-ranked Fubon has the highest efficiency score by the TSN-DEA. The proposed **T-TSN** DEA also finds Furbon as the top-ranked DMU based on all three scores. We identify ten (10) DMUs ranked at least #7 by either TSN or **T-TSN**, evaluate, and report ESs along with respective rankings in Table 2. Surprisingly, Asia (DMU #22), previously ranked #7

overtakes Fubon as the top-ranked DMU by TSN-DEA, while Fubon, a previously top-ranked DMU, slips to No. 2. The ES of each stage for the top-two DMUs, Fubon and Asia, show erratic behavior. Quite obviously, there is no logical reason to explain that Asia replaces Fubon as the top-ranked DMU when the lower-ranked DMUs are not evaluated together with the higher-ranked DMUs. That would be a critical question to be answered for applying TSN-DEA models to rank DMUs. By contrast, the proposed **T-TSN** method ranks Furbon as the #1 DMU based on all three efficiency scores and Asia as the #8 on the average.

For many decision-makers, identifying the top-level rated DMU(s) would be essential for making the final decision. Thus, a ranking method, which can yield robust or consistent ranks for the evaluated DMUs, could be vital to decision-makers. In that respect, the proposed ranking method, along with the traditional TSN DEA method showing each stage's ES, would help the decision-makers identify the top-level DMUs and compare them before making any decisions.

SUMMARY AND CONCLUSIONS

This paper applies and uses the proposed new ranking method, transformed TSN (**T-TSN**) DEA to the 24 popular Taiwanese non-life insurance companies, which have an operation with a TSN structure. Through the numerical example, we observe that the rankings generated by the traditional TSN DEA show such a significant weakness, especially for the top-ranked DMU. By contrast, the proposed method seems to create more robust and consistent rankings than the TSN-DEA method. As shown in Table 5, Asia (DMU #22), with all DMUs rated, becomes a new top-ranked DMU when the TSN-DEA evaluates the top seven DMUs. By contrast, the rankings generated by applying the **T-TSN** DEA method do not change significantly when some lower-ranked DMUs are removed from evaluation.

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References are available upon request from Hong.

Table 1. Data set of the 24 Taiwanese non-life insurance companies.

No.	DMU	Operation expenses (x_{1j})		Insurance expenses (x_{2j})		Direct written premiums (z_{1j})		Reinsurance premiums (z_{2j})		Underwriting profit (y_{1j})		Investment Profit (y_{2j})		TSN $\theta_\omega^{cen.}$	R	$T-TSN$ $\bar{\theta}_\omega^{cen.}$	R
1	Taiwan Fire	$	1,178,744	$	673,512	$	7,451,757	$	856,735	$	984,143	$	681,687	0.6992	3	0.6875	2
2	Chung Kuo	$	1,381,822	$	1,352,755	$	10,020,274	$	1,812,894	$	1,228,502	$	834,754	0.6248	5	0.4301	5
3	Tai Ping	$	1,177,494	$	592,790	$	4,776,548	$	560,244	$	293,613	$	658,428	0.6900	4	0.6802	3
4	China Mariners	$	601,320	$	594,259	$	3,174,851	$	371,863	$	248,709	$	177,331	0.3042	15	0.2076	18
5	Fubon	$	6,699,063	$	3,531,614	$	37,392,862	$	1,753,794	$	7,851,229	$	3,925,272	0.7670	1	0.7627	1
6	Zurich	$	2,627,707	$	668,363	$	9,747,908	$	952,326	$	1,713,598	$	415,058	0.3897	12	0.2027	19
7	Taian	$	1,942,833	$	1,443,100	$	10,685,457	$	643,412	$	2,239,593	$	439,039	0.2766	17	0.2661	14
8	Ming Tai	$	3,789,001	$	1,873,530	$	17,267,266	$	1,134,600	$	3,899,530	$	622,868	0.2752	18	0.2747	13
9	Central	$	1,567,746	$	950,432	$	11,473,162	$	546,337	$	1,043,778	$	264,098	0.2233	20	0.2204	17
10	The First	$	1,303,249	$	1,298,470	$	8,210,389	$	504,528	$	1,697,941	$	554,806	0.4660	9	0.3290	9
11	Kuo Hua	$	1,962,448	$	672,414	$	7,222,378	$	643,178	$	1,486,014	$	18,259	0.1639	23	0.0471	24
12	Union	$	2,592,790	$	650,952	$	9,434,406	$	1,118,489	$	1,574,191	$	909,295	0.7596	2	0.3936	7
13	Shing kong	$	2,609,941	$	1,368,802	$	13,921,464	$	811,343	$	3,609,236	$	223,047	0.2078	21	0.2010	20
14	South China	$	1,396,002	$	988,888	$	7,396,396	$	465,509	$	1,401,200	$	332,283	0.2886	16	0.2759	12
15	Cathay Century	$	2,184,944	$	651,063	$	10,422,297	$	749,893	$	3,355,197	$	555,482	0.6138	6	0.3273	10
16	Allianz President	$	1,211,716	$	415,071	$	5,606,013	$	402,881	$	854,054	$	197,947	0.3202	14	0.1954	21
17	Newa	$	1,453,797	$	1,085,019	$	7,695,461	$	342,489	$	3,144,484	$	371,984	0.3600	13	0.3487	8
18	AIU	$	757,515	$	547,997	$	3,631,484	$	995,620	$	692,731	$	163,927	0.2588	19	0.2469	16
19	North America	$	159,422	$	182,338	$	1,141,950	$	483,291	$	519,121	$	46,857	0.4112	11	0.2470	15
20	Federal	$	145,442	$	53,518	$	316,829	$	131,920	$	355,624	$	26,537	0.5465	8	0.2896	11
21	Royal & Sunalliance	$	84,171	$	26,224	$	225,888	$	40,542	$	51,950	$	6,491	0.2008	22	0.1056	22
22	Asia	$	15,993	$	10,502	$	52,063	$	14,574	$	82,141	$	4,181	0.5895	7	0.5841	4
23	AXA	$	54,693	$	28,408	$	245,910	$	49,864	$	0	$	18,980	0.4203	10	0.4031	6
24	Mitsui Sumitomo	$	163,297	$	235,094	$	476,419	$	644,816	$	142,370	$	16,976	0.1348	24	0.0647	23

Table 2. Comparison of rankings for the top seven DMUs.

No.	DMU	TSN DEA		T-TSN DEA					
		$\theta_\omega^{cent.}$	Rank	$\bar{\theta}_\omega^{cen.}$	**Rank**	CES	**Rank**	SES	**Rank**
1	Taiwan Fire	0.7134	4	0.7081	**2**	0.1673	**4**	0.1676	**5**
2	Chung Kuo	0.6275	7	0.5088	**5**	0.2026	**2**	0.2029	**2**
3	Tai Ping	0.7096	5	0.6921	**3**	0.1492	**6**	0.1495	**6**
5	Fubon	0.7895	2	0.7882	**1**	1.0000	**1**	4.9920	**1**
8	Ming Tai	0.2961	10	0.2898	**10**	0.1917	**3**	0.1952	**3**
10	The First	0.4674	8	0.3892	**8**	0.1463	**7**	0.1477	**7**
12	Union	0.7596	3	0.4472	**6**	0.1656	**5**	0.1726	**4**
15	Cathay Century	0.6306	6	0.3868	**9**	0.1266	**8**	0.1316	**8**
22	Asia	0.8837	1	0.6532	**4**	0.0022	**10**	0.0022	**10**
23	AXA	0.4305	9	0.4108	**7**	0.0042	**9**	0.0042	**9**

CES: Cross-Efficiency Score   SES: Super-Efficiency Score

EFFICIENT FORECASTING MODEL FOR FOOD SUPPLY CHAIN DEMAND

PLANNING

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ABSTRACT

The sustainability of the food supply chain depends on accurate predictions of future demand.

Sales forecasts are the basis for decisions on when to replenish goods from the distribution center

and when to order from suppliers. This study explored future demand prediction methods using

restaurant reservation data. We proposed a model that combines the classic autoregressive

integrated moving average (ARIMA) artificial neural network and a long short-term memory

(LSTM) model to improve the accuracy of forecasts while adding more relevant independent

variables (e.g., bias factors). Finally, we proposed a new workflow that was tested using

reservation data from the international restaurant chain Kura Sushi. The results indicated that the

prediction accuracy of the proposed model is superior to ARIMA-only models, with an estimated

10% reduction in error rate.

*Keywords***:** autoregressive integrated moving average, long short-term memory,

machine learning, deep learning, demand forecast

I.   INTRODUCTION

For food chain retail stores, the fast and accurate prediction of demand is critical, especially for those that incorporate an on-demand, fresh, perishable, cold-chain food supply. Therefore, sales forecasts have been studied in the fresh food industry for many years (Chen et al., 2010; Doganis et al., 2006; Arunraja et al., 2014).

In this study, the complex analysis focused on two aspects. The first was the collection of complex reservation data. These data included hidden messages, which not only revealed regular customer behavior but also provided signs of abnormalities, such as the reservation cancellation rate and reservation–sales conversion rate; these are potentially useful for forecasting.

Second, we selected a hybrid model with long short-term memory (LSTM) architecture. LSTM architecture provides promising results for the fresh food industry with superior accuracy under normal situations and superior sensitivity under abnormal conditions (Yu et al., 2018; Tsoumakas, 2018). In this study, we enhanced our previous prediction workflow (Miau, 2017) by incorporating the LSTM method in an attempt to suggest a more accurate forecasting model.

II. THEORETICAL BACKGROUND

A. Reservation Data

At present, reservation system records are often collected from mobile and onsite devices. Unlike local restaurant sales forecasts, which are usually conducted using point of sale system data (Lee et al., 2012), reservation records preserve information for several days before using it for forecasting. Because of the development of data-matching-based online platforms within the shared economy, new and dynamic patterns for generated data—particularly from platforms associated with social media—should be developed further. This would provide staff with more

time to respond to the demand in advance, which is particularly crucial for the fresh food industry, in which time is a critical factor.

B. LSTM

The LSTM architecture is a variation of a recurrent neural network (RNN). Motivated by an analysis of error flow in existing RNNs (Kremer and Kolen, 2001), with long time lags that were inaccessible to existing architectures, the LSTM model was first proposed in the 1990s (Hochreiter and Schmidhuber, 1997; Gers et al., 1999; Gers and Schmidhuber, 2000). LSTM models have been proven to be more suitable for processing and predicting intervals and delayed events in time series data (Schmidhuber, 2015; Li and Cao, 2018).

We expect the results of the present study to be applied in businesses. However, several restrictions should be considered, namely (1) forecast time and frequency and (2) computational cost. These problems may occur because significant computational power is necessary for deep learning methods, although this is generally not a problem in conventional methods such as the exponentially weighted moving average method.

Although autoregressive integrated moving average (ARIMA) models are widely known to provide high performance for time series forecasts, researchers have indicated that real-world time series data generally contain both linear and nonlinear patterns (Zhang, 2003). Models combining linear ARIMA models with nonlinear artificial neural networks (ANNs) are more effective than ARIMA-only models. The present study compared this combination model with the LSTM model.

III. METHODS

We first used ARIMA, ANN, and hybrid models to determine which could make the most accurate predictions. After conducting this performance comparison, we investigated whether weather was a dependent or independent factor. The multidimensional autocorrelation method was used to determine the correlation between the residual inventory and weather. Once the correlation was sufficiently strong, we applied vector autocorrelation regression to obtain a superior forecasting result. Otherwise, the process was stopped, and one of the three methods was considered the optimal forecasting method.

A. Hybrid (ARIMA and ANN)

After decomposition of the series, a hybrid approach with ARIMA and an ANN was employed to adequately model the linear and nonlinear correlation structures of a time series. This approach incorporates the unique strengths of the ARIMA and ANN models. The proposed method was implemented based on two time series, and its forecasting accuracy was compared with those obtained from ARIMA and ANN separately in the following equation.

$$Hybrid_{forecast} = \quad ARIMA_{forecast} * ARIMA_{weight} + Neural_{forecast} * Neural_{weight} \, , \qquad (1)$$

$$where \; ARIMA_{weight} + Neural_{weight} = 1 \qquad (1)$$

In pratical implementation, the best hybrid forecast is determined by getting the local minimum RMSE value from weight pairs sequence of ($ARIMA\_weight, Neural\_weight)=[(0.2,0.8),(0.4,0.6),, (0.6,0.4)),(0.8,0.2))]$.

B. LSTM

LSTM, a type of sophisticated RNN, contains input, output, and forget gates that function together to form the primary cells. The cell state of each memory cell is updated and regulated using these gates. The character of each model is formed by designing the behaviors of these gates.

Because of its innate flexibility, the LSTM architecture is popular and has undergone several modifications. Most modifications are simplifications of the original modification, such as peepholes in the LSTM and the gated recurrent unit (Gers et al., 1999). We used the classic modification as the starting point for future improvements.

IV. EXPERIMENTS AND RESULTS

A. System and Environment

We used a local Windows computer with an NVIDIA GeForce 1050 graphics processing unit (GPU) to accelerate the calculation process. The computer had 16 GB of memory and an Intel Core i7 central processing unit.

B. Datasets and Tasks

All reservation data were obtained from the reservation system of the international restaurant chain Kura Sushi.[1] Each reservation was recorded, and daily reservations were aggregated. We tested our proposed method by using five different time intervals and lengths for accuracy comparison.

- SJ long: This represents all reservation data from the Taiwan branches of Kura Sushi with the longest history. The accumulated data were collected from December 18, 2014, to May 31, 2018, and they included online and onsite reservation records. In total, 1,314 records were included in this dataset.

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[1] https://github.com/smiau/LSTM-forecast

- SJ short: This represents the reservation data collected from the Taiwan branches of Kura

  Sushi with the longest history, from August 1, 2017, to May 31, 2018. This dataset

  contained 304 records.

  SJ_first_500, SJ_second_500, and SJ_third_500 refer to the first, second, and third 500

  segments, respectively, of data from SJ long, which were collected separately from January

  1, 2015, to May 21, 2016, from March 15, 2016, to February 1, 2017, and from February 1,

  2017, to June 17, 2018, respectively.

  SJ_first_800 and SJ_second_800 were the 800 data points extracted from SJ long from

  December 26, 2014, to March 10, 2017, and from May 20, 2016, to July 30, 2018,

  respectively.

- SJ full clear: The store operates at full capacity most of the time with a stable sales count of

  approximately 400–500 records per day. A few outliers including low sales count were

  attributed to the soft opening and first few days of the Chinese New Year.

C. Data Processing

1) Data Processing for the LSTM model

All missing data were first filled using zeros to examine the cause, which was found to be the

closure of the restaurant during Chinese New Year; therefore, they were removed from the

dataset.

Because the data values may vary widely, minimum–maximum normalization was performed

before the model fitting. Datasets were used for training and testing the model; 70% of the data

were used for training, whereas 30% were used for testing. In LSTM, timesteps must be

confirmed; thus, a 10% data length was adopted for look-back timesteps, and the prediction was

conducted for the next day. For enhanced LSTM performance, long data were truncated into

several subsequences. Each sequence had a length equal to the look-back timestep. An inverse

transform was conducted after the prediction to regain the original range of values. The root

mean squared error (RMSE) was then calculated as an index of the effectiveness of the model.

The RMSE ensures that we get unbiased forecasts. In this research on the supply chain data, we

found that if we use MAE as a KPI, it will lead to higher deviations, and we will eventually use

RMSE as our evaluation indicator.

D. Model Structure

We used CUDA Deep Neural Network (CuDNN) LSTM to accelerate our workflow. The

basic LSTM model used in this study is illustrated in Fig. 1. The model is a single Keras CuDNN

LSTM hidden layer with 64 hidden cells, followed by a Keras dense layer to generate the

forecast output. The normal LSTM layer was replaced with a CuDNN LSTM layer to accelerate

the calculation from several hours to several minutes (Table I).
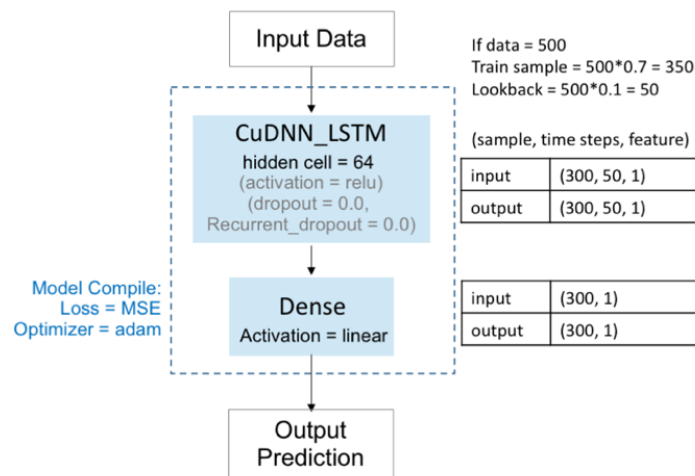
Fig. 1. Basic LSTM model

TABLE I
COMPUTATION TIME USING LSTM AND CuDNN LSTM LAYERS

Layer\	SJ_ short	SJ_1st 500	SJ_2nd 500	SJ_3th 500	SJ_1st 800	SJ_2nd 800	SJ_ full
LSTM	3-4 hour	4-7 hour	4-7 hour	4-7 hour	--	--	--
CuDNN _LSTM	~1 min	1-2 min	1-2 min	1-2 min	2-3 min	2-3 min	4-5 min

Calculation depends on the detailed setting of the model

E. Model Performance Comparison

TABLE II
RMSE RESULTS FOR ARIMA, ANN, AND LSTM MODELS

Model	SJ_1st 500	SJ_2nd 500	SJ_3th 500	SJ_1st 800	SJ_2nd 800	SJ_ full	RMSE
Hybrid	0.37	0.61	0.49	1.45	0.72	1.63	Train
	7.38	7.69	10.34	8.23	8.82	9.71	Test
LSTM	5.05	6.86	6.08	5.89	6.82	6.76	Train
	6.51	7.85	8.30	7.48	7.52	7.12	Test

As presented in Table II, the performance of longer datasets was superior to that of shorter ones, and data lengths exceeding 800 had superior performance. By comparing the results presented in Table II, we noted that the performance of the LSTM model was considerably higher than that of the hybrid model, even in the presence of only hundreds of data entries.

Nevertheless, the default setting achieved the optimal results in the training and testing stages. Hence, the basic model can be used with GPU acceleration.

F. Suggestions for a Workflow Model

The goal of the present study was to develop a workflow model for the data of the selected chain sushi store with high calculation speed and accuracy. The overall experimental

process is summarized in Fig. 2. Our experiment findings led to a suggested workflow model for fresh food cold-chain data, involving data processing (including data cleaning and preprocessing) and deep learning model application, which are highlighted using a double line in the figure.
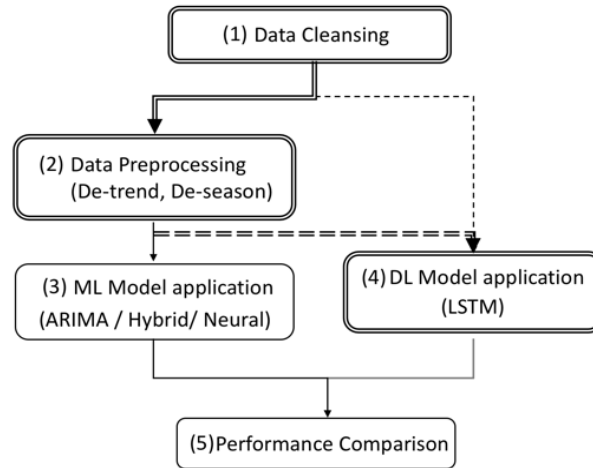
Fig. 2. Overall workflow model analysis.

V. DISCUSSION

Neural networks are generally robust to noise. However, because missing data were deleted and because outliers were present due to the restaurant being closed during Chinese New Year, the precision improved by approximately 10% based on how many external factors were excluded. This result was in agreement with suggestions that external factors such as promotions, holidays, and temperature are critical for food sales prediction (Arunraj et al., 2016; Liu and Ichise, 2017; Tsoumakas, 2018).

LSTM models can be used to learn temporal dependency, which is generally reflected by the number of neurons in each layer as well as the number of layers. Tables II compares the experimental results.

The proposed workflow model tended to reach a conclusion similar to that provided by Gers et al. (1999). The LSTM model is successful when the conventional statistical model fails. However, insights from the data that do not contain the basic trend and seasonality are still required. Furthermore, the removal of missing data and outliers increased the accuracy by more than 10%. However, internal temporal dependency can be identified using the model itself and does not necessarily match the external periods.

VI. CONCLUSION

This study proposed a forecasting model that provides more responsive and accurate forecasting for the food supply chain. Because statistical approaches such as ARIMA require a small amount of data and less computational power, we first used ARIMA to generate quick but less accurate decisions based on sales predictions. We then applied the LSTM model to improve the accuracy and reduce anomalies. The results revealed that the hybrid ARIMA+LSTM model worked well with a moderate amount of data, making it particularly useful for restaurant branches without sufficient historical data.

By fine-tuning the hyperparameters (number of hidden neurons and number of hidden layers), the new hybrid machine learning model yielded a 10% reduction in errors during prediction. By using a GPU in our workflow, the calculation time was also reduced from several hours to several minutes. This method provides fast predictions and can provide predictions for a several days in advance. As more input variables increased the complexity of the prediction, the results became more difficult to interpret. In future studies, more sophisticated autorevision models can be integrated, such as those based on event labeling, geographic location, weather, traffic, and other correlated external factors in real time.

The benefit of a forecasting system based on data analysis is that it provides an alternative solution for the cold-chain food industry to reduce overstocking and unnecessary wastage and increase inventory turnover and freshness. For business operations, financial and human resource planning can also be actualized, creating an ecocycle-friendly environment and increasing profitability.

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A KNOWLEDGE MANAGEMENT APPROACH TO INTEGRATION OF

EDUCATIONAL ANALYTICS

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Abstract

Educational analytics encompasses a variety of computational techniques to process educational big data for improving teaching, learning, research, service, and administrative decision-making. Educational analytics includes three categories: learning analytics, administrative analytics and faculty analytics. This paper discusses a knowledge management approach to integration of the three categories of educational analytics and proposes a semantic network model for implementation of integration of educational analytics.

Keywords: Educational analytics, learning analytics, administrative analytics, faculty analytics, knowledge management, semantic networks

Extended Abstract

Learning analytics administrative analytics, and faculty analytics are the disciplines of systematic computational analysis of data or statistics for education. In this study, the union of the three types of analytics is called educational analytics as these analytics are interconnected and have the mutual objective of improving education. Educational analytics involves complicated processes of big data acquisition, extraction, cleaning, modeling, analysis, and interpretation, and faces all challenges associated with big data including heterogeneity, scale, timeless, privacy, and human collaboration. Despite the research endeavor in educational analytics for decades, integrated students learning analytics, faculty analytics, and administrative analytics into educational analytics is underdeveloped. This study addresses this issue through using a knowledge management approach.

The first part of the paper is a review of literature of the three types of educational analytics: learning analytics, administrative analytics, and faculty analytics. The synergistic relationships between educational analytics and knowledge management are also discussed.

The second part of the paper presents the methodology of the present study, and proposes a knowledge management reference model for integrated educational analytics. It suggests that semantic network as a tool of knowledge management can be applied to integration of educational analytics. The semantic network model provides the structures of interactions between educational big data and users to facilitate educational analytics for all stakeholders in education.

The third part of the paper describes a case study of a shell prototype of interactive educational analytics systems based on the proposed semantic network model and a sample of research papers. Figure 1 presents an example of segment of the semantic network that demonstrates the system features of relationship tracing and searching for navigation.
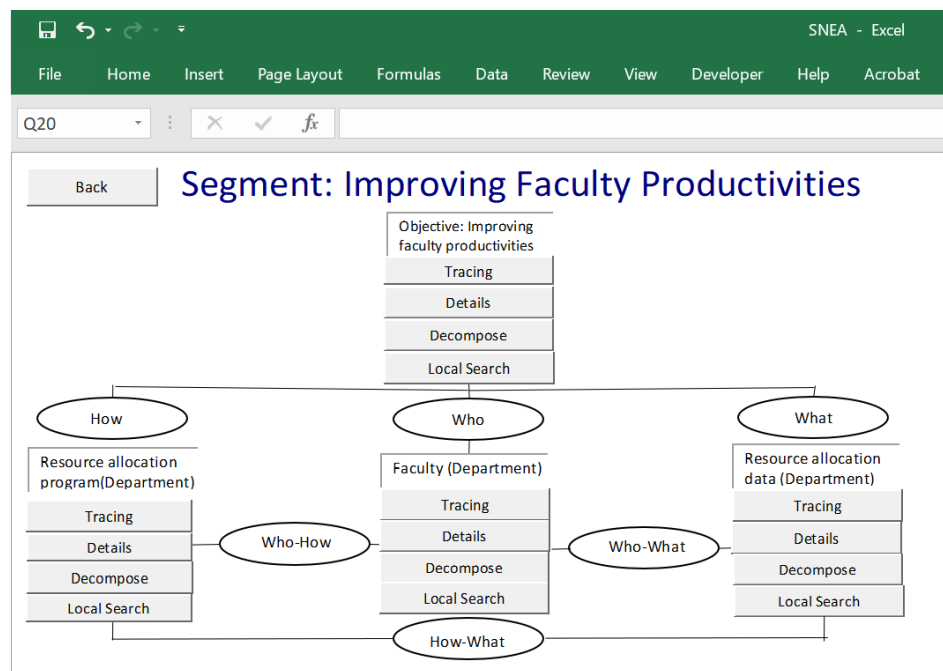
Figure 1. An Example of Segment of Semantic Network

The case study presents a preliminary evaluation of the prototype of integrative educational analytics through a scenario analysis.

The paper concludes that the proposed semantic network model can help educational institutions better understand objectives, processes, stakeholders, and technological objects and their relationships in an analytics-based knowledge-sharing environment. The case study and a preliminary scenario analysis have demonstrated the feasibility and usefulness of the proposed semantic network model for educational analytics integration. This study has opened several venues for future research. First, the semantic network model can be improved by including more elements such as measurable student success factors in the domain analysis results. Second, a computerized system with full functions of modeling, applications, and maintenance of semantic networks can be developed to automate operations. Third, thorough empirical tests of the computerized semantic model must be conducted.

Textual Analytics & Natural Language Processing:

Value and Workforce Training for Business Domains

Jim Samuel, Rick Ferris, Scott Bellamy, Yana Samuel, Suvayan De & Alexander Pelaez.

Abstract:

Amidst the din of ubiquitous artificial intelligence and big data technologies, it is important to identify streams of value creation associated with domain -specific applications of technological advancements. One of the critical areas of advancements in artificial intelligence is the computational processing of text, spoken, typed and written words of human language – this includes the spectrum of natural language processing (NLP), textual analytics, sentiment analysis and related methods and tools. The two objectives of this research article are: 1) to provide insights into the potential for artificial intelligence technologies for NLP applications in finance, marketing, business management and economics, and 2) consider conceptual approaches for training the textual analytics (TAn) and NLP workforce for application, interpretation and innovation with TAn and NLP associated methods, tools and technologies. The article concludes with comments on limitations and potential for economic value creation.

Introduction:

Although many artificial intelligence technologies have been developed over the past few decades, it is only in the past few years that we have seen these technologies being incrementally adopted by businesses and society. One of the important areas of development has been in the expansion of computational methods to understand human language in its various expressions, using textual analytics (TAn) and natural language processing (NLP). TAn and NLP have been used for a wide range of business, social, governmental, political personal and socioeconomic applications. NLP has also been used with a wide range of innovations, including efforts to peek into the future without traditional forecasting mechanisms (Kehl, Jackson and Fergnani, 2020). Deep learning based applications have been used to study "legal word embeddings" in law, and automated fake news detection mechanisms have varying capabilities to detect factual information and distinguish them from fake news (Chalkidis and Kampas, 2019; Saquete, et al., 2020). NLP has been used in healthcare, social media analytics, development of personal assistants such as Alexa, Siri and Bixby, and NLP methods are widely employed in language translations. It has become important to improve our conceptualization of the use of TAn & NLP in business and this paper is an effort in the direction to clarify the ways in which NLP methods can add value to the business management, finance, marketing and economic disciplines.

Furthermore, while it is fairly common knowledge that the TAn and NLP industry market value will increase rapidly to 86 billion US dollars by 2026 according to various market reports (NLP Market Report, 2020) - most companies have not paid attention to educating and developing TAn and NLP specific workforce capabilities beyond acquiring or developing general talent for analytics and associated domains, including methodological application needs such as machine learning. This is also relevant to the ongoing debate on AI science versus AI philosophy – a critical paradigm that needs to be addressed for clarity and sustainability of AI in business and society (Samuel and Garvey, 2021). It is therefore important to investigate and articulate the need for TAn and NLP workforce education, training and development from multiple dimensions including skills, values and adaptability.

Textual Analytics (TAn) & Natural Language Processing NLP

Textual analytics can be defined as being primarily exploratory in nature and is used to generate descriptive insights from textual data. Textual analytics and NLP have fuzzy boundaries which often overlap, as is seen in studies on COVID-19 public sentiment analysis which employs principles of TAn and NLP simultaneously (Samuel, et al., 2020a, 2020b). TAn can also be used for classification and conditional prediction of sentiment based on trends and patterns visible from textual analytics. The scope of NLP goes well beyond TAn, and NLP can be conceptually defined as consisting of methods and technologies which possess capabilities for artificially intelligent multi-way interactions with various expressions of human language. This reflects a broad range of capabilities including computational translations, human like responses to questions and even generation of special purpose sequence of words, such as artificially generated word sequences for social media posts to maximize popularity and virality (Garvey, et al., 2021; Lloret, & Palomar, 2016). Textual data analytics can be complex to perceive and there have been multiple streams of efforts to effectively visualize various forms of analysis associated with TAn & NLP, based on the nature of the underlying text, temporality and objectives of analysis (Conner, et al., 2019, 2020)

TAn & NLP dimensions of application

Prominent forms of NLP include semantic search, question answering and conversational natural language querying (Erekhinskaya, et al., 2020). Semantic search has been defined as a "document retrieval process that exploits domain knowledge" and such knowledge 'can be formalized by means of an ontology, which is often defined as an "*explicit specification of a conceptualization*'" Mangold, C. (2007). Question Answering Systems (QAS) are designed for "*satisfying users who are looking to answer a specific question in natural language*" (Bouziane, et al., 2015). We treat conversational natural language querying as being more nuanced than question answering, and define such querying as a two generative process, wherein a machine needs to first generate semantic equivalence for the input and then generate an appropriate customized response in natural language, which would be significantly more interactive in nature than question answering which can be deemed as being more confined. In addition to these application dimensions of NLP, TAn includes dimensions such as sentiment analysis, text- based user classification, concept generation and intent investigation. Sentiment analysis can be defined as the identification of human sentiment using representative communications; text based user classification can be used to identify a variety of user characteristics to create user profiles, such as the identification of dominant users (Samuel, et al., 2014); concept generation and intent generation depend of semantic sensemaking of underlying text and associated variables. TAn & NLP use a broad range of methods to prepare data and extract insights, including "Tokenization, Stop Word Filtering, Parts-of-Speech (POS) Tagging, Word Sense Disambiguation (WSD), Grammatical Parsing and Chunking, Lemmatization, Stemming, Term Frequency and Inverse Document Frequency (TF-IDF) and Text Summarization(TS), ... Latent Semantic Analysis, ... and key word extraction" (K Waykole, et al., 2019).

Business Applications of TAn & NLP

Textual analysis and natural language processing applications in business are being deployed to solve highly complex business problems that have eluded resolution. Examples of applications being developed in the domains of transportation, manufacturing, safety, customer service, and shopping abound (Symonds, 2019; Oriel, 2020; Pan & Zhang, 2021). Transportation is deploying this technology

to create an enhanced experience for riders in self-driving vehicles and soon interactions with riders in autonomous vehicles. Manufacturing has leveraged this technology to reduce human interaction and the need for human event interpretation of machine automated manufacturing processes. Uses in safety include traffic control, building security, law enforcement, and medical applications. NLP based predictive analytics are used in recommendation services in shopping apps that have wide appeal. Amazon Echo, Google Assistant, Apple's Siri all use natural language processing to perform the tasks asked of them by their users. Each of these services produces lists of related products or services that can increase the interaction with potential customers and enhance their user experience.

Financial Applications of TAn & NLP

TAn and NLP play a vital role in the financial arena. TAn and NLP based techniques for financial forecasting and analysis have been dominant research areas with significant application potential. Text mining technique based on sentiment analysis and behavioral economics are used for generating unique insights with power to predict otherwise invisible future stock market variations. For example, the recent news (Dec 2020 - Jan 2021) of US president-elect Joe Biden's $1.9 Trillion stimulus spending package was treated as having a positive influence upon the stock market index, and yet public sentiment and investor intentions which can be assessed using TAn & NLP will be critical in developing a better understanding of future market behavior. Another important TAn and NLP based financial application involves the foreign exchange (FOREX) market. Textual data analysis with time series estimation provides an important aspect of the trends of forex market and could mitigate lower risk among the investors. As expectations surrounding the newly announced stimulus package push yields of US government bonds higher, TAn and NLP techniques could be invaluable to study public sentiment and investor behavior to better forecast both the stock market, as well as forex markets. Thus TAn and NLP can be used by technologically astute investors to enhance their profits and cut losses and also by institutions and governments for improved risk management (Xing, Cambria & Welsch, 2018; Kumar & Ravi, 2016). The rich application of TAn and NLP in financial services and associated domain merit extensive focused investigation as a domain in its own rights.

Marketing Applications of TAn & NLP

TAn and NLP are leveraged in business to consumer and business to business marketing with the purpose of refining the customer journey through the sales funnel. Customer experience and brand reputation are important relationship considerations. Individual-customer predictive analytics can make connections and suggestions that can create marginal business opportunities and increase customer engagement. Increasing customer satisfaction during the acquisition experience, product use, and after sales service are all possible with applications of TAn & NLP. Consumer sentiment monitoring using TAn & NLP is making a difference in the way businesses operate, interact, and deliver value for their customers. Large corporations collect data that hold insights to customer sentiment. Without these tools data are left to be manually processed resulting in time and attention delays due to their sheer volume for large organizations. Using TAn & NLP, real-time insights can be derived to enable marketers to respond quickly to changing sentiment, empowering businesses in adapting their message and even product/s rapidly to meet consumer expectations (Kang, Cai, Huang, & Liu; 2020). This offer, consumption, feedback loop is being accelerated using advanced tools resulting in closer connections to the end user of a product, leading to higher sales volumes and greater customer satisfaction (Kang, et al., 2020).

Economic and other Applications of TAn & NLP

TAn and NLP provide a more timely and expansive approach to economic research that supplements data economists collect and analyze, with both macroeconomic data and controlled experiments conducted in traditional economic studies. Economic applications utilizing text as an input to economic research are expansive, including the use of text from news and other sources to predict stock prices, media slant, future government policies (Gentzkow, Kelly, and Taddy, 2019). NLP in healthcare and medicine has great potential for expansion to extract narrative and textual data from clinical sources for improved health outcomes and efficiency with earlier medical interventions and greater precision in diagnostics (Ahmed,Z., Mohamed,K., Zeeshan,S. & Dong, X., 2020). Furthermore, NLP can be used for security applications, including surveillance and tracking of sensitive communications at the textual, written and spoken human language levels (Niakanlahiji, Wei & Chu, 2018; Harborne, et al., 2018; Samtani, et al., 2020). TAn, NLP and associated tools such as chatbots are being increasingly used with new innovations and integrations such as home automations, human rights management tools and platforms, and human activity recognition (Baby, Khan & Swathi, 2017; Alhelbawy, et al., 2020; Bacharidis & Argyros, 2020) All of these TAn and NLP associated methods, tools and innovations are expected to lead a significant value creation and cumulative impact upon the global economy.

Limitations of TAn & NLP

TAn & NLP, in spite of the tremendous value potential, have their own limitations. While TAn & NLP can be used to support a variety of human, social and business activities, they are still limited by their constrained capability to manage human like sensemaking of human language. This means that as the NLP models get better, their performance improves, but they remain susceptible to a wide range of linguistic and semantic variations, including adversarial texts and similar mechanisms (Ren, et al., 2020, Morris, et al., 2020). The important takeaway from the present analysis is the emphasis on categories of TAn and NLP which are useful for insights generation and in a limited and risk-mitigated environment, useful for human interactive purposes. However, our analysis shows that in a boundary-less environment (any topic, any tone, variety of users with varying linguistic styles and creative sequences of words), TAn and NLP would provide limited value, and the risk of failure, even if low in probability, would outweigh potential benefits. Another limitation of TAn and NLP is the presence of amplification of social bias based on underlying data – it has been observed that algorithms demonstrate gender bias and other forms of bias, and one strategy to address this would be to provide correctional education and training (Samuel, et al., 2018). A balanced approach ensuring diversity and bias identification would help mitigate such scenarios.

Keys to the Future: TAn & NLP Workforce training

It is necessary to consider conceptual approaches for training the textual analytics (TAn) and NLP workforce for application, interpretation and innovation with TAn and NLP associated methods, tools and technologies, to ensure competitive advantage at the corporate and national levels. Extant research associated with organizational workforce improvement has proved two critical dynamic "(a) training works, and (b) the way training is designed, delivered, and implemented matters." (Salas, et al., 2012). Workforce training and TAn and NLP skills development programs learning outcomes need to be mapped to assessment measures – one useful and proven tactic is to apply the framework and concepts represented in Kirkpatrick's (Kirkpatrick & Kirkpatrick, 2006) work, by either using the hierarchy, including all the four levels (reaction, learning, behavior and performance) or by contextualizing and

making use of the most appropriate elements from select levels. NLP competencies are a moving target as methods and tools are changing rapidly. Resilience is therefore important, and training needs to be imparted not only at the technical level but also to ensure motivation, tenacity and resilience values are built into the workforce – this will help them adapt to the rapidly evolving technological changes. Furthermore, it is necessary to cultivate a strong and unmistakable emphasis on ethics, and accent the usefulness of "proactivity and innovation" both within training initiatives and also as critical values instilled into the workforce (Calluzzo & Cante, 2004; Shneiderman, 2020; Unsworth & Parker, 2003).

An illustrative TAn & NLP Value : Education Framework		
Value	Preferred Education	Preferred Level
Public opinion estimation	Sentiment Analysis	BS, MS, Workshop
Customer feedback analytics	Textual summaries	BS, Workshop
Group/team dynamics management	NLP - creative solutions ~such as dominance detection	MS, workshop
Customer Voice Response Systems	NLP - Speech recognition and response	BS, MS, Workshop
Client or customer interaction	NLP - AI conversation systems	BS, MS, Workshop
TAn & NLP apps. Risk mitigation	Analytics & AI Management	MS, post-MS workshop
TAn & NLP innovation	Analytics, Business & AI Management	MS, post-MS workshop
TAn & NLP Bias & Ethics	Philosophy, law, meanings generation	MS

Table 1: TAn & NLP Value : Education Framework

A critical contribution of this analysis is the TAn & NLP Value : Education Framework (Table 1) – this is an illustrative concept framework, which is expected to serve as a guide for both, academic institutions and corporations. The underlying principle is to first identify the value creation potential of TAn and NLP for an organization or a corporation – the next step would be to match workforce education to the value created. This table is not a finished product, but an interim artifact as we pursue this stream of research further, with the objective of developing a robust industry level TAn & NLP Value : Education Framework which can help improve the alignment of TAn & NLP education with industry needs. The proposed framework will also be expanded to include discipline classifications, such as computer science, data science, business analytics, data analytics, math, linguistics, statistics, philosophy and law. The proposed framework will have great potential to benefit students, institutions, organizations and corporations.

Future Trends & Conclusion

It is important for businesses to engage in a TAn & NLP workforce acquisition and development strategy to ensure competitive advantage. It will become increasingly important, given the ubiquitous expansion of TAn & NLP applications for businesses across industries, to employ such technological capabilities to proactively increase customer satisfaction using advanced technologies to improve products and services, including auxiliary features such as customer service, marketing and product returns management. NLP is increasing in its scope of new applications and every forward-looking corporation is looking for ways to better leverage TAn, NLP and Artificial Intelligence in general.

This research is merely an early step in the direction of maximizing the value creation potential of TAn and NLP concepts, methods, tools and technologies – while there is much research on the computational and mathematical sides of TAn and NLP, there remains a significant need to enhance business understanding of TAn and NLP potential, both from and applications perspective as well from a workforce training and development perspective. The scope for economic value creation, through NLP use in business, and associated industries including healthcare, law, social media and marketing, among others is tremendous. It is anticipated the decade ahead will see a rapid growth in the use of TAn & NLP, contributing to the current boom in artificial intelligence applications.

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Cyber Security, IT, and Emerging Technologies

Research Note

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Global Ethical and Societal Issues and Considerations with Cybersecurity in Digital Health: A rapid review
Research Note Track

Keywords: Societal Impacts; Ethics; Cyber Ethics; Cybersecurity; Public Health

Abstract

Cybersecurity ethics can be defined differently and from different lenses depending on a perspective and topical focus. Attention to ethics is included in many different disciplines. This is warranted because it ensures that all activities are based on ethical principles and thus reduces the potential for unethical or illegal activities. This attention is of particular importance to using cyberspace safely.

The Center for Internet Security (CIS) defines the rules of Cyber Ethics as the code of responsible behavior on the Internet. In the same way that people are taught to act responsibly in everyday life with lessons such as "Don't take what doesn't belong to you" and "Do not harm others," with ethics, there should be an aim to act responsibly in the cyber world (CIS, 2020). On the opposite spectrum, one can also look at the ethical ethos from the view of a hacker. There exists "hacker ethics," where hackers believe the ends justify the means of hacking. In this hacker perspective model, there is a chief philosophy that any computer could be accessed for any legitimate reason and that all information should be free and to distrust authority (Grimes, R. A., 2017). Within the vast space between the two briefly outlined ethics mantras exists a middle-ground area that ideally would lean heavier towards the CIS definition.

Ethics can be considered part of the human side of information security and cybersecurity. The word ethics evolves from the Greek word ethos, also known as character, and the Latin word of mores, associated with customs and norms (Koenig, T. H., Rustad, M. L. 2018). Computer ethics will surround the challenges developed as a result of greater expansion and rapid evolvement of information technologies and products (Koenig, T. H., Rustad, M. L. 2018).

With good ethics as a foundation, there is the potential for better decision-making concerning cyberspace. Information security and cybersecurity can be considered going hand-in-hand with trust. With greater security, greater trust, and thus greater ethics which includes the idea of good decision making or making the best decisions possible related to security. The challenge is

that of producing a product, innovation, profit, and speed to market, versus not introducing problems or issues, especially to those who may be less able to protect themselves.

This research note draws attention to the background on ethics and societal issues surrounding the global public health sphere. In relation to the current and ongoing COVID-19 pandemic response and the increasing ongoing cybersecurity incidents arising, the topic of ethics and society is increasingly relevant. In addition, a proposed outline of cyber and computer-related topics and a checklist that could reduce unethical behaviors are provided for those in positions to proactively review digital health projects at the onset from compliance officers to ethical review groups.

Introduction

The cybersecurity defensive battle is a never-ending and constantly evolving one. It is equivalent to walking in sand, you may make a hole in the sand when navigating, but it quickly fills in with more sand. In parallel, as soon as organizations and individuals put in place cyber protections, newly emerged vulnerabilities and opportunities for hacking arise. Cyber threat actors have a distinct advantage because they stand to gain or expect to gain from their cyber-hacking activity. This paper explores the notion that adoption of cybersecurity ethics and principles as a human societal endeavor has the potential to lessen the cybercriminal proclivities in individuals.

In the 2009 movie Invictus, Morgan Freeman playing Nelson Mandela, is asked if his pursuit of rugby and a world championship is considered a political calculation. Nelson Mandela replied, "It is a human calculation!" Much the same can be considered regarding tackling cybersecurity defenses. We can continue to rely on technical solutions that involve engineered solutions and training, but could we be missing a segment surrounding ethics and applying greater attention in the area? In Invictus, Francois Pienaar, the South African rugby team captain, says to his team, "This country's changed. We need to change, as well." In the same vein, perhaps we need to change our directions by focusing on ethics to gain or stay ahead of the cyber attackers in addition to technical solutions.

Introducing technology to complement health systems via digital health solutions has become more active during the recent COVID-19 pandemic of 2020. The reason for this growth is simple – need, as many patients have been asked to utilize virtual or cloud-enabled technology solutions in replacement of face-to-face traditional health care visits and health monitoring. This paper calls for attention to the inclusion of ethical principles in the implementation of new technology solutions and innovations in digital health. It also highlights the role that different stakeholders play in ensuring cybersecurity for the benefit of all. For example, who is making the rules with regard to the ethics employed with digital health? Who is monitoring and enforcing the rules. In addition, the role of following ethical guidelines can emanate from varied departments, functions and disciplines.

Considering our global society, the World Economic Forum has identified cyberattacks as one of the top 5 global risks, ranked high in the likelihood and impact grid (World Economic Forum, 2020). This is not a new issue, and one that is continuing to gain attraction and growth – clearly, something needs to be done to help stymie this movement for society's betterment.

Methods

Ethical models exist with a variety of focus and goals and with corresponding strengths and weaknesses. More generally, the ethical models can funnel under Descriptive Ethics, Normative Ethics, and Applied Ethics (Ruotsalainen, P. & Blobel, B. 2020). Addressing people's beliefs about morality and values falls under Descriptive Ethics. Normative Ethics is developing standards for right and wrong behaviors. Applied Ethics will target moral problems, practices, and policies in professional contexts (Ruotsalainen, P. & Blobel, B. 2020). The concept of computer-related ethics is classified under Applied Ethics. In considering the cyber world or technologies being implemented within cyber, computing ethics would be most appropriate. A formal definition of computing ethics is the interdisciplinary and collaborative efforts, including technical professionals and academics, to methodically study and affect computing products' contributions and costs in a global society (Hall, B. R. 2014).

Cybersecurity Certifications Inclusion of Ethics and Societal Impacts

Many of the existing technical cybersecurity certifications include the requirements to adhere to ethics. Cybersecurity certification study guides typically include a section or at least a reference to ethics as part of the coursework to be tested upon. Certain certifications, such as the Information Systems Audit and Control Association (ISACA), have set a code for professional conduct and ethics that must be accepted or agreed to and followed. As part of receiving a certification, one is not only tested on content related to ethics, but that must be upheld, and failure to do so could result in an investigation with possible sanctions or disciplinary measures (Cannon, D. L., O'Hara, B.T. and Keele, Allen. 2016). ISACA partly defines ethics as overriding principles for behavior in a moral, honest manner, doing the right thing for someone else ahead of your own interests.

It is difficult to estimate the number of different cybersecurity certification options available to those from beginner to the more expert levels. Research education of societal impacts and ethics in higher education technology and public health projects is an area of interest and can benefit from further advances. In scanning the top Information Technology (IT) vendors and their related cybersecurity certifications, we found that each organization provides at least 10 different training certifications, and some, such as the Global Information Assurance Certification (GIAC) has more than 35 (United States Department of Homeland Security 2019).

The top 10 most popular cybersecurity certifications for 2020, as reported by Forbes (2020) include:
- Certified Information Systems Security Professional-Information Systems Security Management Professional (CISSP-ISSMP) – ISC(2)
- Certified Information Security Manager (CISM) – ISACA

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- Certified in Risk and Information Systems Control (CRISC) – ISACA
- AWS Certified Security Specialty Certified Information Systems Auditor (CISA) - ISACA
- CompTIA: Security+
- Certified Cloud Security Provider (CCSP) – ISC(2)
- Certified Ethical Hacker (CEH) – EC Council
- CompTIA CySA+ (Cybersecurity Analyst)
- Google Cloud Platform Professional Security Engineer

A further analysis of the certification test content or exam overview for each of the top ten certifications indicated is in Table 1, indicating the inclusion of Ethics as content and a process to accept a code of ethics.

Name	Vendor	Exam Includes Ethics	Certification Requires Acceptance Code of Ethics	Source
CISSP-ISSMP	ISC(2)	Yes	Yes	https://www.isc2.org/-/media/ISC2/Certifications/Exam-Outlines/ISSMP-Exam-Outline-Effective-May-2018.ashx
CISM	ISACA	Yes	Yes	https://resources.infosecinstitute.com/category/certifications-training/cism/cism-domain-overview/
CRISC	ISACA	Yes	Yes	https://resources.infosecinstitute.com/category/certifications-training/crisc/crisc-domain-overview/
AWS Certified Security Specialty	Amazon	No	No	https://d1.awsstatic.com/training-and-certification/docs-security-spec/AWS-Certified-Security-Specialty_Exam-Guide.pdf
CISA	ISACA	Yes	Yes	https://www.isaca.org/credentialing/cisa/cisa-exam
CompTIA: Security+	CompTIA		Yes	https://www.comptia.org/certifications/security
CCSP	ISC(2)		Yes	https://www.isc2.org/-/media/ISC2/Certifications/Exam-Outlines/CCSP-Exam-Outline.ashx
CEH	ECCouncil	Yes	Yes	https://www.eccouncil.org/wp-content/uploads/2016/02/CEH-Exam-Blueprint-v2.0.pdf
CompTIA CySA+	CompTIA		Yes	https://www.comptia.org/certifications/cybersecurity-analyst
Google Cloud Platform Professional Security Engineer	Google	No	No	https://cloud.google.com/certification/guides/cloud-security-engineer

Table 1. Top 10 List (Forbes, 2020) of Cybersecurity Certifications with Ethics Inclusion

Similarly, in the health sector, professional associations have codes of ethics that their membership is required to adhere to. Health professionals, whether they are doctors, nurses or other cadres are required to put the patient's interests first and assure good quality care. Doctors mark their entry into the medical profession with "The Oath of Hippocrates" (Ochsner, 2003). Medical ethics has evolved over time to account for professional standards, legal requirements, and other changes. Every American health care cadre has a code of ethics: doctors comply with that of the American Medical Association, nurses by the American Nurses

Association, Ob/Gyns by the American College of Obstetricians and Gynecologists, and public health practitioners by the American Public Health Association. A common thread across all these different health care cadres is the principle of "do no harm" or beneficence.

The principle of beneficence is one of three that health care researchers are required to uphold in their scientific inquiries; the other two principles are respect for persons participating in the research process and justice. All researchers and Institutional Review Boards (IRBs) that oversee the research, pay attention to the extent to which respect, beneficence and justice are addressed in the research procedures and processes (RamaRao and Townsend, 2018).

Literature Rapid Review

We conducted a rapid review of several top-rated global public health and online biomedical and life sciences journals. The search was performed on keywords found in titles of journal articles related to "technology", "cybersecurity", "public health", "digital health", and "ethics". The search was limited to English language journals and meant to obtain a scope on the said focused topic.

U.S. National Library of Medicine National Institutes of Health PubMed Central review:

Title Keywords Search	Results
"Digital Health" AND "Ethics"	2 articles
"Technology" AND "Ethics"	42 articles
"Public health" AND "Ethics"	137 articles
"Cybersecurity" AND "Ethics"	0 articles

 In searching the PubMed Central online repository of research publication articles, more articles titled with the general search of "public health" AND "Ethics" appeared than any of the other defined searches. This is to be expected since the search does not provide a focus on technology. On the other end of the spectrum, as more and more technology is being introduced into digital health systems, with Internet connectivity utilized more, it was found that 0 articles were found titled in this area.

The Lancet review:

Title Keywords Search	Results
"Digital Health" AND "Ethics"	0 articles
"Technology" AND "Ethics"	3 articles
"Public health" AND "Ethics"	14 articles
"Cybersecurity" AND "Ethics"	0 articles

Journal of Medical Internet Research review:

Title Keywords Search	Results
"Digital Health" AND "Ethics"	0 articles

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"Technology" AND "Ethics"	3 articles
"Public health" AND "Ethics"	14 articles
"Cybersecurity" AND "Ethics"	0 articles

Implicit Bias in Information Technology

Implicit bias is more commonly referred to in our current world and environment with regard to social justice, diversity, and discrimination awareness. An implicit bias can also exist regarding putting trust in those individuals, and experts are involved in the creation of technology solutions for use in global public health. It is not uncommon to have a team consisting of public health experts partnering with information technology engineers and practitioners on a project. In such efforts, there can be an assumption that technology experts—in-house staff members or in many cases, consultants—that their ethical and societal views of introducing technology are for the betterment of health efforts. We posit that this assumption needs to be further examined, especially with the growing number of cybercrimes and threats that are being introduced due to the current COVID-19 pandemic. Is there an implicit bias to assume that staff with access to and involvement in technical aspects are doing their activities from an ethical standpoint? Is there a belief that the technology experts believe their approach is unchallengeable via a cyber-technical expertise manner as compared to the public health experts? Does the complexity of the technical aspect lend itself more readily to the assumption of ethical experts; and do unethical technical experts exploit this unspoken assumption?

Reliance on Technology During COVID-19 and Ethical Integration

The use of technology solutions has continued to expand over the past several decades reaching into every faction and function of an organization. Related to industries, the use of Information Technology has taken on a more central role in every activity, involving healthcare, education, business, judiciary, and community service (Well, T. & Murugesan, S. 2020). The disruption caused by the COVID-19 pandemic is one that is global in nature and not restricted to only those more developed countries; technology has seen further expansion during this time period. Examples of how technology played a more integral part in particular industries in responding to the COVID-19 pandemic can be seen in Table 2.

Industry	Response/Impact	Response	Underlying Technology/Operation
Education	Widespread closure of educational institutions.	Virtual learning environment for teachers and students.	Use of more video conferencing and learning management systems, virtual labs in the cloud.
Healthcare	Hospital overcrowding, inability to meet the demands on them.	Use of contact tracing, vaccine development, use of telehealth.	Use of chatbots, telehealth, AI, ML, cloud computing.
Business	Closure of business and avoidance of in-person retail.	Adherence to social distancing, work from	Virtual office, online meeting software,

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		home, using online services.	remote access to work, chatbot, drone delivery.
Retail	Closing of stores, online service increased use.	Online shopping and home delivery.	Online payment, contactless payment.
Government	Increase in demand for citizen assistance.	Moving and migration to more online services.	Cloud expansion, web, online meeting.

Table 2. Transformation of industries caused by coronavirus. Source: Well, T. & Murugesan, S. 2020.

Just as varied as the industries and corresponding impacts and technology adoptions in responding to the COVID-19 pandemic, the inclusion of ethics and integration of them into the functions will need to align and possibly adjust as greater technical solutions are utilized. Increasing use of technology does have the potential for increased risks of cyber threats. As such, considerations for ethical standards will need to be addressed to help minimize the dangers.

Global Public Health Use of Technology

The COVID-19 pandemic has highlighted the need for alternate ways of serving the health needs of populations when face-to-face interactions are limited due to social-distancing or lockdowns. Digital health interventions from telemedicine, online pharmacies to electronic health records are increasingly being adopted due to their acceptability to both health care providers and consumers.   Such digital interventions are likely to continue even after the pandemic subsides since they offer an alternate, viable, and potentially cost-effective way of serving health consumers.

The potential positive features of digital health interventions will have to be examined and balanced against any risks they might pose. Examples of risk include loss of confidentiality of the health care consumer if their medical records are accessible to non-authorized parties or loss of critical information arising from poor archival of electronic records. With the pandemic, it is widely known that cybercriminals have sought to capitalize on the widespread panic by exploiting the technologies used in health and everyday use (Ahmad, T. 2020).

Proposed Proactive Learning Activities Checklist

Health services that intend to include digital health solutions such as telemedicine, online pharmacies or electronic health records will benefit from an independent review by a subject matter expert who can verify that the procedures proposed by the Cyber expert are protective of both the health care consumer and the health care provider. The independent review could also be conducted by the health care provider's compliance officer.

A similar examination of risks and benefits will have to be undertaken by those conducting health research using a technology component. Health researchers have to get approval from, adhere to, and answer to research ethics or Institutional Review Boards (IRB). The ethics

boards or teams are put in place with members from diverse notable and expert backgrounds and bring forward an "ombudsman-like" component to question research activities. This is an important checkpoint to review key risks, ethics, compliance, and approvals for researchers. During an ethics review, the experts will question the actual research activities and motives, consider the risks to both participants and the researchers, and ensure proper ethics. These ethics boards have the responsibility to oversee research carried out on digital health. A concern related to digital health is that ethics boards may not necessarily have the expertise related to high-level technical components to be able to adequately examine the ethical aspects of this type of research (Wykes, T., Lipshitz, J. & Schueller, S.M., 2019).

Institutional Review Boards (IRBs) are often required to partner with research investigators and information technology staff when reviewing research efforts, including technology solutions and components. At stake is a well-informed awareness to fully understand the risks being introduced to not violate any ethics-related matters. Ultimately, the principal investigator (PI) is the responsible party and should be working closely with IT during project planning so that the safety and potential risks of the technology are known and shared with the IRB at the time of submission (Harvard Catalyst. 2016).

Those who are members of ethical or Institutional Review Boards are often subject matter experts with a broad background relative to the health or other organization. Although there may be an IRB member with cybersecurity or security-related expertise, others in the group may not be at the same level of knowledge to minimize risks. It will be important for all existing and newly appointed members, to provide a basic level of training related to cybersecurity, especially since digital health is becoming, well, more digital and technical.

The proposed cybersecurity training checklist should at a minimum contain:
1. Defining the different types and shapes of digital health applications.
2. Outlining the diverse types of connectivity related technologies, including data and information transmission and sharing.
3. Hardware and software options for digital health solutions, as well as their computing models (cloud vs. on premise), and discuss attack surfaces.
4. An explanation on how nefarious technological motives can initiate risks.
5. Providing an array of sample cybersecurity hacking incidents that have occurred related to digital health.
6. An outline of the array of higher-frequency cybersecurity threats and attacks.
7. Classifications of created and stored data (retention and destruction) ensuring a full understanding of privacy and risks.
8. Review an example and simple assessment toolbox for performing cyber or security risk assessment in public health including technology (Mierzwa, S., RamaRao, S., Yun, J. A. & Jeong, B. G. 2020).

Discussion

We have seen societal movements in protecting citizens globally against a variety of threats. The COVID-19 pandemic spurred a global and unified response by countries and communities to wear masks, practice social distancing and washing hands. Such coordinated efforts bring greater awareness and engagement from governments to citizens. We believe that we can apply a similar approach to engaging stakeholders to enhance cybersecurity.

We believe that procedures and processes from certifications to reviews by independent reviewers can build a culture of ethics in individuals. Individuals are members of their professional and lay communities and can thus act as agents of positive change. As community knowledge and acceptance of ethics in cybersecurity gains ground, we believe that we can mobilize societal action.

Can we garner societal action, in the same way as what we are witnessing with the response to the COVID-19 pandemic, when public officials and health experts continue to warn citizens to make sacrifices with physical connections with friends and family as a method to prevent the spread of the virus? As momentum continues to garner speed in Machine Learning and Artificial Intelligence, it will be even more important to emphasize ethics and the human and societal effects. We continue to witness escalating cycles of risk, with the potential for calamitous societal implications of today's attacks. In addressing ethics, one may not be able to simply rely on frameworks and government regulations. A large mental and cultural shift will be required. Everyone, from corporate executives to security practitioners, shares the responsibility for security and privacy. Each of us will own a personal responsibility, not only to the organizations we work for and the customers we serve, but also to society as a whole (Harkins, M. W. 2016).

Limitations

This paper provided a focus into the individual's engagement with ethics and societal norms to contribute towards less nefarious hacking. An important and large segment area of hacking was not tackled; this includes nation or state-sponsored hacking. Do ethics even play a part when it comes to nations interested in the motive of hacking against nations and their companies? During the COVID-19 pandemic effort by pharmaceutical development companies to discover vaccines, there existed hacking in attempts to interfere and gather intellectual property knowledge – a form of espionage. In one example, hackers extorted $1.14m from a University of California, San Francisco research lab working on COVID-19 treatment and vaccines (Tidy, J. 2020). These sorts of hacking incidents were suspected of coming from a well-funded nation-state malicious hacking sources. Similar to what a code of ethics for international physical war exists, further research into the exploration of an ethics mantra for cyberwar is a potential research topic worth exploring in the attempt to determine if rules exist, and if not, should they be developed.

This rapid review article did not address concerns about the common practice of cybersecurity competitions, where students and experts compete against teams or each other while employing and learning methods of hacking. Although such activities are beneficial at teaching

individuals about hacking approaches, a concern is raised about whether those participating in these events go on to become nefarious threat actors – hacking for their financial benefit. An area of potential further research is in relation to these cybersecurity competitions and whether the event organizers require participants to adhere to, agree and sign an ethics agreement.

Conclusion

We believe that individual and societal interests can intersect and synergize the emphasis on ensuring ethics in cybersecurity. The role of ethics in digital health and cybersecurity can benefit from lessons undertaken in other fields. In one example, the ethics of clinical duties of care in medicine have been nurtured during many decades of clinical experience and have inspired confidence and trust (Benatar, S. 2020). The field of digital health and cybersecurity is a much newer advent in comparison to medicine, but the example model can provide hope that it is possible to install this type of movement. The world continues to see an expansion of cybersecurity threats and exploits, and without some sort of intervention, it will only continue to fester.

In this paper we provided background information and knowledge related to the topic of ethics in relation to digital health during the COVID-19 pandemic, when many different technical solutions are being created. The eight segments of training topics related to awareness of cyber threats for an IRB are just a start, and can be further evaluated, built up and refined with further work to advance the research.

Declaration of Interest Statement

The authors declare that they have no conflicts of interest.

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USER ACCEPTANCE OF BIOMETRIC IDENTIFICATION SYSTEMS FOR DIGITAL COMMERCE

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ABSTRACT

Nowadays, digital commerce is a necessity for all types of business enterprises. Customers are the main asset for all business organizations and how to retain them is a big challenge. Enterprises are introducing more advanced business processes that can provide a balance between security and customer experience at the same time. Biometric technologies are designed to create an easy interface while ensuring security, compliance and global acceptance. The purpose of this paper is to study user acceptance of biometric identification systems for digital commerce and how to achieve global acceptance of these technologies.

Keywords: Biometric Identification, User Acceptance, Digital Commerce Security, Sociotechnical Systems

INTRODUCTION

Biometric identification systems are transforming the way customers engage in digital commerce. Currently, we have mobile devices that require biometric authentication to replace PIN codes and biometric data are used to open business accounts. The digital world is undergoing a transformation. While reviewing the background of biometrics, we find that in the 90s of the 20th century there was great development of biometrics that some authors characterized as a biometric revolution. At the beginning of the 21st century, the influence of biometrics started to expand as a new global identification system. A revealing case is the use of biometric data contained on passports embedded its country of origin inside the integrated biomedical information shared with the destination countries (Redpath, 2007). Privacy is a

fundamental aspect widely questioned when a biometric system is used or implemented, based on Nyshadham & Castano (2012). In the last few decades, research streams have analyzed, explained, predicted and designed systems focusing on privacy. The support of the users is a basic requirement when a new biometric system has to be implemented. Moreover, the fact that a biometric characteristic can be captured without the cooperation of the user is perceived as a threat to the privacy of individuals. The detractors of the use of biometric system defend the postulate that this methodology carries the risk of affecting the user's privacy rights (Castano, 2015). These streams of research have included those concerns on the privacy of the training, the impact of the electronic commerce on the privacy of the information, the attitudes, the confidence, the technologies and the culture (Belanger and Crossler, 2011). The information privacy has been interpreted as the perception of what occurs with the information or the capacity to control the information. With the emerging digital age, information can be easily accessed, transmitted and integrated, which poses a large threat if not used with care (Smith, Milberg, and Burke, 1996). With respect to social acceptance and privacy on the use of biometric systems for the finger print captures, the biometric system proponents affirm that it can be used as a protection for the individual's privacy. For example, the access to certain systems based on passwords only can be weak, since it can be accessed or obtained clandestinely by unauthorized users. In this scenario, the biometric systems protect the access to information services to be determined by users (Benamati & Ozdemir, 2016). Currently, the problem of personal identification has become a challenge for information security systems, the technology development and its related applications.

A biometric system can be used for the enrollment, verification and identification of a specific individual (Prabhakar, S., Pankanti, S., & Jain, A. (2003). In case of biometric verification, this is used to certify a specific individual identity. The biometric technics use physiological or behavior characteristics of individuals to be identified, some of them are finger print and iris captures and facial and voice recognition techniques.

Biometric data is usually collected using a device called "sensor". These sensors are used to collect all necessary data for the recognition and to convert all gathered data into digital data. The quality of the used sensors makes a significant impact on the recognition or identification results. Some examples that can be mentioned are digital cameras used for facial recognition and

telephones used for voice recognition (Castano, 2015). Never in our history did we have access and the distribution of personal information this easy, it is treated as a commercial good (Smith, Dinev & Xu, 2008).

BIOMETRICS AND SECURITY IN DIGITAL COMMERCE

On the topic of how to take advantage of biometric identification technologies to improve security in the applications that use e-commerce, Micolta (2015) states that for the practical implementation of a biometric information management system, it is necessary to take into consideration the following characteristics: performance, which refers to the speed; robustness; and accuracy with which technological resources systems are able to process the implemented biometric identification system. In addition, how operational or environmental factors can affect the accuracy of the identification process and what are the advantages in terms of costs and benefits.

As a result of the continuous growth of the Internet usage, the implementation of digital commerce is expected to make huge transformations in this field. Technologically, digital commerce is possibly the most innovative contribution of companies, because it is not limited to changing processes and products as the past, but it changes its relations with the outside world, becoming to produce transformations in the structure and organization of the companies itself (Lobo & Rico, 2012). But the phenomenon goes beyond the scope of commercial enterprises. Digital commerce, so called by this name due to the technologies on which it is based, has been defined as Internet Commerce, a definition in which all its terms are restrictive. Although commercial transactions and the intensive use of the Internet are the main features, the consequences that derive in practice go much further than its terms, it can be said that what is really consequential is how to organize the relations between institutions, enterprises and citizens not to mention the whole society (Robayo, 2011).

Several governments are actively working to incorporate or create new laws to regulate this type of trade. International organizations are working on standardization work, professional forums are debating their consequences and new uses are being introduced. This has resulted in transformations of all electronic trade activities. In addition to this, large companies in the fields of telecommunications and information technology are increasingly being introduced as new players, which make enormous economic and technological resources available to digital

commerce, thus further accelerating change (Laudon, Laudon, Traver, Janal, Schwartz, Griffith, & Bannan, 2009).

ACCEPTANCE OF BIOMETRIC TECHNOLOGIES

In the Technology Acceptance model postulated by Davis (1989), the acceptance of biometric technologies in digital commerce by users is based on two main characteristics: perceived utility and perceived ease of use. First, perceived utility refers to the degree to which a person believes that using a certain system will improve his or her performance on the job. Second, perceived ease of use indicates to what extent a person believes that using a certain system will make less effort to perform their tasks. It exposes that the existence of the perceived facility of the use of biometric technologies and that of the perceived utility as the main determinant variables of the use of the same, exerting its influence through the attitude towards its use and in turn influences the intention of the use of them. Per this model, there are external variables that influence directly in the perceived usefulness and perceived ease of use. In addition to this direct influence of both perceptions, the external variables that influence indirectly are the attitude towards the use, the behavioral intention to use and the behavior of the real use.

Perceived ease has a causal effect on perceived utility, in addition to the significant effect of this variable on the user's attitude, that is, a feeling for or against the use of biometric technologies. The purpose of the Technology Acceptance Model is to explain the causes of the technologies by users. This model proposes that a person's perceptions regarding the perceived utility and usability of a biometric system are conclusive in determining their intention to use a biometric technology system. Both variables have an impact on the attitude of using biometric technologies, the intention to use them and their influence by the current use of biometric technological systems. Although the Technological Acceptance Model helps to know if a biometric technology will be accepted by users or used in an optimal way, it is necessary to identify the external variables that affect it, such as those that directly influence the utility and ease of use. Use perceived by the users of the biometric technologies and to determine the relation of said variables with the result of their use. This study seeks to identify the external variables that affect the acceptance of biometric technologies of digital commerce by users.

Experts from specialized firms have found that the current lack of privacy of cyber users, which even threatens their security, has given rise to growing concern and could cause considerable

losses to companies engaged in e-commerce. According to a survey by market research firm Forester Research (2014), 65 percent of 10,000 consumers surveyed were very concerned or extremely concerned about their privacy when browsing e-commerce on the Internet.

This lack of trust has caused digital commerce customers shopping online to refrain from doing business resulting in millions of dollar losses around $ 10.2 billion, and it was found that 54% companies either slowed down or completely stopped their digital commerce business. The survey showed that the higher the popularity of the Internet sites, users were more fearful of the security of the data that they brought to the sites they accessed on the Internet related to e-commerce. Every time someone connects to the network, they are vulnerable by sharing their personal data confirming that they are looking for information for business purposes or with real criminals that pretends to appropriate credit card numbers with an identity thief threat (García, 2004).

Tavera, and Londoño, (2014) conducted the study titled: Factors determining the technological acceptance of E-Commerce in emerging countries using Davis Technology Acceptance Model (1989), and Ajzen Model of Planned Behavior (1991). The researchers integrate both models with security builders, trust and innovations to explain the phenomenon of technological acceptance of E-Commerce in emerging countries, in which users know the existence of technology, but do not have full access to it given the penetration rates. The theoretical model was contrasted, empirically, with a sample of 497 users of the metropolitan area of the city of Medellin, Colombia; Later, a confirmatory factor analysis was developed to guarantee the reliability and validity of the measurement model and then the final model was estimated by means of systems of structural equations. The results allowed to show the pertinence of the models already described to explain the adoption behavior by the users of the E-Commerce, confirming that the constructs subjective norms and perceived control belonging to Ajzen's Model of Planned Behavior (1991), was constituted as a relevant antecedent of the channels of perceived utility and ease of use of the Technological Acceptance Model, respectively. Perceived trust is the main direct antecedent of the intention to use the E-Commerce (Tavera, and Londoño, 2014). The study contributed to the closing of the gap in research in emerging countries about the acceptance of technologies, especially electronic commerce, in relation to those in advanced countries.

RECOMMENDATIONS FOR BETTER ACCEPTANCE

We can see that the field of biometrics faces challenges specifically for the user acceptance of getting their biometric stored on mobile devices and over cloud services. On the other hand, commercial organizations, based on a research survey performed on 2019 by Ping Identity, affirm that the biometric authentication is an effective way to protect the user's identity data stored by business organizations. For general mobile devices, the users are realizing that using only passwords for digital commercial transactions is not very secure. The use of biometric technologies personalizes the access to business platforms by using the user's biological uniqueness and comparing it with the information stored on a backend database local or business platforms divided on the most common groups, fingerprint authentication, voice recognition, facial recognition, and retina scanning. This makes it difficult for someone to try to duplicate the biometric characteristics. We envisage that more academic and professional research to be done on this topic. All the aspects of biometric identification and security are evolving and the goal is to provide the users the trust on more security features.

CONCLUSION

The importance of the biometric security to access digital commerce platforms can never be overstated. From the user perspective, biometric or multimodal authentications are an efficient way to increase the security rather than just a pin number to perform electronic transactions like banking and online purchases. The implementation of additional layers of security will improve the user's protection and help increase the trust to accept biometrics for current and future use for digital commerce. As the biometric technology evolution continues, more enhanced tools can be provided to users and that will result in universal acceptance.

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AUGMENTED REALITY OR PRICE CUT: WHAT MATTERS AND TO WHOM? A CASE OF PEER-TO-PEER ACCOMMODATION

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Abstract

One important technological development expected to impact the hospitality industry is augmented reality (AR). Despite the increasing popularity of AR-enabled applications, academic investigations on consumer response to AR technology in the peer-to-peer accommodation context remain rare. To fill this research gap, we conduct a series of two studies. The first study focusing on the booking stage examines whether consumers value an AR-enabled service more than a price discount. The second study focusing the post-check-in stage investigates the interactive impact of technology characteristics (information enhancement, vividness, and interactivity) and information overload of user on consumers' responses drawing from affordance theory.

Keywords: Augmented reality, Price discount, Information overload, Perceived value, Airbnb

Introduction

Augmented reality (AR) is one important technology trend today (Porter & Heppelmann, 2017). AR is expected to impact significantly the tourism and hospitality industry as the firms in this industry primarily sell physical environments (i.e., hotel rooms) or experiences (i.e., exploring tourism destinations), which can be improved by AR (Revfine, 2020).

Lately, the largest peer-to-peer accommodation, Airbnb, has shown its interest in AR. Airbnb blog (2017) indicated that each house's setup is likely to be different, and customers can be stressed when all instructions are in a foreign language or when they do not know how to use an espresso coffee machine. To make a seamless guest experience, Airbnb is considering an AR-enabled guest book (Murphy, 2017), which can recognize surroundings and provide interactive and timely information (e.g., offering instant translations on how to use a foreign coffee

machine). The AR-enabled guest book may increase customers' ability to learn and act on the information (Porter & Heppelmann, 2017).

Nevertheless, Airbnb is unsure when precisely they will launch the AR-enabled guest book (PYMNTS, 2017). Airbnb (2017) noted that the technology is still in an early stage, and numerous experiments are required to discover innovative ways to enhance their guest experience through AR.

Although prior research on AR in tourism and hospitality has developed a number of implications (Please see section 2. *Augmented Reality in the Context of Tourism and Hospitality*), two research gaps are identified. First, industry professionals have argued that adopting AR in businesses necessitates great caution because of its expensive costs. One estimates that establishing AR apps alone can cost "anywhere from $300,000 to $30 million" (Rigby, et al., 2019). The new venture capital funding for AR has greatly declined in the year 2018, compared to 2017, due to the high development costs and underwhelming consequences from early adopters of AR (Doty, 2019). The subsequent question arises: Is implementing AR in businesses worthwhile? Rigby et al. (2019) asserted that investigating whether consumers value AR "more than a price cut" (p.3) is one way to answer this question, as the increased cost due to the AR adoption can be passed along to the final customers by increasing products' prices. If the customers are unwilling to pay more for the AR-enabled service and prefer reduced prices, the AR adoption may not be a good investment. Hence, our first study's objective is to respond to Rigby et al.'s (2019) recommendation by examining whether customers value the AR-enabled guest book more than price discounts at the booking stage. The results of this study will help practitioners improve their decisions on AR investment.

Second, Fiol and O'Connor (2003) and Darban and Polites (2020) showed that individuals' responses to a certain technology and their adoption behaviors are affected by the joint impacts of technology's and user's characteristics. Yet, many empirical studies have focused on one side of these attributes, while a holistic assessment necessitates an investigation of both attributes, jointly. Thus, the objective of our second study is to investigate the interactive impact of technology's characteristics (information enhancement, vividness, and interactivity) and user's characteristic (information overload) on consumers' responses at the post check-in stage drawing from affordance theory. The findings of this study will provide practical implications regarding for whom and how to design AR applications to improve the lodging experience.

Augmented reality in the context of tourism and hospitality

Porter and Heppelmann (2017) defined AR as "a set of technologies that superimposes digital data and images on the physical world" (p.4). Recently, AR has garnered attention in the tourism and hospitality industry.

Prior research on AR in the context of tourism and hospitality has developed a number of implications from diverse perspectives, including users' acceptance of AR in a tourism attraction (Tom Dieck & Jung, 2015), tourists' intention to use AR (Chung et al., 2015) and to recommend other people to use AR in a tourist site (Jung et al., 2015), user requirements for the development of AR tourism application (Tom Dieck et al., 2016), prospects and challenges of AR adoption (Kounavis et al., 2012), design and assessment of AR tourism interfaces (Yovcheva et al., 2014), and effects of AR on hotel employee training (Koo et al., 2019). Earlier studies also showed that AR-enabled service can enhance visitors' experience and enjoyment (Tussyadiah et al., 2018), improve their willingness to pay (He et al., 2018), and increase their revisit intentions in a tourism attraction (Jung et al., 2016).

Hypotheses development

Perceived value

Chen and Chen (2020, p. 30) defined perceived value as "the consumer's overall assessment of the utility of a product (or service) based on perceptions of what is received and what is given." They suggest that perceived value functions as a trade-off between perceived benefits and monetary sacrifice, that is, the perceived net gain or benefit versus the perceived net loss or risk. Likewise, Chen and Dubinsky (2005) outlined perceived value as a person's perception of the net benefits gained in exchange for the cost incurred in obtaining the desired benefits.

Earlier studies imply that understanding consumers' perceived value is important when implementing a technology in businesses. For instance, Jung et al. (2020) argued that perceived value is a primary motivation for customers to accept a technology and pay a premium to use it. Hong et al. (2017) asserted that perceived value is a part of a person's system usage experience due to its significant propensity to shape behaviors and intentions. tom Dieck and Jung (2017) noted that investigating the association of consumers' perceived value with AR is necessary "to create business models that reflect the significant impact of consumer value on the delivery of information systems" (p. 111).

In a series of two studies, we examine the impact of AR on consumers' perceived value in a peer-to-peer lodging environment. Study 1 examines the perceived value of AR compared to price cuts at the booking stage, and Study 2 investigates the joint impact of AR's and user's characteristics on perceived value at the post-check-in stage.

Study 1: Price cut or AR

Lodging managers have commonly used room price cuts to attract customers in the short term (Kim et al., 2018). Given the industry characteristics (perishable inventory and small marginal costs), selling more rooms at reduced prices is usually better than letting the rooms be empty (Kim et al., 2019).

Earlier empirical research has found that room price discounts tend to immediately improve hotel revenue (Kim et al., 2016) and mitigate hotel occupancy loss in times of low demand (Kim et al., 2019). Such favorable impacts maybe because the room price cuts can attract price-sensitive guests who would otherwise be less willing to stay at a hotel, or because the price discounts may enhance the value of the hotel product, in which the value can be understood as a trade-off between benefits and costs (Chen & Dubinsky, 2005). Accordingly, many lodging managers have regarded reducing room rates as an imperative and useful strategy to immediately increase demand (Pappas, 2015).

As aforementioned, Rigby et al. (2019) argued that examining whether customers value AR "more than a price cut" (p.3) is one way to justify an AR implementation in businesses regarding its expected costs. Therefore, this study examines the following research question:

RQ: How do guests value an Airbnb with an AR-enabled guestbook with no price discounts versus a discounted Airbnb with a traditional (hard copy) guestbook?

Booking intention is often used to forecast an accommodation's actual demand (Kim et al., 2017) and is an imperative determinant of Airbnb's revenue (Pan, 2007). The positive impact of AR user's perceived value on purchase intention is supported in earlier research (Jung et al., 2020; Hilken et al., 2017). Therefore, we also include booking intention in Study 1 for completeness purposes without formally hypothesizing the relationship.

Study 2: Joint impact of AR's and user's characteristics

AR characteristics. Reviewing the relevant research on AR and basing on Porter and Heppelmann's (2017) discussion, we identify three AR characteristics that may affect user's perceived value: 1) information enhancement, 2) vividness, and 3) interactivity. Each of these system's characteristics is further discussed as follows (See Figure 1).

Information Enhancement. Information enhancement of AR occurs when "virtual representations are used to present information in a method that improves upon methods available in physical reality" (Kim et al., 2018, p. 696). The AR-enabled guestbook in a peer-to-peer accommodation can recognize surroundings and present information with additional visual data and cues on time. This could accelerate guests' ability to absorb and act on the information, resulting in an improvement of task's success (Porter & Heppelmann, 2017). Since AR can filter information by highlighting and/or diminishing certain details (Kim et al., 2018), the task's efficiency may also improve. For example, reading entire instructions about how to use an amenity (e.g., an Italian espresso machine) from a hard copy of guestbook may be overwhelming to guests. Instead, they can simply search specific operation tips and rules using their mobile AR applications that eliminate unnecessary details.

Enhanced information quality leads to higher perceived value (Han yet al., 2016). Individuals are likely to use AR to acquire information when they value the AR feature facilitating knowledge absorption (Jung et al., 2016). Thus, we hypothesize:

H1: Perceived information enhancement of AR-enabled guestbook will enhance customers' perceived value.

Vividness. Vividness is a technology's capability to create a sensorially rich environment (Steuer, 1992). In the context of AR, vividness combines a sensory experience of real objects with a non-sensory experience of virtualized objects to create a clear image in a user's mind. AR can enhance vividness by enriching the breadth of the presented information, i.e., the quantity of the sensory dimensions, for example, by using videos with sound effects. Similarly, enhancing the depth of information, i.e., the quality of the offered details, can improve vividness, for example, by creating realistic and high-resolution images (Yim et al., 2017).

Mental imagery theory (Thomas, 1999) argues that vividness is the main attribute of a person's generated mental images, and as these images become more vivid (i.e., sharp and clear AR images), the quality of the person's experience will enhance. Consistent with this notion, He et al. (2018) found that the vividness of an AR-enabled service improves visitors' experience and willingness-to-pay in a museum. Besides, a vivid display of a product can promote a person's cognitive elaboration of the presented information, facilitating the process of learning and helping recall the information in future usage contexts (Petrova & Cialdini, 2005). Prior research revealed that the ease of learning a technology could lead to better decision-making, lower cognitive burden (Darban & Polites, 2016), and higher user's perceived value with the technology (Bawden & Robinson, 2009). Because of these benefits, vividness becomes an essential feature of AR and explains why an individual would be more motivated to use an AR-enabled application than a non-AR application (Steffen, 2019). Based on these pieces of evidence, we hypothesize:

H2: Perceived vividness of AR-enabled guestbook will enhance customers' perceived value.

Interactivity. Interactivity generally refers to "the extent to which users can participate in modifying the form and content of a mediated environment in real-time" (Steuer, 1992, p. 84). Interactivity outlines the technology's properties, which enable a user to interact and engage with the content more easily (Hoffman & Novak, 2009). AR introduced a new level of interactivity by integrating control panels overlaid directly on the product and operated using hand gestures and voice commands. Therefore, an AR app is capable of adding interactivity to people's lodging experience since they can, for instance, point a smartphone or a tablet at an amenity to see and navigate the available digital content related to that amenity.

Research on interactivity has shown that this feature represents numerous cognitive and behavioral responses. For instance, previous studies found that AR interactivity can increase ease of use and usefulness perceptions (McLean & Wilson, 2019), users' immersion and enjoyment (Lazarus, 1966), their satisfaction and experience (Poushneh &Vasquez-Parraga, 2017), and intention to adopt an AR app (Yim & Park, 2019).

AR interactivity tends to transform its users from being spectators to active participants. It can afford the users to easily control and access the available contents. For instance, an Airbnb guest, using an augmented interface, can freely choose the content and navigate the application

to watch an augmented tutorial video while controlling its frame size, speed, volume, etc. Enhanced AR interactivity enables individuals to gather and personalize information in a more effective way as it allows for manipulation and control of the content in a 3D virtual environment (McLean & Wilson, 2019). IT usage research found that increased user control can form a higher perceived value of the technology (Baird & Raghu, 2015). Summarizing the above arguments, we expect that higher levels of AR interactivity magnify people's perceptions of value as it helps them to form favorable assessments of the utility of the AR-enabled product. Thus, we hypothesize:

H3: Perceived interactivity of AR-enabled guestbook will enhance customers' perceived value.

User characteristics. Prior research suggests that the success of the implementation of a technology could vary based on individuals' characteristics. For example, Darban and Amirkhiz (2015) argues that individual differences impact perceptual benefits and effectiveness of a technology. Jung et al. (2020) showed that visitors' cultural differences affect their intentions to use AR apps in tourism destinations. Huang and Liao (2005) and Tom Dieck and Jung (2018) found that AR users' innovativeness influences their tendency to use AR apps and their perceptions of usefulness and ease of use of AR, respectively. Therefore, the implementation of a particular technology can produce various outcomes with different users.

In this respect, Steffen et al. (2019) argued that researchers should consider the user alongside the technology attributes. This argument is consistent with affordance theory (Gibson, 2014), where affordance refers to the potential of an IT artifact (e.g., AR-enabled app) to meet a user's goal. Affordance theory, which highlights the relation between a technological object's characteristics and a user's characteristics (Volkoff & Strong, 2013), argues that certain IT qualities may afford certain benefits/actions to some users, but not others (Markus & Silver, 2008). For instance, the AR feature of a lodging app offers certain benefits, such as instructions to use an Italian espresso machine. This feature affords to make an espresso drink to those who are coffee drinkers. However, for tea drinkers, this feature of the app does not offer the same affordance.

User characteristics have only recently attracted the researchers' attention in the area of AR app usage. For instance, Jung et al. (2020) explored the role of AR users' cultural traits, such as

Long/Short-term orientation. They found that that tourists' cultural differences impact how they form the intention to use AR apps in tourism destinations. Also, Huang and Liao (2005) and tom Dieck and Jung (2018) found a positive effect(s) of AR user's innovativeness on her tendency to use AR in online shopping contexts and on her ease of use and usefulness perceptions in a tourism setting, respectively.

Put differently, affordance theory indicates that while a technological artifact has properties that users can employ, the existence of these features (i.e., affordances) alone may not lead to successful outcomes, such as effective usage. Rather, whether users' benefits from these affordances depend on their characteristics and capabilities. It is useful to examine AR via the frame of affordance because it links technology attributes and user attributes and offers an angle to investigate why individuals would employ the technology. Consequently, affordance helps to explore why a user prefers to alter a real environment and how she perceives the value of such augmentation (Steffen et al., 2019).

User's information overload. People have limited and diverse capacities of information processing (Miller, 1994). This suggests that they may be overwhelmed by the flood of information presented to them, for instance, on their devices. Also, different individuals may find a similar amount of the presented information overwhelming differently. People might be influenced, although differently, by such an overload that could act as a stressor. Such an experience possibly decreases user's satisfaction, engagement (Chen et al., 2019), and concentration in using a mobile app (Ren et al., 2008). This phenomenon referred to as information overload and related to the perception of receiving "too much" information. Information overload has long been recognized as a potential problem for the design of technologies and for the IT users (Bawden & Robinson, 2009). However, earlier studies have less paid attention to the potential information overload in AR-enabled applications to date.

Miller (1994) suggests that considering humans' limited capacity of information processing, grouping or organizing information into units can improve user engagement in the focal activity. When individuals experience mental burden or stress, they tend to develop strategies to cope with the stress and actively look for a solution to minimize potential negative impacts of the situation (Beaudry & Pinsonneault, 2005; Darban, in press). For those users of AR, presenting the information in an ordered, categorized manner, that is information enhancement (Steffen et

al., 2019), can be seen as a potential solution in coping with the experienced mental burden. Accordingly, we argue that AR users who experience information overload will find the information enhancement attribute of the AR-enabled guestbook, valuable.

This argument is in line with the stress-coping theory (Lazarus, 1966), which discusses how a person normally goes through to cope with a stressful situation to form an effective adaptation behavior. The AR's information enhancement feature organizes and groups information for the users; therefore, they can make use of the presented information and identify the useful information effectively. Whereas, for the individuals with lower levels of perceived information overload this characteristic of AR may not be deemed necessary and valuable. Thus:

H4: Perceived information overload moderates the relationship between AR information enhancement and perceived value, such that the relationship is stronger in the presence of higher, rather than lower, perceptions of information overload.

The AR vividness refers to the clarity of the information provided, e.g., realistic and high-resolution images, and the multiplicity of sensory dimensions, e.g., integration of videos and sound effects (Yim et al., 2017). However, a person experiencing information overload may not fully appreciate the vividness of the AR app. It is because higher levels of perceived information overload tend to exhaust person's cognitive resources, interest, and energy, leading to information processing fatigue (Guo et al., 2020). Therefore, higher levels of vividness, that is presenting digital contents via multiple sensory dimensions (Yim et al., 2017), may look even more confusing and less valuable for the person with higher perceived information overload. Referring to the information overload problem from the field of visual analytics, Keim et al. (2016) highlighted the danger of getting lots in data if we add multiple dimensions of information (e.g., sound, video, text, etc.).

Similarly, McLean and Wilson (2019) found that providing a vivid experience of AR results in enriched experiential values for users because they feel that the technology is easy and enjoyable to use. However, these benefits can be reduced in the presence of information overload. Since AR vividness may not be a sensible and valuable attribute to cope with the encountered stressor, i.e., high perceived information overload, it imposes further cognitive processing load by offering further information dimensions. In such a situation, a person may adopt to survive with the information overload by simply neglecting the additional information

sources, referred as to information withdrawal (Sparks & Browning, 2011). Thus, we hypothesize:

H5: Perceived information overload moderates the relationship between AR vividness and perceived value, such that the relationship is weaker in the presence of higher, rather than lower, perceptions of information overload.

Technostress literature reveals that a person reacts to challenges created by an IT event, for instance, using a new technology or adjusting its features, by developing stress-coping strategies (Chen et al., 2019). Especially when people have a high perceived control over the IT threat, they are likely to adopt a "disturbance handling" strategy to deal with technostress (Beaudry & Pinsonneault, 2005), consistent with stress-coping theory (Lazarus, 1966). Utilizing this strategy, users take a problem-focused approach to advance the situation. They make an effort to minimize the adverse impacts of the IT event, *and* actively find ways to improve the situation and even make good use of it (Lazarus, 2000).

Meanwhile, AR's interactivity feature offers users an ability to control and manipulate the presented information (Javornik, 2016; McLean & Wilson, 2019; Yim et al., 2017). Thus, it is possible that AR users, who are stressed due to experiencing higher perceptions of information overload, may adopt the disturbance handing strategy and actively seek to resolve the encountered disruptive condition (Lazarus, 2000). Hence, they may find the AR's interactivity even more valuable because this feature helps the users reduce the potential adverse impacts of high perceived information overload. Contrarily, for individuals who do not experience high levels of information overload, the interactivity attribute of AR will probably be perceived as less valuable. Thus, we hypothesize:

H6: Perceived information overload moderates the relationship between AR interactivity and perceived value, such that the relationship is stronger in the presence of higher, rather than lower, perceptions of information overload.

Organizations adopt AR-enabled services to develop favorable customer behavioral intentions (Porter & Heppelmann, 2017). The positive impacts of AR user's perceived value on word-of-mouth intention and revisit intention are supported in prior empirical studies (Jung et

al., 2016). Therefore, we include this hypothesis in our proposed model (See Figure 1) for the completeness purposes without formally hypothesizing the relationship.

Methodology

Sampling

We will recruit participants using Amazon's Mechanical Turk (MT), which is an online crowd-sourcing platform. Participants in this study will be 18 years of age or older, currently live in the U.S., and have stayed in an Airbnb during the most recent one-year period to ensure a proper sample. Participants will receive money for completing the surveys.
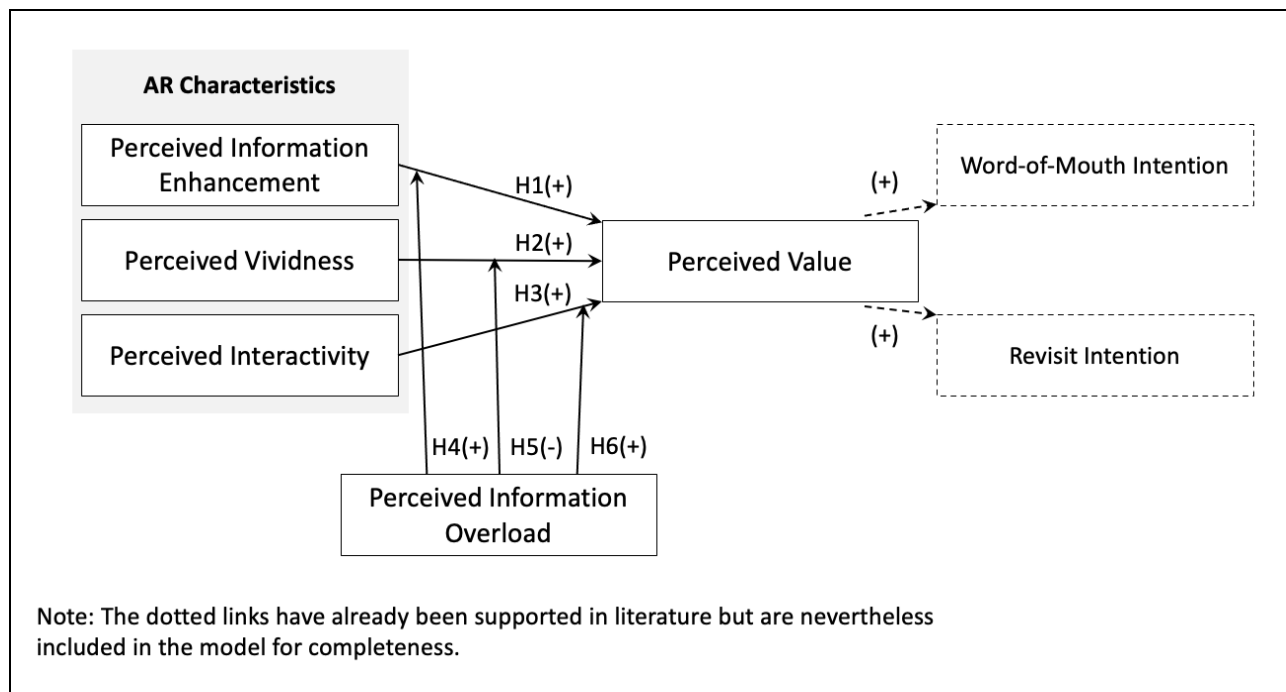
Figure 1. Research Model (Study 2)

Study 1

Design and stimuli. Dependent variables at the booking stage (Study 1) are perceived value and booking intention, which will be measured by a 7-point bipolar scale (1=Strongly Disagree, 7=Strongly Agree) following Jung et al., (2020) and Sparks and Browning (2011).

This study will employ a 2 (Guestbook type: AR-enabled vs. hard copy) by 3 (price discount level: none vs. low vs. high) between-subjects experimental design. We will randomly assign participants to one of the six experimental cells. The scenarios will instruct participants to

imagine an Airbnb booking experience in which the Airbnb offers either an AR-enabled guestbook or a hard copy of guestbook, and the room price is either non-discounted rate (0% off), low discount rate (5% off), or high discount rate (20% off) following (Hu et al., 2006). The room price will be identified based on the actual prices on the Airbnb website (www.airbnb.com). These manipulations will be checked with several questions asking participants to recall the price discount levels and adoption of AR. Data for those who fail the manipulation checks will be eliminated from data analysis.

Study 2

Design and procedure. Data collection consisted of two online surveys administered at two points of time with at least a one-week interval in between. In the first survey, after answering demographic questions, participants will be asked to read a description of an AR-enabled guestbook, and they will also watch a short (around one and half a minute) video in which they will experience an Airbnb with AR-enabled guestbook. In the video scenario, the participants will be asked to imagine they are staying in an Airbnb and using the AR app to access the augmented contents. The video portrayed the AR-enabled guestbook experience from a first-person point of view. In the video, they will see how AR can be used, for example, to read manual, find the location of a tool, watch a tutorial to use an amenity, tweak the AR's settings, etc. Then, the sample will answer questions about their perceptions of AR characteristics, perceived information overload, and the control variables.

In the second survey, after watching the same video, the sample will answer questions regarding their perceived value and word-of-mouth intention and revisit intention. Three bogus items with a clearly correct answer will be included in both surveys to help us screen the data and control the engagement of the respondents. We will exclude the responses that provide an incorrect answer for the bogus questions, as it reflects the respondent is not attending to the content of the other items of the survey either (Meade at al., 2012).

Measures. Dependent variables at the post-check-in stage (Study 2) are perceived value, word-of-mouth intention, and revisit intention. The independent variables are interactivity, vividness, and information enhancement, and our moderator is information overload. We will use previously validated seven-point Likert scales with a range from Strongly Disagree to Strongly

Agree. We will modify the wordings of the survey items to fit them to our research setting. The adopted scale items for perceived value (Jung et al., 2020; four items), word-of-mouth and intention revisit intention (Kim et al., 2017; one item each), interactivity (Yim et al. 2017; four items), vividness (Yim et al., 2017; six items), information enhancement (Steffen et al., 2019; two items), and information overload (Karr-Wisniewski & Lu 2010; three items), yielded 21 measurement items.

Prior research found that a user's sense of spatial presence may affect the perceived value of AR (Hilken, et al, 2017), where spatial presence is a person's belief that the augmented contents are situated in reality and in an authentic way in which she can interact with them (Wirth, et al., 2007). Additionally, Yim et al. (2017) showed that a user's perceived AR novelty, defined as the extend a person perceives an experience unique and new (Massetti, 1996), may influence her AR experience. Therefore, we will statistically control the potential effects of a user's spatial presence and perceived AR novelty on perceived value.

Analysis. We will use structural equation modeling (SEM) to conduct confirmatory factor analysis (CFA), evaluate the psychometric properties of the scale and the structural model using AMOS 25 with maximum likelihood estimation. Recommended techniques and thresholds will be used for determining the presence of acceptable construct reliability, convergent, and discriminant validity. Accepted measures of overall model fit, and results of path coefficient testing will be reported for each hypothesis in the model.

The longitudinal nature of the study (i.e., two surveys at two points of time) will potentially help overcome concerns regarding common method bias (CMB) to some degree since such designs are less vulnerable to CMB, compared to cross-sectional studies (Darban et al., 2016). However, we will apply both procedural (e.g., anonymous participation, randomizing the items, etc.) and statistical remedies (e.g., adding unmeasured latent method factor in CFA) following Bagozzi (2011).

Expected contributions

The rising significance of sharing economies such as peer-to-peer accommodations and the advent of potentially relevant technologies such as AR-enabled guest manuals call for extensive research on the processes of the user and technology interactions. Understanding how individuals

use AR is essential for AR designers and providers. However, we are lacking a clear understanding of when and how people with diverse personal characteristics would prefer to virtualize differently. The research identifies the role of user characteristics in conjunction with the features of the AR technologies to investigate how people assess the values of an AR-enabled system, which influences their word-of-mouth intention and revisit intention.

Hence, our primary contribution is to develop a framework at the user level that describes AR in relation to the joint characteristics of users and technology. In doing so, we extend affordance theory to the area of AR-enabled technologies and outline an exploratory model to better understand how AR features enable affordances that are valuable for the user and how the user's attribute, i.e., information overload, plays a role in this context. Besides, the first study explores the source of value for Airbnb guests, i.e., AR vs. price cut. The findings can shed light on how AR adoption in the peer-to-peer accommodation industry can proceed.

Our multi-sample study supports the implication that peer-to-peer lodging guests want to use AR to enhance positive experience of their stay. There is a common view of AR, which poses that AR only offers overly expensive entertainment. However, to show the potentials and value of AR to the consumers, the developers and designers should focus on their user and the AR design characteristics. For instance, if the perceived value, which also corresponds to the level of acceptance the product, is low, it may be necessary to make some modifications to the design in order to increase the perceived value and successfully introduce AR to the public.

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THE INFORMATION SECURITY INFLUENCED BY THE LEADERSHIP STYLES: A STUDY IN THE CONTEXT OF BRAZILIAN MULTIPLE BANKS

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Abstract

Employees are still considered the weakest link in IS and managers play an important role in encouraging the desired behavior. This is relevant in the context of Brazilian multiple banks, but there is no academic research in this context. To address this gap, this study analyzed the influence of leadership styles (based on Full-range leadership theory) on employees' IS compliance and participation intentions, through PLS-SEM. The results showed that transformational leadership has a positive influence on employees' IS intentions and passive leadership has negative influence. In addition, the results showed moderation by the control variables age, education level and work experience.

Keywords: Information security behavior, Leadership styles, Full-range leadership theory, Brazilian banks

Introduction

Employees are still considered the weakest link in defending against internal and external threats to organizational information assets (Crossler et al., 2013). For this reason, ways have been sought to encourage them to improve the protection of these information assets (Boss, Galletta, Lowry, Moody, & Polak, 2015), which leads to the analysis of factors that influence the

employees' IS behavioral intentions. In this study, the following behavioral intentions are considered: compliance, that is, reaching the minimum acceptable IS standard; and participation, which is characterized by actively promoting organizational IS (Guhr, Lebek, & Breitner, 2019). Among these factors, there is the leadership style of managers, as leaders play an important role in encouraging employees to be aware of and to comply with organizational IS policies (Humaidi & Balakrishnan, 2015a). In this research, the Full-range leadership theory (FRLT) is used, which stands out for its application in academic research with regard to the perception of the followers in relation to the styles of the respective leaders (Salter, Harris, & McCormack, 2014). According to FRLT, these leadership styles are classified as: (i) transformational - proactive leaders, which aim to optimize development and innovation; (ii) transactional - define expectations and promote performance to achieve them; and (iii) passive - they tend to react only when problems get worse to take corrective actions and can avoid making any decisions (Avolio & Bass, 2004).

IS research is relevant in the current context, where organizations suffer high financial losses as a result of cyber-attacks. Thus, Brazilian banks manage high financial amounts and are subject to risks and high losses resulting from cyber-attacks, which lead to the need for employee engagement in the organizational IS and there is no academic research that solves this problem in this specific context. In the academic literature, there is a study that analyzes the influence of managers 'leadership style on the respective employees' IS-related behavior intentions (Guhr et al., 2019), but there is no research applied to the specific context of banks in Brazil.

Thus, this study analyzes the influence of managers 'leadership styles on employees' IS-related behavior intentions in the context of Brazilian banks, by applying the model of Guhr, Lebek & Breitner (2019) to a sample of 517 employees' non-managerial positions of three representative banks. In addition, this study complements the model, by analyzing the moderating effect of the following control variables: age, gender, education level, work experience and IT knowledge. Thus, there are new contributions to academic literature with practical implications:

First, this study addresses the gap mentioned by Guhr, Lebek & Breitner (2019), by applying the model to a new context, contributing to the extension of the behavioral IS literature. In addition, another gap mentioned by the same authors is addressed in this study: the inclusion of new moderators in the model, which brings a new contribution to the literature.

The measurement model was also improved, generating a new contribution: the IS compliance intention was measured using the scenario-based technique, which is more effective to capture the real intention of the individuals' behavior, without generating any concern to the respondents (Moody, Siponen, & Pahnila, 2018).

Finally, the results showed that transformational leadership has a positive influence on employees' IS behavior intentions and, therefore, it is recommended that it be encouraged. Passive leadership has a negative influence, so it is recommended to avoid it. In this way, as practical contributions, the results of this study can support the decisions of Brazilian bank executives regarding the development of leadership, with gains in the organizational IS.

Literature Review

The influence of leadership on employees' IS behavior

As already discussed in the literature, leaders' styles have a direct and indirect influence on the respective employees' IS compliance behavior, through awareness of IS severity and benefits (Humaidi & Balakrishnan, 2015a). Like transformational leadership applied to the IS context, the leader is expected to articulate an IS vision so that all employees clearly understand what the goals of IS efforts in the organization are, so that transformational leadership is strongly related to culture of IS and awareness of IS in the organization (Flores & Ekstedt, 2016).

The role of leadership is crucial in the IS context and the leader must make it clear to each employee what their role is in the organization's IS efforts, their responsibilities, who to turn to at risk to IS and encourage cooperation to achieve the objectives of IS in the organization, that is, achieving and maintaining an effective IS level (Flores & Ekstedt, 2016).

Thus, to obtain effectiveness in IS practices, the relevance of the role of managers is verified through formal and informal measures: formal measures are focused on promoting compliance behavior and punishment for non-compliance; informal measures are characterized by the development of an organizational culture of IS awareness (Mishra & Dhillon, 2006).

With regard to organizational culture, management commitment represents a relevant dimension of the IS culture, which has an indirect influence on the employees' intention to comply with the IS (Nasir, Arshah, & Hamid, 2019). In addition to the direct and indirect influence on the attitude

of employees through management participation in IS initiatives and their influence on the organization's IS culture, this participation can be considered the most relevant external factor in the behavior of employees in relation to IS (Hu, Dinev, Hart, & Cooke, 2012). Thus, the participation of management in IS initiatives is essential for the effectiveness of organizational IS and is relevant for training and employee awareness programs to be more effective (Hu et al., 2012).

It is emphasized that, for the effectiveness of IS policies, the participation of employees in IS is crucial and managers must encourage this behavior, that is, actions beyond compliance with IS policies and that increase engagement with the objectives of the organizational IS (J. S. C. Hsu, Shih, Hung, & Lowry, 2015).

In relation to employees' awareness of IS in organizations, management participation in IS is one of the elements that directly or indirectly impact it and make it more effective (Hwang, Wakefield, Kim, & Kim, 2019). Thus, managers are considered key components for the effectiveness of the IS and, when they are engaged with the IS, the result is positive for the organization and this influences several aspects related to the employees' IS awareness (Hwang et al., 2019).

Although previous studies show the influence of leadership in the IS behavior of their teams, in the development of a culture favorable to IS and the relevance of support from top management to engage employees in IS best practices (C. Hsu, Lee, & Straub, 2012; Knapp, Marshall, Rainer, & Ford, 2006; Puhakainen & Siponen, 2010), the role of leadership in the development of successful actions in SI is still an object of study and offers relevant research opportunities (C. Anderson, Baskerville, & Kaul, 2017). Thus, this study contributes to the behavioral IS literature and analyzes the influence of leaders' styles on the employees' IS behavioral intentions in a specific context (Brazilian banks).

Full-range leadership theory (FRLT)

In addition to Burns' (1978) study of leadership, Full-range leadership theory (FRLT) was developed by Bass & Avolio (1994). In the initial study (Burns, 1978), it was stated that leadership could occur in a transformational or transactional manner. Thus, the basic difference consisted of: the transformational leader seeks to elevate the needs of the subordinate according

to his own objectives, while the transactional leader focuses on trying to maintain the status quo and satisfy the current needs of the subordinate (Bass, Waldman, Avolio, & Bebb, 1987). The Full-range leadership theory (FRLT) stands out for its application in academic research with regard to the perception of the followers in relation to the leaders (Salter et al., 2014) and in the identification of factors that stimulate the performance of employees for exceed expectations (Rafferty & Griffin, 2004). In addition to considering transformational and transactional leadership styles, FRLT conceptualized the third style - passive / laissez-faire (Bass & Avolio, 1994).

With regard to passive leadership, leaders tend to react only when problems are aggravated to take corrective actions and can avoid making any decisions (Avolio & Bass, 2004).

In transactional leadership, this leadership style emphasizes the transactions or exchanges between leaders, colleagues and followers, related to the leaders' specifications about their expectations (requirements) and the rewards that the other party will receive if they fulfill those requirements (Bass & Avolio, 1994). In this way, there is an exchange between the parties, and the purposes of the leader and the followers can be different (Jensen et al., 2019; Stewart, 2006). In short, transactional leadership occurs when the leader rewards or disciplines the led based on their performance: the leader approaches the led with a view to negotiation and the leader's focus can be on correcting a problem or establishing an agreement to achieve positive results (Bass & Avolio, 1994).

In transformational leadership, the leader encourages collaboration between the team, unlike transactional leadership, in which individual interests prevail (Burns, 1978). In addition, the leader and the followers share the same purpose (Stewart, 2006). Thus, transformational leadership consists of the expansion of transactional leadership and occurs when leaders (Bass & Avolio, 1994): encourage colleagues and followers to view their work from new perspectives; develop colleagues and team members at levels higher than their potential; and motivate colleagues and team members to look beyond their own interests and focus on those who benefit the group. This allows the development of team members, who start to consider higher and more challenging needs (Bass et al., 1987; Ng, 2017). Transformational leaders are charismatic and encourage followers to adapt their values and standards, transcending their own interests in favor of the team or the organization (Dong, Bartol, Zhang, & Li, 2016; Jung & Sosik, 2002). In this way, a relationship of trust is created, where the followers trust the vision and values of the

leader and tend to act according to their example (Bass, Avolio, Jung, & Berson, 2003; Bass et al., 1987).

Employees' IS compliance and participation intentions

Even though research seeks to understand and predict individual behavior, measuring the real behavior of individuals has been a challenge for researchers, especially for research related to organizational environments (Hu et al., 2012).

According to the Theory of Planned Behavior, intention indicates the readiness of an individual to perform certain behavior and can be preceded by attitude, subjective norm and perceived behavioral control (Ajzen, 1991). In addition, research shows a strong and consistent relationship between intention to behave and actual behavior (D'Arcy & Lowry, 2019; Webb & Sheeran, 2006), including in the context of compliance with IS policies (Lebek, Uffen, Neumann, Hohler, & Breitner, 2014; Siponen, Adam Mahmood, & Pahnila, 2014), especially when there is a short time between them (Ajzen, 1991, 2011).

Thus, the constructs used in this study consider the employees' IS compliance and participation intentions, due to their proximity to the respective actual (current) behaviors of employees, based on the model of Guhr, Lebek & Breitner (2019), which was the first study to analyze the relationship between all leadership styles according to the FRLT and the constructs related to the intentions of compliance and participation in IS.

In general, IS compliance intention is defined as the intention to behave in accordance with what is established in the organization's IS policies, that is, the intention to comply with what is established in those policies (Chan, Woon, & Kankanhalli, 2005; Herath & Rao, 2009a, 2009b). It can also be defined as the intention to protect the organization's technological and informational resources against potential vulnerabilities (Bulgurcu, Cavusoglu, & Benbasat, 2010) and is characterized by not requiring specific knowledge or skills in IT and applying to all employees of the organization (Guo, 2013). Therefore, the intention to comply with the IS consists of the intention to accomplish something that is expected under the IS aspect and not to do what is not allowed, considering the organizational IS (Guo, 2013). In this way, this construct represents the intention to comply with IS standards and policies, to achieve the minimum acceptable IS standard in the organization (Guhr et al., 2019).

Both the IS compliance and participation intentions contribute to the effectiveness of IS policies in organizations (J. S. C. Hsu et al., 2015). However, if organizations depend only on compliance, they can develop a fragile social system (Zhu, 2013) and, to promote and sustain IS, the prevalence of this behavior is insufficient for organizations (Guhr et al., 2019).

The extra-role behavior stands out, which consists of the set of employee actions that are not defined or established as part of the job, their position or role in the organization and are not reflected in the organization's remuneration system (Zhu, 2013). This behavior can increase the effectiveness of organizations, through the transformation of organizational resources and through adaptability (Zhu, 2013). Thus, the construct of IS participation intentions was defined based on the extra-role behavior (Guhr et al., 2019), which is also recognized as organizational citizenship behavior (Clarke & Ward, 2006; Rafferty & Griffin, 2004), that is, individual discretionary behavior, which is not recognized directly or explicitly by the formal reward system and which, as a whole, increases the organization's efficiency (Organ, 1988).

While the IS compliance intention is seen as a formal part of the employees' work in the organization, the IS participation intention extends these actions and presents a larger voluntary element (Clarke & Ward, 2006), which benefits the organizational IS by do not limiting to simply adhering to the minimum IS standards (Guhr et al., 2019). Thus, the IS participation intention is fundamental to the effectiveness of the IS in organizations, considering that the organization's performance regarding the IS is composed of the set of efforts of each employee (J. S. C. Hsu et al., 2015). The IS participation intention in the IS therefore consists of actively promoting the organizational IS and actions that are not specified in the formal work agreement (Guhr et al., 2019).

Hypotheses/Model

The research model was developed based on the adaptation of the initial model (Guhr et al., 2019) and with the familiar symbolism to the PLS-SEM (Bido & Da Silva, 2019; Ringle, Silva, & Bido, 2014). Thus, the model for this research is represented in Figure 1 below:

Figure 1: Research model
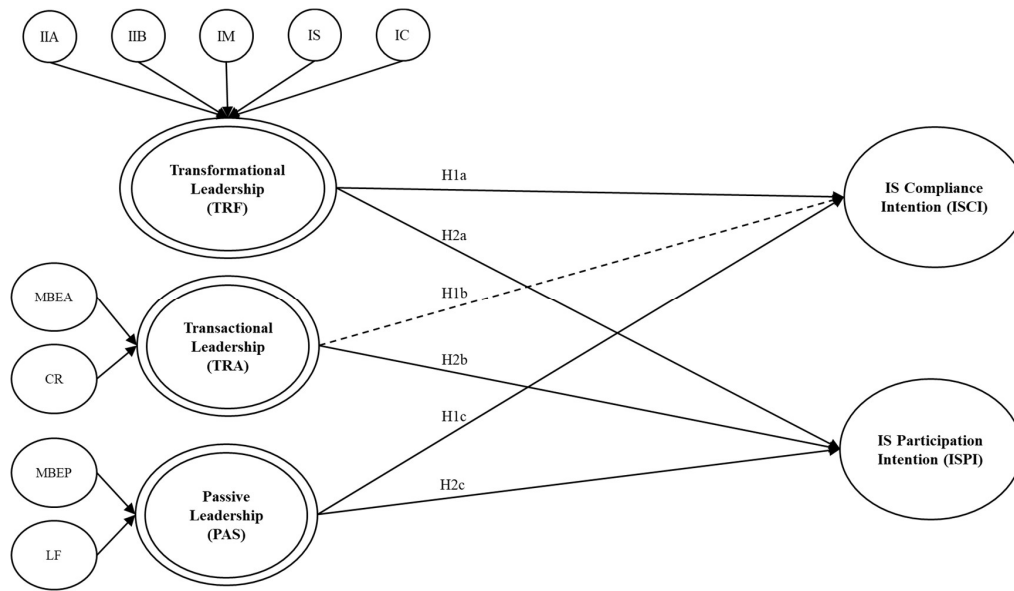
Hypothesis development:

Transformational leaders encourage team collaboration and motivate team members to look beyond their own interests (avoiding IS guidelines for convenience, for example), focusing on those interests that benefit the group (Bass & Avolio, 1994; Burns, 1978; Jung & Sosik, 2002). In addition, a relationship of trust is established (Stewart, 2006), where the leader and the team share the same purpose and the team members tend to act according to the leader's example (Bass et al., 2003, 1987; Dong et al., 2016).

It is also verified that the IS participation intention demands a greater voluntary element (Clarke & Ward, 2006) and the transformational leaders develop their followers so that they reach a higher potential, that is, they motivate the team to do more than initially intended (Bass & Avolio, 1994; Bass et al., 1987; Ng, 2017).

Thus, it is expected that the transformational leader transmits to employees the value and relevance of complying with IS policies, generating high team commitment towards IS, and that this leader's behavior positively influences employees' IS compliance and participation intentions.

Based on this argument, the following hypotheses are proposed:

Hypothesis H1a: The transformational leader's behavior is positively associated with the employees' IS compliance intention.

Hypothesis H2a: The transformational leader's behavior is positively associated with the employees' IS participation intention.

Transactional leaders reward or discipline those led based on the result of the tasks performed (Avolio & Bass, 2004; Bass & Avolio, 1994; Bass et al., 1987; Bono & Judge, 2004; Podsakoff, Bommer, Podsakoff, & MacKenzie, 2006) and there are research that shows that formal measures of reward and punishment directly or indirectly influence the compliance intention with IS (Bulgurcu et al., 2010; D'Arcy, Hovav, & Galletta, 2009; Liang, Xue, & Wu, 2013). Thus, the behavior of transactional leaders should positively influence employees' compliance and participation intentions, as these leaders reward behaviors related to IS compliance and actions that exceed what is formally defined as part of the job.

Based on this argument, the following hypotheses are proposed:

Hypothesis H1b: The transactional leader's behavior is positively associated with the employees' IS compliance intention.

Hypothesis H2b: The transactional leader's behavior is positively associated with the employees' IS participation intention.

Passive leaders tend to react only when problems worsen to take necessary corrective actions and can avoid taking responsibility and making any decisions (Avolio & Bass, 2004; Bass & Avolio, 1994; Bass et al., 1987; Stewart, 2006), overloading the team members with decision-making responsibilities on which IS measures are appropriate for each situation. In addition, the learning of those led by eventual errors and deviations in IS compliance can be difficult, since passive leaders also avoid defining agreements, establishing expectations, goals and standards to be reached by those led (Bass et al., 2003; Sadeghi & Pihie, 2012) and are indifferent to the needs of the team (Sadeghi & Pihie, 2012). Therefore, the behavior of passive leaders should not positively influence employees' IS compliance and participation intentions.

Based on these arguments, the following hypothesis is proposed:

Hypothesis H1c: The passive leader's behavior is not positively associated with the employees' IS compliance intention.

Hypothesis H2c: The passive leader's behavior is not positively associated with the employees' IS participation intention.

Control variables:

Some characteristics of the individuals (including sociodemographic) were included in the model as control variables and linked to the dependent variables, to investigate their moderating effect, that is, to identify possible differences in the structural paths of the model based on these characteristics. The following are the control variables and the rationale for their inclusion in the model:

•   Age (AGE): as it is known that age can influence individuals' behavior intentions towards IS (C. L. Anderson & Agarwal, 2010) and the relationship between the behavior of the transformational leader and the performance of the subordinate (Kearney, 2008), this study considers the age of employees as a control variable. Thus, it is expected that the digital native generations will present different results in the research in comparison with the non-digital native generations, because, unlike the others, the digital native generations are used to the use of technology in different contexts (Vodanovich, Sundaram, & Myers, 2010);

•   Gender (GEN) and Education level (EDU): this study also analyzes gender and education level as control variables, considering that previous research has shown that these characteristics of individuals can influence the behavioral intentions related to IS (C. L. Anderson & Agarwal, 2010; Herath & Rao, 2009a, 2009b). It is expected, then, that the results will present differences between groups of different genders and levels of education, with emphasis on the comparison of individuals who have undergraduate and those with graduate degrees;

•   Work experience (EXP): as previous surveys identified positive influence of the employees' work experience in their intentions for IS-related behaviors, as well as in their awareness of IS (Bulgurcu, Cavusoglu, & Benbasat, 2009; Humaidi & Balakrishnan, 2015b), this study considers the employees' work experience as a control variable. Thus, it is expected that the results demonstrate differences in the structural paths between individuals with low and high work experience;

•   IT knowledge (KIT): this study also included employees' IT knowledge as a control variable, as previous research showed that employees' IT knowledge can positively influence IS

compliance (Son, 2011). Thus, it is expected that the results show differences between individuals with little and advanced IT knowledge.

Methods

The items of the data collection instrument (questionnaire) related to the dependent variables (ISCI and ISPI) were based on previous research (Guhr et al., 2019), with the necessary adaptations to the new context. For that, these items referring to the intentions of compliance and participation in the SI were translated into Portuguese and translated back for validation. However, as some concerns be generated in the respondent when asked directly (self-reported) about a situation of compliance or non-compliance with norms/policies, an intrusive / intimidating perception may occur and the answers may not reflect their real intention or behavior (Boss et al., 2015; D'Arcy et al., 2009; Moody et al., 2018; Siponen & Vance, 2010). Thus, the IS compliance intention construct (ISCI) was adapted, using scenario-based technique, to capture the individuals' real intention to behave and without generating any concern or intrusive perception (Moody et al., 2018).

As the scenarios reflect specific contexts, it was decided to use three scenarios to increase the generalization of the study. From the scenarios developed by Siponen & Vance (2010), who interviewed 54 IS managers, a recent survey selected and validated the three most relevant scenarios (Moody et al., 2018). Thus, these three scenarios used in those surveys (Moody et al., 2018; Siponen & Vance, 2010) were used, which were translated into Portuguese.

Regarding the items of the leadership styles, following the recommendations of the FRLT (Avolio & Bass, 2004), the Multifactor Leadership Questionnaire (MLQ) 5X-Short (rater form) was used without changes.

After being translated, the questionnaire was sent for validation by two specialists in behavioral IS, with experience in IS in the corporate environment and academic training in the area.

In addition, following recommendations in the literature (Malhotra, 2019), a pre-test with a small sample was carried out, composed of professional master's students from FGV EAESP and employees of non-managerial positions at a representative bank.

As the variance of the common method is a potential problem in behavioral research and the bias of the collection method is one of the biggest causes of measurement errors (Podsakoff,

MacKenzie, Lee, & Podsakoff, 2003), following procedures recommended by Simmering et al. (2015), a latent variable with four formative indicators (Yoshikuni, Lucas, & Albertin, 2019) was included in the model, unrelated to the other constructs of the model (MLMV - measured latent marker variable).

To measure the MLMV variable, following procedures recommended by Simmering et al. (2015), a seven-point ordinal scale was used: (1) I totally disagree with (7) I totally agree.

The electronic questionnaire was sent to respondents through a social network (LinkedIn) from 07/20/2020 to 08/15/2020, observing the desired profile: employees of non-managerial positions of the three representative Brazilian banks.

The minimum sample size was calculated using the G * Power 3.1.9.6 software, in which the latent constructs ISCI and ISPI were evaluated, which have the same number of predictors (total of three). The evaluation used the following parameters (Hair Jr, Hult, Ringle, & Sarstedt, 2016): statistical power of 80%, significance level of 5% and effect size f^2 of 0.15. The G * Power calculation suggested the minimum sample of 77, but it is recommended to double or triple this value to obtain better results in the analysis (Bido & Da Silva, 2019; Ringle et al., 2014). Thus, 231 was established as the minimum sample size for this research, that is, three times the calculation of the G*Power.

From the collection carried out through an electronic questionnaire, 517 valid responses were obtained (after application of the quality control criteria), a sample consistent with the minimum size calculated.

Results

The presentation of results is divided into two stages: the evaluation of the measurement model and the evaluation of the structural model (Hair Jr et al., 2016). Also presented are the results of checking the bias of the common collection method (MLMV) and analyzing the moderating effect of the control variables.

To assess the measurement model (reflective constructs), the following procedures were performed: validation of internal consistency (composite reliability), convergent validity (reliability of indicators) and discriminant (cross-loads, Fornell and Larcker and HTMT) (Bido & Da Silva, 2019; Hair Jr et al., 2016; Ringle et al., 2014).

The evaluation of the structural model verified: the significance and relevance of the model relationships, the coefficients of determination (R^2), the effect size f^2, the predictive relevance (Q^2) and the effect size q^2 (Hair Jr et al., 2016). As second-order constructs are hierarchical components (HCM - Hierarchical Component Models) of the reflexive-formative type, multicollinearity was also verified (Hair Jr et al., 2016).

Structural coefficients and R^2 values were compared without the MLMV variable and with this variable linked to the dependent variables (ISCI and ISPI). As the differences in the R^2 values of the endogenous ISCI and ISPI constructs are 0.5% and 0.3%, respectively, the presence of variance from the common method was not identified and the MLMV variable was removed from the model.

The evaluation of the significance and relevance of the model's relationships was performed through bootstrapping (5,000 repetitions), which demonstrated that only the relationship between the latent constructs TRA and ISCI was not significant.

To facilitate the reading of the significance data of the relationships and the determination coefficients (R^2), Figure 2 was created, which represents the research model updated with these results.

Figure 2: Results
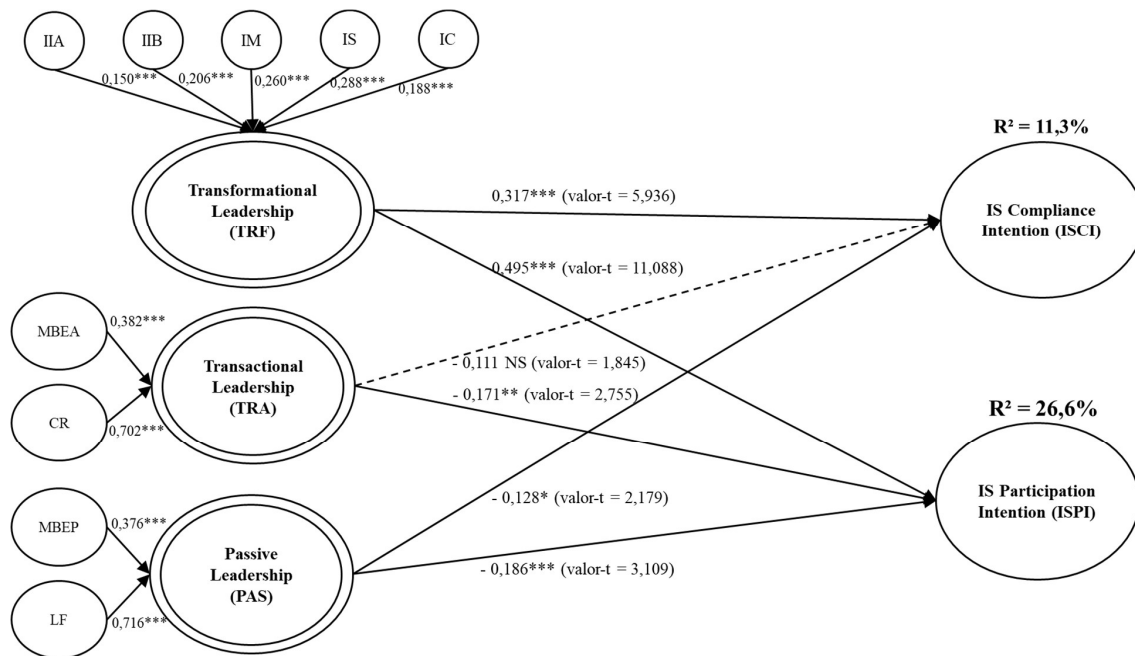
Control variables:

Only the relationships between the control variables "gender (GEN)" and "IT knowledge (KIT)" with the dependent variables were not statistically significant and, therefore, were not considered in the multigroup analysis.

After analyzing the significance of the relationships between the control variables and the dependent variables (ISCI and ISPI), multigroup analysis (PLS-MGA) of the AGE, EDU and EXP variables (parametric analysis, bootstrapping with 5,000 repetitions) was performed.

For the age-related control variable (AGE), two multigroup analyzes were performed. In the first analysis, the groups were considered: (1) respondents who are not digital natives (generation X and baby boomers) and (2) digital natives (generations Y and Z) (Vodanovich et al., 2010). The second analysis considered two digital native groups, corresponding to generations Y and Z, respectively (STEWART et al., 2017).

In the first multigroup analysis regarding the AGE variable, it was found that age (AGE) moderates the relationship between leadership styles and the intention to conform to IS, with a statistically significant difference between groups in the structural path TRF -> ISCI (p-value <0.01), as shown in Table 1.

Table 1: First multigroup analysis (control variable AGE)							
Paths	Group 1 (n = 100): not digital natives		Group 2 (n = 417): digital natives		Group 1 vs Group 2		
	Loadings	Std. error	Loadings	Std. error	$|\beta1 - \beta2|$	t-value	p-value
PAS -> ISCI	-0,281	0,123	-0,111	0,066	0,170	1,154	0,249
PAS -> ISPI	-0,322	0,138	-0,165	0,067	0,157	1,031	0,303
TRA -> ISCI	-0,337	0,164	-0,085	0,064	0,252	1,651	0,099
TRA -> ISPI	-0,157	0,172	-0,174	0,067	0,018	0,110	0,913
TRF -> ISCI	0,687	0,116	0,270	0,055	0,417	3,326	0,001
TRF -> ISPI	0,441	0,118	0,522	0,048	0,081	0,711	0,477

With regard to the second multigroup analysis referring to the AGE variable, the results also showed that age (AGE) moderates the relationship between leadership styles and the IS compliance intention and there is a statistically significant difference between the groups in the structural path TRF - > ISCI (p-value <0.05), as shown in Table 2.

Paths	Group 1 (n = 195): generation Y		Group 2 (n = 222): generation Z		Group 1 vs Group 2		
	Loadings	Std. error	Loadings	Std. error	$\|\beta1 - \beta2\|$	t-value	p-value
PAS -> ISCI	-0,187	0,093	-0,118	0,092	0,069	0,523	0,601
PAS -> ISPI	-0,223	0,096	-0,145	0,087	0,078	0,602	0,547
TRA -> ISCI	-0,149	0,106	-0,036	0,086	0,113	0,837	0,403
TRA -> ISPI	-0,173	0,115	-0,151	0,080	0,023	0,165	0,869
TRF -> ISCI	0,417	0,091	0,180	0,069	0,237	2,113	0,035
TRF -> ISPI	0,490	0,093	0,539	0,062	0,049	0,451	0,653

Table 2: Second multigroup analysis (control variable AGE)

The multigroup analysis of the control variable corresponding to the level of education (EDU) considered the following groups: (1) respondents with an education level up to higher education and (2) respondents with postgraduate studies (specialization, MBA, master's or doctorate). From this analysis, as shown in Table 3, it was found that the level of education (EDU) moderates the relationship between leadership styles and IS compliance and participation intentions, with a statistically significant difference between the groups in the structural paths PAS - > ISCI (p-value <0.05), PAS -> ISPI (p-value <0.01) and TRF -> ISPI (p-value <0.05).

Paths	Group 1 (n = 283): up to higher education	Grupo 2 (n = 234): posgraduate	Group 1 vs Group 2

Table 3: Multigroup analysis (control variable EDU)

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	Loadings	Std. error	Loadings	Std. error	|β1 - β2|	t-value	p-value
PAS -> ISCI	-0,052	0,070	-0,316	0,089	0,265	2,369	0,018
PAS -> ISPI	-0,034	0,079	-0,355	0,081	0,322	2,820	0,005
TRA -> ISCI	-0,060	0,075	-0,153	0,105	0,093	0,739	0,460
TRA -> ISPI	-0,175	0,072	-0,127	0,105	0,048	0,385	0,700
TRF -> ISCI	0,273	0,064	0,380	0,093	0,107	0,980	0,327
TRF -> ISPI	0,591	0,053	0,367	0,081	0,225	2,383	0,018

Finally, the multigroup analysis of the control variable regarding work experience (EXP) was based on the following groups: (1) low work experience (up to five years) and (2) high work experience (over five years). After analysis, the following results were obtained (as shown in Table 4): work experience (EXP) moderates the relationship between leadership styles and IS compliance and participation intentions, showing a statistically significant difference between the groups in the structural paths PAS - > ISPI, TRF -> ISCI and TRF -> ISPI (p-value <0.05).

Table 4: Multigroup analysis (control variable EXP)							
Paths	Group 1 (n = 327): low experience		Group 2 (n = 190): high experience		Group 1 vs Group 2		
	Loadings	Std. error	Loadings	Std. error	|β1 - β2|	t-value	p-value
PAS -> ISCI	-0,080	0,074	-0,229	0,092	0,149	1,254	0,210
PAS -> ISPI	-0,093	0,077	-0,334	0,087	0,241	1,998	0,046
TRA -> ISCI	-0,099	0,074	-0,162	0,114	0,063	0,487	0,627
TRA -> ISPI	-0,232	0,071	0,025	0,120	0,256	1,961	0,050
TRF -> ISCI	0,251	0,060	0,510	0,100	0,259	2,366	0,018
TRF -> ISPI	0,558	0,053	0,324	0,088	0,234	2,433	0,015

Discussion and Conclusions

Research model and hypotheses:

The research objectives were achieved, as the influence of transformational, transactional and passive leadership styles (according to the FRLT) on employees' IS compliance and participation intentions, in the specific context of Brazilian banks, was analyzed and the effect was analyzed moderator of control variables.

The H1a hypothesis was strongly supported ($\beta = 0.317$; t-value = 5.936; p-value <0.001) and the results showed that the behavior of the transformational leader has a positive and statistically significant influence on the employees' IS compliance intention and that the transformational style is the biggest predictor of the ISCI construct. Thus, the results showed that the transformational leader transmits to employees the value and relevance of complying with IS policies, generating high employee commitment in relation to IS, corroborating with previous research (Guhr et al., 2019) and contributing with the extension of the behavioral IS literature, demonstrating that the development of transformational leadership is relevant for increasing the compliance of those being led with the IS. Additionally, this study brings a new contribution to the behavioral IS literature, by applying the research model to a new context (Brazilian banks).

The H2a hypothesis was also strongly supported ($\beta = 0.495$; t-value = 11.088; p-value <0.001) and the results showed that the behavior of the transformational leader has a positive and statistically significant influence on employees' IS participation intention; in addition, it was found that transformational leadership is the greatest predictor of the ISPI construct. So, it was demonstrated that the behavior of transformational leaders positively influences the employees' IS participation intention, so that their actions exceed what is formally defined as part of the work, reinforcing previous research (Guhr et al., 2019; Lebek, Guhr, & Breitner, 2014), contributing to the extension of the behavioral IS literature and demonstrating that the development of transformational leadership is relevant for increasing the participation of those being led in the IS. The results also bring a new contribution to the behavioral IS literature, through the development of research in the context of Brazilian banks.

However, the results of this study did not support the H1b hypothesis and the relationship between the transactional leadership style and IS compliance intention was not statistically

significant. Some research argues that formal measures of punishment and reward (characteristics similar to the behavior of the transactional leader) can positively influence the fulfillment of IS policies (Bulgurcu et al., 2010; D'Arcy et al., 2009; Liang et al., 2013). However, in the academic literature, there are different approaches and results for the influence of these formal measures on the behavior of employees in relation to IS and there is still no definitive solution to this gap (D'Arcy & Herath, 2011).

In addition, previous research shows that there is no direct influence of these formal measures on IS compliance intention, while other factors can directly influence it, such as: social disapproval, self-disapproval and the ability to perform the tasks provided for in the IS regulations (Chen, Wu, Chen, & Teng, 2018). Even so, the results of this study contribute to the extension of the IS behavioral literature, since they corroborate with previous research (Chen et al., 2018; Guhr et al., 2019) and there is a new contribution: it was found that there is no direct influence of the behavior of the transactional leader in employees' IS compliance intention, in the specific context of Brazilian banks.

Regarding the H2b hypothesis, the results were statistically significant (β = -0.171; t-value = 2.755; p-value <0.01), but they did not support the hypothesis: contrary to what was proposed, the behavior of the transactional leader had negative influence on employees' IS participation intention. As mentioned earlier, there are different approaches in the literature for the influence of formal measures of punishment and reward on the behavior of employees in relation to IS and there is still no definitive solution to this gap (D'Arcy & Herath, 2011). In addition, previous research has analyzed different mediators and moderators in the relationship between these formal measures (reward and punishment) and employees' organizational citizenship behavior (Tremblay & Gibson, 2016; Walumbwa, Wu, & Orwa, 2008), as well as there is research that demonstrates that these formal measures have no direct positive influence on this behavior (Dartey-Baah, Quartey, & Adotey, 2020). In this way, the results contribute to a new approach to the behavioral IS literature, specifically for the context of Brazilian banks.

Regarding passive leadership, hypothesis H1c was supported (β = -0.128; t-value = 2.179; p-value <0.05) and the results showed that the behavior of the passive leader has a negative and statistically significant influence on the intention to employee compliance with SI. Through these results, this study contributes to the extension of the behavioral IS literature, reinforcing previous research (Buch, Martinsen, & Kuvaas, 2015; Kelloway, Mullen, & Francis, 2006). Additionally,

there are new contributions to the behavioral IS literature: (i) development of research in the specific context of Brazilian banks; and (ii) the results showed a negative relationship between the PAS and ISCI constructs, which was not statistically significant in the research by Guhr, Lebek & Breitner (2019), this gap being addressed in this study.

Still in relation to passive leadership, hypothesis H2c was strongly supported (β = -0.186; t-value = 3.109; p-value <0.001) and the results showed that the behavior of the passive leader has a negative and statistically significant influence on employees' IS participation intention. Thus, the results corroborate with previous research (Buch et al., 2015; Kelloway et al., 2006) and contribute to the extension of the behavioral IS literature. Just as for the H1c hypothesis, there are new contributions to the academic literature of behavioral IS: research developed in a new context and the relationship between the PAS and ISPI constructs was statistically significant, addressing the gap of another study (Guhr et al., 2019).

Control variables moderating effect:

The results of the first multigroup analysis of the AGE variable showed a statistically significant difference (p-value <0.01) between the groups in the structural path of the TRF and ISCI constructs, that is, the influence of the behavior of the transformational leader on the employees' IS compliance intention is higher in generations that are not digital natives (generation X and baby boomers). Regarding the second multigroup analysis of the AGE variable, the results also showed a statistically significant difference (p-value <0.05) between the groups in the structural path of the TRF and ISCI constructs: the influence of the behavior of the transformational leader on the employees' IS compliance intention is greater in Generation Y than in Generation Z. Thus, age has been shown to moderate the relationship between the behavior of the transformational leader and the employees' IS compliance intention, which contributes to the extension of the literature of behavioral IS, reinforcing previous research (C. L. Anderson & Agarwal, 2010; Guhr et al., 2019). In addition, there are new contributions to the behavioral IS literature: research in the context of Brazilian banks and comparative analysis between generations Y and Z, both digital natives.

For the control variable referring to education level (EDU), the multigroup analysis considered in a group the respondents who have even higher education and, in the second group, the

respondents with graduate degrees. The results showed that there is a moderation in the level of education of employees in the following structural paths: PAS -> ISCI (p-value <0.05), PAS -> ISPI (p-value <0.01) and TRF -> ISPI (p-value <0.05). For passive leadership, the relationship with the dependent variables (ISCI and ISPI) was even more negative in the group with graduate degrees; however, for transformational leadership, the relationship with the ISPI variable was greater in the group that has even higher education. Thus, this study contributes to the extension of the behavioral IS literature and reinforces previous research, which showed that the level of education of individuals can influence their behavior intentions related to IS (C. L. Anderson & Agarwal, 2010; Herath & Rao, 2009a, 2009b). There is also a new contribution to the behavioral IS literature, by complementing the model by Guhr, Lebek & Breitner (2019) and by including the level of education of employees as a moderator.

In the multigroup analysis of the control variable regarding work experience (EXP), groups with low work experience (up to five years) and with high work experience (over five years) were considered (Humaidi & Balakrishnan, 2015b). The results showed that work experience moderates the following structural paths (p-value <0.05): PAS -> ISPI, TRF -> ISCI and TRF -> ISPI. Thus, for the group with greater work experience, the relationship between the PAS and ISPI constructs was even more negative and the relationship between the TRF and ISCI constructs was stronger. For the group with less work experience, the relationship between the TRF and ISPI constructs proved to be superior.

In this way, the results contribute to the extension of the literature on behavioral IS and corroborate with previous research, with regard to the influence of work experience on the behavior intentions related to IS (Bulgurcu et al., 2009; Humaidi & Balakrishnan, 2015b). In addition, this study brings a new contribution to the behavioral IS literature, by complementing the model by Guhr, Lebek & Breitner (2019) and by including the moderating effect of the employees' work experience.

Final considerations and practical implications:

In this study, there is also a new methodological contribution to the measurement model: the ISCI construct was improved and measured using a scenario-based technique. In the study by Guhr, Lebek & Breitner (2019), respondents were directly questioned (self-reported items) about

compliance or non-compliance with rules/policies and an intrusive/intimidating perception may have occurred, with a consequent impact on responses, with regard to the real behavior intention (Boss et al., 2015; D'Arcy et al., 2009; Moody et al., 2018; Siponen & Vance, 2010). Thus, to capture the real intention of the individuals' behavior, without generating any concern or intrusive perception in the respondents, this study measured the ISCI construct through the scenario-based technique (Moody et al., 2018).

Based on the results presented, this study concludes that the transformational leader's behavior positively influences both employees' IS compliance and participation intentions. In addition, unlike transformational leadership, the passive leader's behavior negatively influences employees' IS compliance and participation intentions.

The results did not show any influence of the control variables of gender and IT knowledge in the ISCI and ISPI constructs. However, for the other control variables (age, education level and work experience), it was concluded that there is a moderating effect of these control variables on the relationships between leadership styles and employees' IS compliance and participation intetions.

Thus, in addition to the extension of the behavioral IS literature, this study has new theoretical and methodological contributions: (i) two research gaps were addressed by Guhr, Lebek & Breitner (2019), when developing the research in a new context and including new moderators; (ii) the construct referring to IS compliance intention was adapted using the scenario-based technique and the measurement model was improved; (iii) it has been demonstrated that passive leadership negatively influences employees' IS compliance and participation intentions; (iv) the questionnaire was improved by using additional quality control criteria; (v) the structural model was improved by checking the common collection method for bias (MLMV variable); and (vi) specific analyzes have been suggested in future research, based on the findings of this study.

The results of this study demonstrated the influence of leadership styles (according to the FRLT) on employees' IS compliance and participation intentions, in the specific context of Brazilian banks. From these results, it was found that transformational leadership has a positive influence on employees' behavior intentions towards IS (compliance and participation). As for passive leadership, the influence on these behavioral intentions is negative.

Thus, for the followers to develop the appropriate behavior in relation to the IS, with a consequent increase in the levels of organizational IS and protection of information assets, it is

recommended the development of transformational leadership. In addition, it is recommended that behaviors related to passive leadership be avoided, given their negative impact on organizational IS.

It is also important to note that some factors moderate the relationship between the leadership styles and employees' IS compliance and participation intentions: age, education level and work experience.

Thus, the results of this study contribute to the management of IS in Brazilian banks, adding greater efficiency to corporate actions aimed at improving IS and mitigating risks, with a consequent strengthening of organizational IS and reducing losses resulting from cyber-attacks.

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Decision Making: Public Administration and Policy

MONTE CARLO SIMULATION TO ESTIMATE PROBABILITY DISTRIBUTIONS OF PARTY REPRESENTATION IN POLITICAL REDISTRICTING

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Abstract

Each ten years states create legislative districts for representation in their federal and state legislatures. In this paper we present a Monte Carlo technique that can be used to determine the probability that a set of districts have been drawn without partisan bias – gerrymandered. From this it will be possible to test the hypothesis that a particular redistricting plan does not unfairly disenfranchise voters of that state.

KEYWORDS: Gerrymandering, Redistricting, Monte Carlo, Simulation, Probability

Introduction

The constitution of the United States requires that the federal government conduct a decennial census. The primary purpose of this census is apportionment; using the current population data to create state and federal legislative districts. The population data from the data determines the number of districts in each state. The state then has the responsibility of creating the districts. The only constitutional constraint is that each district have approximately equal populations.(*United States Constitution, Article I, Section 2*, 1787)

Each state determines their own process for redistricting. Questions will often arise when the process is controlled by a single party. In the Commonwealth of Pennsylvania, for example, a redistricting commission is created. This five member commission consists of four people selected two each from the Republican and Democratic caucuses. A single fifth member is then selected by both parties together. If they cannot decide on this fifth person, and history has shown that they will not, the Supreme Court of Pennsylvania appoints a person(*Constitution of the Commonwealth*

of Pennsylvania, Article II, Section 17, 1968). The Supreme Court has normally selected a representative of the party that has the majority on the court. As a final step, any maps created must be approved by the current governor of the Commonwealth. While the process is always partisan, since the majority of the Supreme Court will always be from one of the parties, the process has famously been one sided.

It is this partisan nature of redistricting that has resulted in gerrymandering; a process going back over 200 years in which the districts are drawn to favor the party who controls the process. This approach to redistricting became known as gerrymandering despite the fact that Elbridge Gerry, Governor of Massachusetts in 1812 from whom it is named was opposed to the district map that was created and approved(Spann, 2020).

Gerrymandering is not new; in fact it has been common since the nineteenth century. Until recently it was limited by the time consuming nature of the process. But modern computers have made it possible to create districts in which one party has such complete control that it has eliminated any interparty competition(Kang, 2020). Many of the issues with today's political climate have been attributed to this gerrymandering. The theory is that if the district has no possibility of competition from the outside – another party – then the competition becomes internal. In this case any challenge to the incumbent will be in the primary election by a member of their own party. It is well documented that since voters in primaries tend to the extreme of their party's ideology, the threat of being primaried will often push candidates to these more extremes.

While there has been a push over the past ten or so years to eliminate the partisan redistricting in favor of a non-partisan committee to draw the maps, in most states the change has not been implemented. Instead, most states continue to have elected representatives from the political parties to create the districts.

This is not to say it has not had legal challenges. On the state level, the Supreme Court of Pennsylvania ruled that Congressional maps drawn in 2012 disenfranchised voters by not having their votes count equally. They ordered the legislature to redraw the maps for the 2018 election(*League of Women Voters of Pennsylvania, et. al. v. Commonwealth of Pennsylvania et. al.*, 2018).

At the federal level the Supreme Court of the United States did not take the same course. Instead, while ruling that the individual states have the right to create biased districts, they also stated that there is not a standard or mandated method to test if the districts were indeed unfair. In this case, the Robert's court stated

> "determining when political gerrymandering has gone too far"–cannot be grounded in a "limited and precise rationale" because the issue "lacks judicially discoverable and manageable standards for resolving." (Rucho et. al. v. Common Cause et. al., 2019)

The legal aspects are best left to attorneys and legislators. But the issue of manageable standards

may be more addressable.

The issue of the probability of a particular outcome has recently become a topic of research. In a recent paper an attempt is made to evaluate the degree of partisanship that results from the hyper-partisan redistricting(Burden & Smidt, 2020). In this paper the authors have used the simulation techniques to estimate the probability distribution of a known set of district maps.

It is hypothesized that if a probability distribution of the expected party representation in the districts were known, then an interval estimate can be made as to what a fair district map might be. In this case we would define fair as one that is likely – within some probability p to occur if the districts had been assigned randomly. This has been attempted using Markov Chains(Barkstrom, Dalvi, & Wolfram, 2018). In this model the authors created random districts then calculated an estimate election outcome. Their hypothesis is that if the probability of attaining a mix that is the same as the actual legislative model is small then the process must be a result of partisan gerrymandering. In their model they create the districts using Markov Chains.

We aim to take a different approach. Since the precincts in a state can be modeled as nodes of a graph, and the districts formed from those nodes are trees, a set of random districts can be formed by creating k connected trees from the graph. Once the formed the precinct level election results can be used to form an expected outcome of the districts with respect to an actual state or national election. By repeating this random district creating thousands of times a probability distribution for each possible election result can be estimate. This bootstrapping technique creates the interval estimation of this party representation. With the expected distribution of party representation a probability that the actual representation could have occurred without partisan interference can be predicted.

Methodology

There are two parts to the development of the interval estimate of party representation: the network graph and a set of N trees formed from the graph, and the estimation of the probability distribution. The probability distribution will be estimated using a Monte Carlo technique known as bootstrapping. The development of the N trees will be the application to which the bootstrapping will be applied.

Bootstrapping is a simulation technique in which you generate random values that represent the outcome of a process(Murphy, 2012). With each iteration the outcome is recorded. By repeating the random number generation thousands or even millions of times, the frequency distribution of each outcome can be estimated. This relative frequency will be an estimate of the probability of that outcome.

For the bootstrapping, the random variable, **X**, will be a tuple representing the number of repre-

sentatives of each party. The sum of the two values will always be equal to the number of districts. Thus, if there are N districts then the sum of each value in X_k will equal N.

$$X_k = (x_{k1}, x_{k2}) \tag{1}$$

$$N = x_{k1} + x_{k2} \tag{2}$$

This creates a probability distribution with the random variables

$$X = \{(0, N), (1, N-1), \cdots, (N, 0)\} \tag{3}$$

Each outcome will have a probability estimated by the bootstrapping. This involves generating random numbers to determine the outcome – in this case the number of representatives from each party. For each outcome a frequency is generated by the simple matter of counting the number of times each outcome occurs. The probability is then estimated as the relative frequency,

$$P(X_k = (x_{k1}, x_{k2})) = \frac{f_k}{n} \tag{4}$$

where n is the number of times that the simulation is run. The individual outcomes will be generated by creating random trees from a network graph that describes the state.

In this model, each voting district, heretofore a precinct, will be represented by a node on the graph. By creating an adjacency list of the nodes, random trees will be created. Each tree will represent a possible legislative district. The number of trees will thus be equal to the number of legislative districts, in this case N. As this is a simulation to determine the probability of a particular outcome tree, there will be no assumption that the trees are anything other than that they are connected. They will not be, nor are they intended to be, minimum cost trees(Wayne & Sedgewick, 2011).

Beginning with the unconnected graph where each node is a precinct, we will begin connecting them into a tree to form a district. Since the decision to stop adding nodes to the graph is determined by a preset population value, an accumulator for the population is set to zero. Then a currently un-connected node will be chosen at random and its population is added to the accumulator. Using the nodes in its current adjacency list, a second node is randomly selected, and a third and fourth until the tree is complete. Each time the population of the additional precinct is added to the accumulator. The process is repeated until a maximum population threshold is reached.

Once the first district – the first tree – is created, the process will be repeated starting with another, currently unconnected, node. This tree creation will be repeated until N districts have been formed.

The N trees create the legislative districts, but the goal is the probability distribution of the political party representation. After each district is created, we will use a vote total for each candidate from all of the precincts to determine the district's winning party by popular vote. Once all districts are constructed, we will record the number of Republican districts and number of democratic districts in the region. This will be a single outcome for the probability distribution.

Each time that the party representation is calculated the accumulator for that outcome is incremented. By repeating this process n times the discrete probability distribution of the party representations will be estimated.

This probability distribution can now be used to predict the probability that the current arrangement could happen by random assignment. If this probability is small, then a statistical argument can be made that the hypothesis of no bias is invalid and should be rejected. This could be done for both the federal districts, state districts, state senate districts, or any state. To test the algorithm, a data file will be created of random precincts. Each precinct will have an ID, a population, an adjacency list of its surrounding precincts, the number of Republican votes and the number of Democratic votes.

The inputs to the model are the maximum regional population size m, the desired number of districts N, and the desired number of runs in the simulation, n. Throughout each run, the program maintains an adjacency list for all of the unconnected precincts. Note that by definition, two precincts are adjacent if they have at least one vertex in common. As precincts are added to districts in a run, they are removed from the adjacency list. The adjacency list is reset at the beginning of each run.

A tree object represents each tree (district). The object contains the following attributes, which are each dynamically modified throughout the district construction process:

- nodes: a list of precincts included in the district

- choices: a list of precincts outside of the district that are adjacent to at least one precinct within the district. This yields possible choices for selecting a new precinct to add to the district.

- population: the total population of the district

- r_k: the total number of Republican votes in district k

- d_k: the total number of Democrat votes in district k

As the outcomes $X_k = (x_{k1}, x_{k2})$ are updated throughout the simulation, the program maintains a list d of length $n + 1$. The value at index i of the list, $d_k[i]$, is the number of times that a region has i Democratic district wins in the run. Once a region is created and the winning party of each

district decided, the $d_k[i]$ list is updated accordingly – if the region has i predominantly Democratic districts, then $d_k[i]$ is increased by one. At this point, the adjacency list is reset to contain all precincts again; new regions are created and processed according to the procedures outlined above until the script reaches the specified number of runs.

Once all of the regions have been constructed, the program generates a probability distribution from the information stored in the d list. The first two columns correspond respectively to the number of Democratic districts and number of Republican districts that could occur in a run. The third column reports the frequency - that is, the number of times that the arrangement defined in the first two columns occurs (notice that the frequency for row i simply corresponds to $d_{\mathrm{wins}}[i]$). The fourth column converts this frequency to a probability, dividing by the number of runs.

Table 1: Structure of table generated by script that displays probability distribution

Democrats	Republicans	Frequency	Probability
0	N	d_{k1}	d_{k1}/n
1	$N-1$	d_{k2}	d_{k2}/n
$\vdots$	$\vdots$	$\vdots$	$\vdots$
n	0	d_{kN}	d_{kN}/n

Results

We ran the simulation on a set of sample precinct data for the geographic district modeled by the network given below.
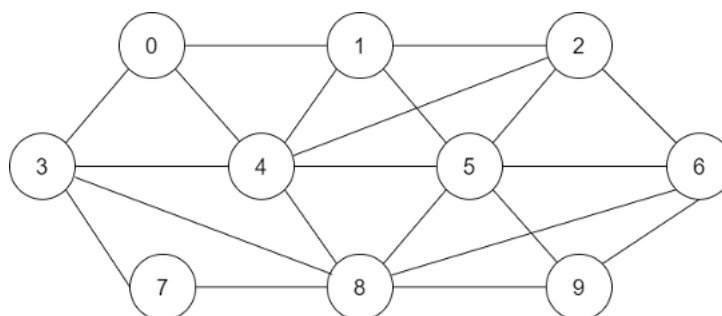
Figure 1: A network representation for a district

In this example, the population for a precinct is uniformly distributed between 500 and 1500. The number of Republican votes is uniformly distributed between 25% to 75% of the corresponding

Table 2: Data for the evaluated region

ID	Population	Adjacencies	Republican	Democratic
0	1411	$\{1, 3, 4\}$	656	755
1	971	$\{0, 2, 4, 5\}$	541	430
2	1163	$\{1, 4, 5, 6\}$	319	844
3	744	$\{0, 4, 7, 8\}$	397	347
4	760	$\{0, 1, 2, 3, 5, 8\}$	276	484
5	625	$\{1, 2, 4, 6, 8, 9\}$	216	409
6	1329	$\{2, 5, 8, 9\}$	975	354
7	1006	$\{3, 8\}$	592	414
8	1379	$\{3, 4, 5, 6, 7, 9\}$	897	482
9	1073	$\{5, 6, 8\}$	537	536

precinct's population, and the remainder of the precinct's population is accounted for by the other party. The data set for the region is

We ran the simulation on this data set with a maximum population size of 10,000, 3 districts per region, and 10,000 total runs. The probability distribution generated by the simulation for the data set was:

Table 3: Probability distribution generated for the given geographic district

Democrats	Republicans	Frequency	Probability
0	3	1074	0.1074
1	2	6117	0.6117
2	1	2762	0.2762
3	0	47	0.0047

Of all of the ten precincts in the example given above, four of them have a democratic majority. The expected number of Democratic wins is 1.1782, while the expected value of Republican wins is 1.8218. The most likely outcome is 1 Democrat and 2 Republicans; the least likely outcome is 3 Democrats and 0 Republicans.

The original question posed by the Supreme Court opinion was whether it can be shown that the redistricting was biased. From a statistical approach bias would be determined by whether or not it would be reasonable to accept that the districting results would be expected to happen. Using a critical value of 5% we can expect the three Democratic representatives to happen less than 5% of the time. As such we would reject a hypothesis that a three Democrat, zero Republican redistricting was not gerrymandered to provide partisan favoritism.
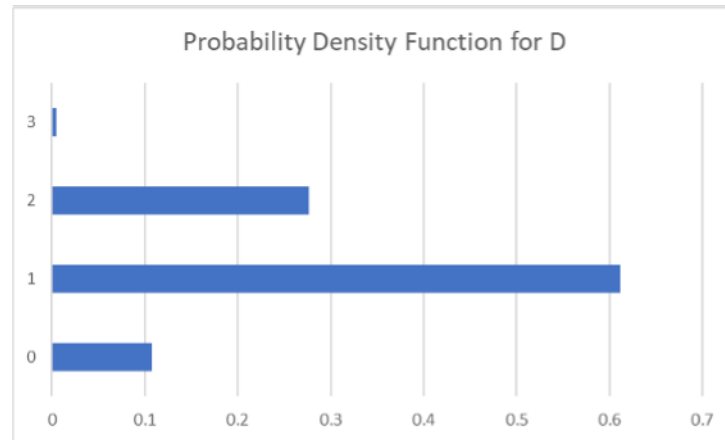
Figure 2: Probability density function for D

Conclusions

In the case of an election in the provided region, it is most likely that a Republican candidate would win the region. In particular, it is very unlikely that all three regions would be dominated by the Democratic party.

We are currently in the process of setting up and conducting the simulation on historical data for Pennsylvania. We began the process by writing a Python script that reads in shapefiles containing data for each of Pennsylvania's precincts. The resulting data set contained data for 9253 precincts, each with an id, name, population, and adjacency list. After obtaining voting data for each precinct, we will perform the same simulation but now with eighteen districts per run.

The distribution generated by the simulation will then be used to determine the probability of an associated historical outcome occurring. If historical records reveal an outcome that is unlikely by random assignment according to the distribution, we would reject the hypothesis of no partisan gerrymandering and conclude that there is statistically significant evidence that the historical election's district map is unfair.

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CHANGES IN POLICE ORGANIZATIONS

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Abstract

This paper looks at the history of law enforcement in the United States. It has been suggested by some that police departments have not changed since the establishment of modern policing. In modern policing there have been three eras identified: the political era, the reform era, and the community policing era. The three eras would indicate that there have been changes, but that does not mean that substantial changes were made. To identify what changed within law enforcement agencies that sparked the identification of a new era requires an in-depth analysis of departments. Since the changes happened so far in the past, this paper took an in-depth look at the available literature pertaining to the different eras and the lessons that can be used to address the current call for police reforms.

Keywords: Police, History, Changes, Modern Policing, Law Enforcement

Introduction

In 2020 the future of law enforcement in the United States has been at the forefront of national debate. The conversation is not a new one though; throughout the history of law enforcement in the US, there have been supporters, detractors, and reformers. For the past few years the detractors have been making many allegations against law enforcement; some of the arguments have merit while other are quickly shown to be lacking. This research paper takes a look at one particular complaint. It has been suggested that police departments in the US have not changed since the establishment of the modern policing model. Without first studying the history of law enforcement in the United States a definitive response to the allegation cannot be made. This paper seeks to determine if there have been changes to modern policing in the United States in the nearly 200 years since its inception.

Modern policing in the United States is modeled after the military both in rank and structure (Vickers, 2002). Throughout the different eras of policing the basic configuration of departments has not changed, leaving the quasi-military structure in place. Major changes in organizational structure is a quick way to identify if any modifications have been made in an organization; when major changes to structure are not made, it becomes harder to identify what has been altered. To identify what changed within law enforcement agencies that sparked the identification of a new era requires an in-depth analysis of departments. Since the changes happened so far in the past, this paper takes an in-depth look at the available literature pertaining to the different eras. The researcher also draws upon professional experience of working as a civilian member of a police department for knowledge about law enforcement practices as it pertains to different aspects of policing.

While law enforcement agencies are resistant to change, there have been at least three historical instances of change (Marks & Sun, 2007). According to the books and articles written on the history of policing in the United States, there are three eras of modern policing: the political era, the reform era, and the community policing era. The fact that there are three different eras of policing would suggest that, in fact, there have been changes since the creation of modern policing. However, just because there have been three eras in policing, it does not necessarily mean that there have been major changes to the organizations and how the job is performed. To better determine if the argument that police organizations have not changed does not hold, there must be a comprehensive look at the different eras. An in-depth look at the

different eras of policing will help to attribute the eras to significant changes to improve the services rendered to the public, or as symbolic changes to appease those pushing for reform.

Each of the three eras was born out of a cry from the public for change. First it was a new country fighting to survive which led to the creation of modern policing that would later come to be known as the political era (Walker, 1942). When the citizens found that they were not receiving the services they required from law enforcement they pushed for a change; this led to the reform era that sought to rectify the errors of the political era (Gultekin, 2014). While the new era worked to correct the missteps of the previous era, it still left much to be desired. In an attempt to reconnect with the communities that they served, police departments worked to make changes yet again, leading to a third era of policing (Maguire, 1997). According to the literature on the three eras of policing, we are currently in the third era, known as the community policing era. While there are only three recognized eras of policing, some have suggested that law enforcement has actually transitioned into a fourth era (Hooper, 2014; Marks & Sun, 2007). Only time and study of the changes will tell if a new era of policing has occurred.

Statement of the Problem

The history of law enforcement in the United States is not a well-known by the public, and even within police organizations. Before the public, and even law enforcement, can be told definitively that there have been changes within law enforcement, the history of the organization must be studied. Since the late 19th century literature has been produced about the nature of policing in the United States. However, it was not until the mid- 20th century when writing on the subject became more common. This history that was put together to evaluate the current climate in policing and also as a way to show where policing was headed. This process should be repeated often to make sure that the current organizations are not repeating the mistakes of the past. It is also important that the general public is made aware of the types of changes that have been made within policing as a way to show that the organization strives to provide the community with comprehensive service.

Research Question and Method of Inquiry

The inquiry and review for this study was based on the following research question: What can we learn from the history of modern policing to inform the current call for police reforms?

In addressing this question, the study followed an integrated literature review approach in an attempt at moving beyond merely summarizing the literature but substantially contributing

new and valuable knowledge of police reforms. The literature search covered a broad range of academic databases (e.g. EBSCO Host) to identify the different eras of reforms within modern policing.

Predecessor to Modern Policing

The term modern policing is used often when referring to the current style of policing in the United State. Such a term implies that there was a system of policing in place before the current standard that is used. The start of modern policing is marked by the creation of a system of law enforcement; the design of the new system was the employment of full-time officers in a stable agency that would patrol specific areas as a way to prevent crime (Walker, 1942). This new system was born out of "the older system of the night watch" (Walker, 1942, p. 3). The night watch was a reactive force that was rooted in colonial America and Britain, and it "was a weak reed at best in the face of mob violence" (Walker, 1942, p. 4).

The new system of policing was created as a way to curb the violence and disorder that was extremely prevalent in the new republic (Walker, 1942). By the mid-1830's many feared that if something was not done to bring order to the young country, the United States would not survive (Walker, 1942). This cry for order and security led to the creation of the first departments of modern law enforcement in the United States. The first of the new departments were in the south but not much is known about them; much more is known about the creation of police departments in the north. Due to the lack of knowledge about the southern departments Boston is able to claim the title of being the oldest department in the US. The Boston police department was founded in 1838 and the second in New York in 1844 (Walker, 1942). The beginning of this new style of policing would later come to be known as the political era.

ERA	YEARS	TRAITS
Political Era	1838 - Early 1900s	- Full-time Employees - Centralized - Close ties to local politicians
Reform Era	Early 1900s - Late 1970s	- Also referred to as the Era of Professionalization - Took nearly 60 years to be widely accepted - Two different directions Reformers wanted to take Police Organizations - Increased Bureaucracy
Community Policing Era	Late 1970s - Late 1990s/Early 2000s	- Reconnect with communities - Problem-solving - Community Based - Decrease Bureaucracy
New Era?	Late 1990s/Early 2000s - Present	- Information Based - Increased Collaboration - Specialized Task Units - National Security

Eras of Modern Policing

The Political Era

The first era of modern policing has come to be known as the political era. Originally, the new system of law and order was called the new police (Walker, 1942). The *new police* were created as an answer to the mob violence that plagued the states. However, the system that was created to curb riots had little effect on ending the violence (Walker, 1942). Before the creation

of police organizations in the United States, the idea of a full-time police force had only ever been tried in London (Walker, 1942); the London Metropolitan Police was established in 1829 and was designed as a paramilitary operation (Walker, 1942). Mimicking the militaristic style of the London police, American towns disbanded the local night watch and constables, and replaced them with a centralized police force (Price, 1977). The new police force would engage in patrolling the streets on specific routes to "reduce criminal opportunities" (Price, 1977, p. 2). The quasi-military style of structure was used in hopes of injecting a sense of duty in police officers (Price, 1977).

In many places it took as long as two decades for cities to recognize the new system of law enforcement (Walker, 1942). There are many factors that worked against the recognition of a formal system of law enforcement. Other factors that stood in the way of the creation of police departments were the different political factions, and the change in function of officers (Walker, 1942). Once local agencies were established and part of the local government a relationship formed between the police and politicians (O'Conner & Shon, 2019). The relationship between local leaders and the new law enforcement agencies helped to legitimize police in communities across the country (O'Conner & Shon, 2019). The creation of the new police required a shift in mentality; no longer were police a reactionary force that worked to solve crimes, but instead they were to function in a proactive manner to prevent crime (Walker, 1942). There was also the concern of how departments would be administered. The administration of departments fell to the local politician. "Neighborhood particularism meant that police officers were recruited by the political leaders in a given ward or precinct" (Walker, 1942, p. 8). This meant that there was not a uniform response to various incidents; each neighborhood within a city or town would receive a different response to crimes as it served different political functions (Walker, 1942). Many areas of policing at the time were informal, including the uniforms, which could vary from neighborhood to neighborhood (Walker, 1942). However, the relationship between police and politicians would become toxic.

Not only were the patrolmen chosen by the local political power, but many times the chiefs were as well; other times chiefs were elected or in some cases the position was just assumed by an individual because no one wanted it (Bopp & Schultz, 1972). It was realized, though, that this system was unsustainable. The solution to the broken system were partisan administrative boards. The partisan administrative boards were made up of not just politicians

but also judges, businessmen, and private citizens" (Bopp & Schultz, 1972). "The boards, whether appointed or elected, were partisan in nature, meaning that they still reflected the views of the political party in power" (Bopp & Schultz, 1972, p. 42). The local control led to police corruption.

The corruption that took place in police departments across the nation due to local political control caused the state legislatures to enact statutes that striped local control (Bopp & Schultz, 1972). The corrupt local control of law enforcement agencies was replaced with a system of state control. The changes that happened during this time were not only administrative and function, but also in form. During this time there were limited technologies available to police departments, so officers did their jobs on foot. As the era progressed, departments adopted the use of call boxes and even vehicles towards the end of the era (Reiss, 1992). The technological advances aided police officers in patrolling the community, allowing them to do the job more efficiently.

During this first era, law enforcement agencies were controlled by politicians who used the organizations to help in their political agendas (Gultekin, 2014). This led to historians naming the time period the political era. The political era started in the mid-19th century and lasted until the early to 20th century (O'Conner & Shon, 2019). Before the state took away local control of police departments a bipartisan board was also tried (Bopp & Schultz, 1972). Unfortunately, "politics could never be eliminated from management of police departments" (Bopp & Schultz, 1972, p. 62). Ultimately the bipartisan board was short lived. This led to a deeper look at how police departments were run and what could be done so they served the community in a more uniform way.

The Reform Era

The reform era is sometimes referred to as the era of professionalization (Price, 1977; Gultekin, 2014). The call for professionalism in police departments started not long after the creation of the modern police. As early as 1860, there was a rhetoric of professionalism, however, the idea did not become ubiquitous in policing until close to the 1920s (Price, 1977). The reform era was the response to the issues that arose during the political era, namely the corruption that plagued the profession (Gultekin, 2014). During this time police became more autonomous, breaking the control that politicians held over them (Gultekin, 2014). There were two thoughts on reform for police departments. One style of reform that was put forth was a

change in procedure when it came to solving crimes, the other style of reform was for officers to be in a more social work type of role (Walker, 1942). The disagreement over the types of changes that should happen within agencies delayed reform from taking place.

The biggest step forward towards reform and professionalization was the creation of professional organizations (Walker, 1942). The first professional organization was arranged in 1871 and the three-day event brought together around 100 individuals that represented 21 states and included both administrative personnel such as chief as well as patrol officers (Walker, 1942). Also, in 1871 was the first meeting of the National Police Chiefs Union, which is still around today (Walker, 1942). The National Police Chiefs Union is now known as the International Association of Chiefs of Police.

Overall, the basis of professionalization was the idea that there should be a "division of labor and unity of command" (Gultekin, 2014, p. 514). The new division of labor and unity of command style led to police departments to become more bureaucratic which also led to departments becoming impersonal to the citizens. The focus of police during the reform era became crime fighting which was evident in the creation of more specialized units (O'Connor & Shon, 2019). New technologies aided police departments in this shift of focus. The new technologies such as the patrol car and two-way radio changed how officers responded to reports of crime (Reiss, 1992; Maguire, 1997). This was later enhanced with the creation of the 911 system, which allowed police to respond to crimes and crises much faster than in the past (O'Connor & Shon, 2019).

The creation of the 911 system meant that departments would need to hire more people; these new department members would answer 911 calls and then dispatch the appropriate officer(s) depending on locations and type of incident. 911 systems and patrol cars removed police from the streets where they would have interactions with the community on a regular basis. The increase of bureaucracy in policing led to a divide between law enforcement agencies and the communities they serve. With the new system, police mostly had contact with the public in response to an incident where they would be interacting with victims or perpetrators.

Other reformers pushed for police to act more as social workers than as crime fighters. These reformers saw it as "the police had an obligation to help uplift society" (Walker, 1980, p.137). Because police officers were in direct contact with the community, particularly when crime was involved, reformers thought that officers should try to intervene before a crime was

committed (Walker, 1980). However, this endeavor became increasingly difficult as resources were taken away from patrol and instead reallocated to administrative functions as part of the unity of command (Gultekin, 2014).

The Community Policing Era

Since the late 1970s law enforcement has been in an era called community policing. The goal of the current era of policing is to reconnect police agencies with the communities they serve. Reformers suggested that police organizations need to be less complex as a way to help meet the demands of community policing (Maguire, 1997). In the 1980s the change in policing really started to gain traction; during that time "the community policing movements has gained a great deal of support from scholars, reformers, politicians, and the public" (Maguire, 1997, p. 554). Community policing is the idea that police should be problem-solving oriented and community based. A problem-solving approach goes beyond individual incidents and instead starts to look at the underlying problems (Eck & Spelman, 1989/1987).

This idea is similar to the concept put forth by reformers in the reform era of police as social workers. This approach would reduce the number of calls for service because by addressing the underlying condition, incidents would be less likely to recur (Eck & Spelman, 1989/1987). While officers have always tried to be problem solvers, they have been given little guidance and in some instances were actively discouraged from the practice (Eck & Spelman, 1989/1987). In order to find the underlying cause of the incidents, patrol officers are tasked with gathering more information from more varied sources (Eck & Spelman, 1989/1987). Once the information is gathered and analyzed officers are able to create plans to provide resources to community members in an attempt to solve the underlying issue. Police "have worked with businesses, the military, citizens' groups, state and federal agencies, and non-profit organizations" (Eck & Spelman, 1989/1987) as a way to help better serve the community and provide the necessary resources. Providing the necessary resources requires police departments to build relationships with outside organizations that have the knowledge and ability to provide services that the departments do not have.

The concept of community policing was also to build relationships with community members (Seagrave, 1996). When officers are not on calls, they are encouraged to find other ways to interact with the community. This type of interaction serves not only to bridge the gap between officers and the community, but it aids in the gathering of information. When the

community knows the officers from their local department, not only in the capacity of the person that shows up when there is a problem, the community is able to build a relationship with the officers. That relationship leads to a deeper trust of the police so that citizens are more likely to share information that can aid in an investigation. Also, when officers are out in the community it acts as a form of crime prevention by reducing the opportunity for criminal activity to take place. Police departments have also increased their contact with the communities they serve with the implementation of crime prevention programs. These programs provide community members with information that aids them in preventing them from being victimized by opportunistic criminals.

However, to accomplish the goals of community policing, departments need to become more efficient and flexible (Maguire, 1997). For police departments to become more efficient and flexible they must start to reverse the increased bureaucracy that took hold during the reform era. For police departments to truly embrace the spirit of the community policing era there would need to be both structural changes and philosophical changes (Maguire, 1997). For departments to reconnect with the community, more resources would need to be given to patrol officers and less to administration. During the reform era there was a boom in bureaucracy in police agencies, which took resources away from the patrol officers, increasing the divide between the departments and the citizens. Even with re-allocating resources within a department, police are not able to provide every service the public requires. In order to best serve the community, police departments formed relationship with other organizations that could provide the services the departments could not.

A New Era?

Hooper (2014) found was that while the Community Era is still dependent on information gathering, the difference with the Information Era is the amount of data and how it is used. Starting in the late 1990s policing began to move towards the idea of "evidence-based policing" (Hooper, 2014, p. 3). Evidence-based policing is actually a form of research that police agencies do as a way to help prevent crime. "Predictive policing builds on intelligence-led policing through exploiting technologies that allow the police to ostensibly forecast where crime may be most likely to occur" (Hooper, 2014, p. 3). While policing started to evolve again during the 1990s, a major change came at the beginning of the 21st century.

Unlike previous changes in law enforcement, which were brought about by outside reformers or a natural evolution, the most recent changes were brought about by a major event. At the beginning of the 21st century law enforcement in the United States had to contend with the aftermath of the events of 9/11 (Marks & Sun, 2007). Some of the changes made after 9/11 only impacted federal agencies and large departments, while other changes affected policing as a whole. The changes, whether large or small, impacted how officers approach different aspects of the job.

The event forced agencies to look at how they gathered information, the kind of information they got, how it was communicated within the law enforcement community, and what was being done with it. The biggest change that occurred in policing following 9/11 was the sharing of information (Marks & Sun, 2007). Across the board, there was an increase in the sharing of information and an increase in collaboration amongst departments (Marks & Sun, 2007). To aid in the sharing of information there is a federally funded program call "The Matrix Project" which stands for the Multistate Anti-Terrorism Information Exchange in order to exchange information (Marks & Sun, 2007).

The increase of collaboration and information sharing is only one part of the changes that have been made to law enforcement after 9/11. Local police departments and federal agencies have added specialized task units. The new specialized units have mainly been implemented in large departments, such as New York City, Los Angeles, and Philadelphia (Marks & Sun, 2007). However, the increased specialization is the opposite of the goals set forth by community policing standards and police reformers. These changes in policing following 9/11, along with others, have been described by some as entering a new era, a fourth era of policing. While according to Hooper (2014) law enforcement is now in the information era of policing, Oliver (2006) contends that policing is in the homeland security era.

According to Oliver (2006), the reason that the United States has now entered a fourth era of policing is because the authorization provided for officers to carry out their jobs has changed. During the political era, the authorization for policing came from politics and law; during the reform era the authorization came from law and professionalism; during the community policing era the authorization came from community support (political), law, and professionalism (Oliver, 2006). Now, during the homeland security era, Oliver (2006) claims that the authorization comes from national/international threats (politics), law (intergovernmental), and professionalism. "In

addition, citizens awareness of the issue of terrorism reached a critical juncture on that day and as a result, citizens have given authorization to government to target terrorism and protect the home front" (Oliver, 2006, p. 53).

The authorization that was given to the government from citizens "to target terrorism and protect the home front" (Oliver, 2006, p. 53) is accomplished by information gathering. Previous eras of policing were so named for the overarching theme that wove throughout that time in law enforcement. By that standard the current era should be named as Hooper (2014) suggested, the information era. Regardless of what it is called, though, the events of 9/11 made an impact on policing. This impact seems to have propelled law enforcement into a new era, the fourth era.

Conclusion

"In this duty of law enforcement, the policeman is in a very real sense a judge" (Wood, 1919 as cited by Walker, 1942, p. 8). Today the sentiment by Woods is still very much a reality in American policing. Officers from all agencies have a level of discretion in how they enact laws. However, many other things about law enforcement in the United States have changed. The reform era brought about a level of professionalism in policing and with it a command and control structure that is governed by policy and procedure. The level of discretion law enforcement officials have has changed since the inception of the modern police officer. That discretion is now governed by the policies and procedures of the department they work for and by the same laws they are entrusted to enforce.

Since the creation of the modern police, the profession has gone through various types of reform that involved planning, debate, and implementation. The changes made to police organizations mostly came from outside reformers. This led to top-down changes that left little room for buy-in from patrol officers (Anderson, 2020). Modern police have been around since the mid-1800's and had already gone through many changes before the concept of studying organization development. Organizations changed long before the field of organization development, however, if the concepts of organization development were used in police organizations, the process of change probably would have gone much smoother. If law enforcement agencies had given officers the option to be involved in the planning, by providing their knowledge about the job, the administration and reformers would have gotten better buy-in from organization members (Anderson, 2020; Gallos, 2006).

While there have been quantifiable changes in police organizations in the almost two hundred years since the creation of modern policing, there have also been small, imperceptible changes as well. Outside of the organizational changes amongst law enforcement agencies, there have been societal changes as well that have affected the culture within departments. The fact that society has changed lends itself to showing that law enforcement has as well. The criminal justice system, which includes police, is an open system, which means that any changes in the social, political, or economic environment it belongs to will create changes in the system (Marks & Sun, 2007). In the 1840's, when modern policing started, a woman would never have been a police officer, but today they make up a fifth of officers in the US. Even sixty years ago a gay police officer would not dare to be open about their sexuality, now however, they are a welcomed part of the force. These changes happened in police departments due to the changes that took place in society as a whole. As society continues to change and evolve, law enforcement agencies will do the same.

So, the suggestion police departments in the US have not changed since the establishment of the modern policing model is in part true, but in a larger part not factually correct. In the end, there are some things in police organizations that have remained, in the very least, similar to the creation of modern policing in the United States. However, much more has changed than has stayed the same. Slowly, over long periods of time, with the help of changes in society and pushes from reformer, police organizations have changed. Just because some things have changed in law enforcement does not mean that there is nothing left to change. Police organizations have the obligation to change and grow in way that will best serve the communities to which they belong.

Going forward, it would serve law enforcement well to utilize organization development concepts when looking to create change. The old style of command and control has been shown time and again to have minimal long-term impact; organization members need to understand the importance of why changes are being made and where that will lead them (Anderson, 2020). It is also important for reformers and organization members to not only work with members of police department when creating change, but to also to study the history of the profession. It is only by understanding the past that we can truly move forward because in the wise words of George Santayana, "Those who cannot remember the past are condemned to repeat it".

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Breaking Down the Stigma of Mental Wellness with Law Enforcement

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Abstract

One area that is often overlooked when considering law enforcement is the aspect of officer wellness and self-care. Recent events in the national media have brought forth attention to use of force by police officers and have begun to push the idea of organizational change within law enforcement. With a desire for change, this looks at one aspect of change that can have an impact on officer conduct while also helping to improve the lives of police officers and to reduce the already high suicide rates for the law enforcement population. By helping law enforcement leaders break down the stigma of asking for help and focusing on ways to better support police officers around operational stress, change can begin to happen. Research has shown increase in conduct issues because of poor self-care and lack of support around managing stress.

Keywords: Law enforcement, wellness, law enforcement leadership, operational stress, organizational change

BREAKING DOWN THE STIGMA OF MENTAL WELLNESS WITH LAW ENFORCEMENT

Introduction

Currently, there is a lot of controversy surrounding law enforcement officers (LEOs) in the United States. There have been demands for reform and there are many people who are looking for ways to make changes and adjustments to improve policing and to reduce the frequency of the use of force. In addition to this, there is an increase in the attention to the number of suicides of LEOs (Thoen, et al., 2019). Mumford, et al. (2014) found that officers in their study screened positive for higher rates of posttraumatic stress disorder, other mental disorders, and increased use of alcohol.

Law enforcement agencies are currently under scrutiny. There are calls for reduced use of force and change in organizational culture. The nature of work that officers do puts them under an exuberant amount of stress. If they are not adequately equipped with skills to cope with stress, or are not adequately supported by their agencies, this stress may negatively affect officers' individual wellbeing and conduct (Plazas, 2018), and by extension negatively affect their agencies' reputation. This is a problem. To find solution, it is beneficial to develop a better understanding of the existing support offered to the officers and whether the scope of support depends on style/qualities of law enforcement leadership.

As law enforcement leaders begin to explore culture changes to better support officers, they can explore programs to help shift the organizational culture to being more positive and understanding of these issues. Additionally, law enforcement leaders can utilize their added support of the officers to shift organizational stress which would improve job satisfaction and assist in reducing the improving the ability to cope and manage with operational stress. The stigma behind seeking mental health treatment is associated with law enforcement organizations and environmental factors. Organizational factors include occupational stress characteristics such as day-to-day of the job and environmental factors such as abiding by social and law enforcement culture ideologies (Velazquez, & Hernandez, 2019).

The objective of this review paper is to illuminate the stigma of mental wellness with law enforcement and to develop a better understanding of the adequacy or otherwise of existing support offered to officers.

Research Question and Method of Inquiry

The inquiry and review for this study was based on the following research question: What are the common organization development (OD) interventions that are needed to address stigma of mental wellness with Law Enforcement?

In addressing this question, the study followed an integrated literature review approach in our attempt at moving beyond merely summarizing the literature but substantially contributing new and valuable knowledge mental wellness with law enforcement. The literature search covered a broad range of academic databases (e.g. EBSCO Host) to identify the type of duty-related trauma expected by police officers, how influential stigma is amongst the police culture and what current intervention strategies are employed to assist police officer mental health wellness.

Negative Impact

The President's Task Force on 21st Century Policing (2015) found that suicide rates of LEOs is 2.4x higher than the general population. Several studies have also identified alcohol use as a risk factor for suicide in law enforcement (Mumford, et al., 2014; Violanti, 2018). In addition to this, Plazas (2018) noted that police are continually preparing to respond to threats which results in constant hypervigilance. Gilmartin (2002) reflects on the need for officers to recognize this and learn how to manage the hypervigilance outside of work to reduce the negative impact that policing can have on officers when they are home.

In considering the negative consequences that can come up in law enforcement, Moran (2017) identifies some of the risk factors for complaints filed against officers, to include those with less than 10 years of experience in law enforcement and military history. With this knowledge, it would be important to focus more on newer officers and those who are transitioning from military service to working in law enforcement. As new officers are coming into this line of work, it is important to address these issues early in training and throughout the officer's career to reduce risk of complaints filed against officers. Recognizing some of the causes that contribute to these issues is important in identifying the need for change and the steps to start taking to mitigate the difficulties.

Providing Support and to Reduce Stigma

With the ongoing stress that LEOs deal with on a regular basis, there is an increasing concern about the welfare of officers and there has been more of a focus on how to better care for them and to begin addressing some of the mental health issues that arise from the ongoing

traumatic experiences they are faced with (Cohen, et al., 2019). As a result of the stigma around mental health, the law enforcement population is generally not open to discussing their own mental health issues. In one study looking at suicide prevention programs for law enforcement, one officer declined to participate in the research, stating "the general public doesn't need to know officers are suicidal" (Thoen, et al., 2019, p. 3).

In some law enforcement agencies, support would be provided in the form of external support. Thoen et al. (2019) found that 52.7% of those surveyed had access to an Employee Assistance Program. However, 10.9% had no formal or informal support offered to LEOs on behalf of the organization. The President's Task Force on 21st Century Policing (2015) did note that partnerships outside of the law enforcement agency are necessary and that for any program to succeed, there needs to be buy-in from the agency.

Arnetz et al. (2013) looked at a prevention program designed to improve psychobiological responses to stress within the law enforcement population. This training was conducted by Special Forces officers who were trained by the authors of the research. This training worked to help officers reduce anxiety and enhance their performance when in stressful critical incidents. In follow up assessment 18 months after the training of their somatic and psychological health, in addition to stress biomarkers, all officers showed improved health and lower levels of stress response.

The Cleveland Police Department worked with the Partnership for a Safer Cleveland to provide a training to police supervisors regarding recognizing operational stress experienced by officers (Chapin et al., 2008). This training reviewed the effects of operational stress and how it is like combat stress in the military. As part of this training, police supervisors were also given a dog tag for volunteering to take the training and additional dog tags to hand out to officers who are reaching out for help or for officers who are helping other officers. The benefit of this study was that it began to address stigma and provided an incentive for officers to help others or to seek out help themselves.

In another study, Kowalski (2019) showed that leaders who had previously experienced traumatic incidents had more of an understanding of what officers were experiencing. However, in this study, some respondents felt that there were challenges faced when trying to get into the mental wellbeing of the officers they supervised. Given this, it can be challenging to provide support to the officers when they are most in need of it. Kowalski (2019, p. 86) also noted that if

supervisors can move beyond the constraints, even if they are perceived, then they can proceed with assessing how the supervisees are doing.

Another aspect to consider for use in providing support is formal or informal peer support systems. Graf (1986) points out the bond built between police officers both on the job and off the job and how that relates to how officers can provide support to each other around officers providing peer support to each other. This idea has been utilized and is being talked about in the State of Maine. Ferguson (2018) met with LEOs to explore how one police department is working to provide support to each other through their newly developed Critical Incident Stress Management Team. Through this team, officers will check in with each other after they respond to critical incidents. Patterson (2003) goes on to point out that stress management programs for police should not only focus on the stressful experiences at work, but also on stressful life experiences outside of work.

Role of Leadership in Job Satisfaction and Reduced Stress

Leaders can have a significant impact on employees within an organization, especially within law enforcement. When considering the impact of organizational stress, there are several things that leaders can do to address this and work towards moving forward in a positive direction. Shanafelt, et al. (2015) explored leadership qualities of physician supervisors with Mayo Clinic's three campuses and they found that supervisors who had certain leadership qualities ended up having a direct effect on the personal well-being of those they supervised. Though not directly related to law enforcement, the traits identified could be applied to many different occupations.

Another aspect to consider is how leaders manage things when a subordinate is feeling burnt-out or exhausted. Kranabetter and Niessen (2016) looked at steps to help support employees which consisted of information gathering, planning, execution, and feedback. It was noted of the importance of providing support and looking into the underlying causes of the stress, even if it was from things outside of work. The next stage was focused on looking at various behaviors and things to see how they could provide support, to include reflecting on their own leadership behaviors regarding the situation and how it might impact things. Next, during the execution phase, they focused on task, resources, and emotional support to the employee. Finally, in the feedback stage, the leaders sought feedback from their employees to determine if

they were helpful. In doing this, the leaders followed up on health, stress levels, and monitored the employee's goal attainment as well as their work hours.

Jirek (2020) explored the management of employees who are exposed to secondary traumatic stress on a regular basis and the researcher found this specific organization was not very effective at supporting its employees. Part of the organizational culture was the focus on the employees needing to figure out how to utilize self-care while also having high expectations of how much support each employee would provide to the organization. The emphasis in this research was the employees identifying the need for their employer to do more to provide them additional support and guidance around selfcare, to include being led by example of how to care for oneself.

It has also been found that supervisors are important to consider when looking at workplace wellness programs (Wieneke, et al. 2019). Given the close work between employees and their supervisors, this can be helpful when looking at how to rollout wellness programs and who might have the most influence on the employees in an organization. Given the impact of leaders in the workplace, it is important to consider their role when looking at ways to improve mental wellness. Adler et al. (2008) noted in a study of military leaders that they desired and lacked training on supporting their personnel around operational stress. This contributes to the emphasis of leaders wanting and needing training to best support their employees.

Changing of the Culture

In the process of identifying the need for change and ways to begin making changes, it would be important to consider Lewin's force field analysis (Anderson, 2020, p. 79). This seems to apply very well to the current state of law enforcement. Many people within our society feel that law enforcement policies and its culture need to change. This desire to change is the force pushing it, however many LEOs do not feel anything needs to happen and they are pushing to keep the status quo. This will be one challenge in starting this process and in getting changes to stay in place.

Changing an organizational culture can be difficult, especially in law enforcement. Haake et al. (2017) found that it can be difficult for law enforcement leaders to assist in making the changes needed within a law enforcement agency. What was noted in this research is that the "middle managers" tend to look both up and down the chain of command. If those below them don't agree with certain changes, it would have an impact on those supervisors following

through. This idea is consistent with the President's Task Force on 21st Century Policing (2015, p. 62) indicating that "no program can succeed without buy-in from agency leadership as well as the rank and file".

It is important to remember that change can be difficult. However, maintaining change can be even more challenging. Anderson (2020) reflects on the requirement of "more conscious energy, emotion, or attention" (p. 371) to assist with maintaining change. This will be a challenge for some law enforcement agencies to manage, but it will be important for them to continue seeking out added support from external organizations to help them keep the change moving forward. Marks (2003) noted the challenges in holding long term change within the law enforcement population. For lasting change to hold in law enforcement, Marks outlines three levels of change – structural, behavioral, and attitude (p. 236). By starting to look at these areas, it will encourage and support change within the law enforcement organizations that will be lasting.

One step to assist with sustained change would be to utilize the seven practices to encourage maintenance and renewal of a change (Anderson, 2020): periodic team meetings, organizational sensing meetings, periodic intergroup meetings, renewal conferences, goal-directed performance review, periodic visits from outside consultants, and rewards in the research. Chapin (2008) utilized tokens to give out to those that were working towards making the changes of asking for help. By using these steps, it can provide some structure and support to ongoing change and to keep law enforcement agencies moving in the correct direction.

Governor Andrew Cuomo of New York issued an executive order in June 2020 that requires all municipalities with a police department to begin looking at police policy and procedures and to work on a way to improve things. As a result of this, Greene County developed a collaborative to begin exploring this (Trafton, 2020). As the group began to consider challenges and issues, they recognized officer wellness as a top priority. The collaborative recognizes the need to work closely with the county mental health center on this.

This is a good approach to take and focuses on something that law enforcement agencies and their leaders can do to prevent or reduce future challenges with conduct issues in officers. Toch (2008) noted the challenges of punishments of law enforcement not always seeming to match what they are being punished for and the challenge of trying to sort through the various things that may have impacted the decision-making process around the punishment. An

intervention, such as a Peer Review Panel, can be helpful in resolving these types of issues (p. 69).

One step to begin working on changing the culture would be to consider the use of focus groups to define the current culture and to determine what changes should be made (Anderson, 2020, p. 346). In utilizing Schein's process to work on changing the existing culture, small groups could work to identify the culture and values, analyze them, describe how certain values impact the goal of officer wellness, share, and explore subcultural differences, then discuss and agree upon action steps to move toward change.

Organizational Change

In the process of planning this change, it would be important to consider Lewin's three-phase model of change (Gallos, 2006, p. 141-143). In leading organizational change within the law enforcement culture, one would need to start with unfreezing and work towards ending the complacency with where things stand at this time. From there the organization can shift into moving and work towards identifying the motivation to change and finding a way to get those comfortable with the status quo to be interested in change as well. As change is put into place, the refreezing can happen to keep the new changes in place.

It has been found that action research is an effective method of research to use with law enforcement (Cosner & Loftus, 2005). Given those participating in the model of research are going to be affected by the results, officer involvement enables them to become more engaged and to become a part of the change. A consultant can use this as an intervention to help work towards change. The consultant, whether internal or external, can follow the steps of gathering data around the problem, planning for the change, acting, and evaluating the results of the intervention. Action research is viewed as a way that research findings could help the organizations involved, and then help other organizations by sharing the research data (Anderson, 2020, p. 117).

In considering this, it would be helpful to recognize and utilize action science in the process of working towards change. Gallos (2006) identifies action science as an intervention approach that is aimed at the individual, team, and organizational levels. This approach can help those involved learn to be more effective in social situations via improved awareness of their actions and interactions.

In considering action science as part of the intervention to be used for organizational change within law enforcement, one argument for this being an effective model would be that it gets to a deeper level than action learning (Gallos, 2006, p 206). This deeper level of thinking helps the individual to examine what their reasoning is and to improve their actions based on the deeper understanding of their beliefs. Within this process, participants will take personal responsibility in sharing for everyone to make informed choices. This helps to work towards a situation where everyone wins in the intervention.

In looking deeper at the change in the larger law enforcement system and the changes required, it will also be important to recognize that not all law enforcement organizations are the same size, nor will certain interventions have the same impact. For example, in some larger law enforcement organizations, it would be important to consider large group dynamics and to look at what changes might be more effective within that setting. It will be important to consider this as change is explored, especially in looking at how to work with the various precincts and various shifts in various law enforcement agencies.

The dilemma of voice, (Gallos, 2006, pp. 317-318) notes the importance of considering the differences when it comes to large groups and the challenge around not hearing every voice. Due to the larger groups, individuals do not feel heard and some are more talkative and take over the meeting. This can result in frustration and resentment, which will have an impact on the implementation of any upcoming change. In situations like this, it can be helpful to break larger groups into smaller ones to have more structure and to give everyone more of a voice in the discussion.

In considering the size of the organization and the size of the group that is being worked with, the dilemma of structure within large groups and how larger groups can impact individual's anxiety and the ability to engage with the group (Gallos, 2006, p. 319). As the consultant is considering options for how to work with the group, it is also important to consider the structure of the intervention as this can have an impact on the functionality of the group and ultimately how they will move forward. The amount of structure will also determine if the group is able to get through the agenda and planned tasks. If there is too much structure, or too little, it will contribute to how group members will interact with the group.

One process that could be beneficial to help work through this change would be utilizing a dialogic OD consultation and intervention (Anderson, 2020). With this process, a consultant

could assist in gathering information about the organizations challenges and to assess where things stand in terms of stigma around officer wellness. As the consultant gathers information, this can be fed back to the group and they can use some structure to a group discussion to help the officers bring up their issues and work towards identifying changes and ways to make improvements and to work on positive change.

Another study looked to identify ways to encourage officers to accept change and start to move forward. Brimbal et al. (2020) identifies one option of doing this as being a way to get senior officers involved in the change to incorporate their experience and knowledge into the new programs that are being initiated. This approach can assist in getting more buy-in and assisting more senior officers in feeling like they are part of the solution and contributing to the upcoming change.

Conclusion

Given the ongoing issues with law enforcement and the demands for change, looking at officer wellness is one way to begin moving towards change. As Plazas (2018) noted, there are numerous negative outcomes associated with poor self-care and wellness within the law enforcement population, and by working towards having leaders in the organizations focus on these areas and supporting their officers, it has the potential to reduce some instances of poor judgement and misconduct. By building this into the law enforcement culture and implementing the organizational change to keep this a part of the way of life for LEOs, there are many benefits that will help address the many negative things that society is asking for change around.

There are a lot of areas that law enforcement may be pushed to change. By approaching officer wellness and making positive changes around providing better care and support, it is one positive approach and may be easier to get investment from officers themselves. With this easy investment from the officers, it will assist in implementing change quicker, and being able to sustain that change. Given the negative consequences that can come from not providing this support, the results of providing support will help with some progress towards reducing conduct issues in law enforcement and in reducing suicide rates among police officers.

As law enforcement leaders work towards these changes, they can track use of force reports and other conduct issues to see how this change is impacting the frequency in which those types of issues come up. In addition to this, by shifting the culture, reducing stigma associated with help seeking behavior, and by adding more support for officers, it can help to

reduce issues around alcohol use and ongoing post-traumatic stress related to critical incidents. In addition to the reduced problems around alcohol, there should also be reduced suicide rates.

With the complications around working towards such a large change across so many organizations, it will be important to consider the most effective ways to implement and sustain change. In addition to getting buy-in from officers, another step would be building bridges between law enforcement organizations and behavioral health organizations. With this, it will be important to developing a process in which progress can be assessed over time. With the ongoing assessment and external involvement, it will assist in continuing with the forward movement of change and ensuring that things do not return to how they had been. By addressing the negative effects from poor officer wellness, law enforcement leaders providing support for officers can have an impact on the conduct issues and they can show the public that they are actively working towards changes to better our communities.

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RE-EXAMINING THE PHILOSOPHICAL UNDERPINNINGS OF THE MELTING POT VS. MULTICULTURALISM IN THE CURRENT IMMIGRATION DEBATE

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Abstract

Immigration to the United States is certainly not a new phenomenon, and it is therefore natural for immigration, culture and identity to be given due attention by the public and policy makers. However, current discussion of immigration, legal and illegal, and the philosophical underpinnings is 'lost in translation', not necessarily on ideological lines, but on political orientation. In this paper we reexamine the philosophical underpinnings of the melting pot versus multiculturalism as antecedents and precedents of current immigration debate and how the core issues are lost in translation. We take a brief look at immigrants and the economy to situate the current immigration debate. We then discuss the two philosophical approaches to immigration and how the philosophical understanding of the philosophical foundations can help streamline the current immigration debate.

Keywords: Immigration, multiculturalism, melting pot, ethnic identity, acculturation, assimilation

Immigration to the United States

Immigrants are certainly not a new phenomenon to the United States of America, and it is, therefore, natural for immigration, culture and identity to be given due attention by the public and policy makers. In fact, "The United States of America has been the preferred destination for immigration since the discovery of the New World" (McGruder, 2016, p. 1). As such, feelings around immigrants and approaches to immigration policy have gone through many phases and iterations in this country.

It seems, however, that "once again, the United States finds itself in an era of nativism and exclusion, as our politicians contemplate immigration restrictions and deportation policies that are reminiscent of those enacted nearly a century ago" (Young, 2017, p. 218). Indeed, over the last few years the media has sensationalized the irregular migration from what is considered the 'third world' to well-to-do western nations (Flahaux & Haas, 2016), while lawmakers and politicians alike "frequently portrayed immigration as a threat to the nation" (Young, 2017, p 218). This is not new. Indeed, the country has a fraught relationship with its own views about the immigrants who founded the United States in ways that dominated over, excluded, and actively marginalized Native American populations, and the varying view of later inflows of immigrants. For over a century, however, two opposing schools of thought took shape and have driven the issues and polices of immigration in the United States: assimilation (the melting pot) and acculturation (multiculturalism). In light of the current policy environment, framed by the administration's motto "Make America Great Again", this paper discusses the philosophical underpinnings, as well as some of the outcomes, of those two schools of thought.

At the turn of the century, Rudmin (2003) noted that the issue of acculturation is becoming increasingly important for converging reasons: high-speed, high-volume new technologies; a flow of millions of new immigrants as a result of war, political oppression, economic disparities, and environmental pressures; regional and global free-trade arrangements that resulted in international marketing and recruitments for skilled personnel. Chiswick and Hatton (2003) further stated that the characteristics of the late 20th century would continue into the 21st century with an increase in the movement of people across international borders. For Nee and Sanders (2001) the immigration of people to advanced capitalist societies is among the major societal movements of our time. Furthermore, Rosenblum (2017) noted that today's immigration

flows are much more complex, not just because of technology and lower travel costs, but also because they come on the foundation of previous immigration flows.

As far as the size of immigration flows goes, Martin (2016) notes that while the United Nations report counts 244 million immigrants worldwide, "The US is the nation of immigration, with almost 20 percent of the world's international migrants and half of the unauthorized migrants in industrial countries" (p. 295). According to Perlstein (2017) the United States welcomed 59 million immigrants between 1965 and 2015. In fact, the National Academies of Sciences, Engineering, and Medicine (2007) asserted that today more than 40 million individuals who call the United States home were born in other countries, and roughly an equal number of people have at least one foreign-born parents; this means one person out of five is either first generation foreign born or their children. It is thus not surprising that immigration is front and center on the national policy agenda.

In terms of the composition of those immigration flows, while in 1980 there were only 816,000 immigrants who identified themselves as black in the United States, that number quickly climbed to 4.2 million by 2016, with most of the growth taking place since 2000 (Anderson, & López, 2016). Likewise, Antonio Flores (2016) of Pew Research Center reported that the Latino population in the US was approaching 58 million by 2016. There are also about 11 million undocumented residents living with almost 6 million US-born children (Warren & Kerwin, 2017). Overall, Martin (2016) reported that the majority of immigrants in the United States are from Latin America and a fourth are from Asia. What seems to matter most however – and perhaps this has always been the case – is the perceived integration of current immigrants (Woldeab, Yawson & Woldeab, 2019). Indeed, "for neo-conservative wings of the New Right, the questions of how many or what color are less important than the issue of the potential for recent immigrants to assimilate into the mainstream economy and society, as did previous waves of immigrants" (Ansell, 2016, p 126-127). Although each immigration wave tends to trigger worries about integration, national identity, cultural integrity, crime, and job stability among others, the period we are in now and that started long before the November 2016 election is marked by seemingly sharper differences between advocates of immigration restrictions and those who hold more liberal views on the topic (Martin, 2016). Indeed, as "a nation of immigrants" the US remains "unsure about the best migration policy for the future" (Martin

2016, p. 295). This is particularly clear in the cyclical views of the relationship between immigration and the economy, which is the subject of the next section.

Immigrants and the Economy

The United States – which was built on the backs of first people, slaves, and immigrants – has long seen immigrants both as an opportunity to develop and advance its economy and also as a burden on its social services. Indeed, Abramitzky and Boustan (2017) asserted that "the history of immigration to the United States has been shaped both by changes in the underlying costs and benefits of migration as well as by substantial shifts in immigration policy" (p.5). McGruder (2016) noted that opinions are very much divided: some see immigrants as taking a toll on social services, taking jobs away from those US-born, leading to increasing violent crime, and diluting American values and identity; others contend that immigrants advance the US economy by creating a market for goods previously in low demand, increase new business entrepreneurship, and add to the work force by taking low wage jobs native workers do not desire. López and Bialik (2017) of the Pew Research Center estimate that of the 160.4 million in the labor force in 2014, 19.5 million were immigrants and 8 million were unauthorized immigrants. The authors also make the distinction that lawful immigrants often perform professional jobs in management, business, or finance; unauthorized immigrants, however, are most likely to work in service or contracting jobs.

Some researchers hold that "immigrants inject vitality into the American economy; they bring their intellectual and scientific talents to U.S. research and development efforts, and help boost U.S. labor force productivity". Indeed, "a century of Latino migration, for example, has resulted in millions of law-abiding citizens who contribute to the U.S. economy and are as patriotic as any other American" (McGruder, 2016, p.1). In fact, Minier (2017) noted that more than half of the 87 technology startups valued at over a billion were co-founded by immigrants. Minier (2007) further pointed to a letter signed by nearly 1500 economists, citing the numerous benefits that a constant flow of immigrants brings to the US economy. That letter also asserted that the "benefits to immigration are significant, and outweigh the costs, particularly when combined with effective policies to increase the productivity of American-born workers…Furthermore, in 2016, all six American Nobel Prize laureates in economics and sciences were immigrants" (Minier, 2007, p. 1).

A National Academies of Sciences, Engineering, and Medicine (2017) study shows that "the mix of skills possessed by arriving immigrants – whether manual laborers, professionals, entrepreneurs, or refugees – will influence the magnitude and even the direction of wage and employment impacts". However, "when measured over a period of more than 10 years, the impact of immigration on the wage of natives overall is very small" (p. 4). Nonetheless, Abramitzky and Boustan (2017) find that concerns of US-born Americans continue to focus around fears that immigrants would not only lower their wages, but also that they may not integrate well into the social fabric. The concerns over wage and employment shortages are certainly not new. As Lee et al. (2017) describe, around the Great Depression – between 1929 and 1937 – almost half a million people of Mexican descent (many already American citizens) were forcibly deported to Mexico in order to save and create jobs for US-born citizens. Not only did it not work as hoped, it in fact backfired: in those places that sent away most Mexican-Americans, the job markets got smaller and unemployment rose (Lee et al., 2017).

As this discussion shows, both old and new views of immigration oscillate between benefits and detractions. So what should the role of immigrants be in the US, in the long run? This question has been asked for some time, and seems no closer to having a clear answer. It has, however, engendered two distinct schools of thought. The following section discuses the philosophical bases of these two approaches.

Two Philosophical Approaches to Immigration

In its early days, the United States of America accepted immigrants freely. As a country of immigration from its origin, and given the low overall population, there were no immigration laws or restrictions to bar immigrants from entering the country. However, this changed in the early 1900s. The 20th century, without dispute, was the time when various ideas around immigration, its impact on the American culture, and the acculturation processes of individuals and groups were most hotly debated. As a result, two competing schools of thought emerged. The viewpoint of the majority group demanded full Americanization and Anglo-conformity, which stipulated immigrants who chose the United States as their new home become part of the melting pot. This vision later became a "central element in the development of the assimilation school of race and ethnic studies in American sociology" (Hirschman, 1983, p. 398).

Advocates of the melting pot philosophy expected that as new immigrants arrived to the new land, they would become culturally and racially mixed to create an America 'Utopia'.

Therefore, these 'conformists' set in motion to materialize this vision through the model of the melting pot. A model described by Gordon (1961) as Anglo-conformity demanded English language and English-oriented cultural patterns to be the standard way of life. It is important to note that the philosophy of the melting pot is mostly associated with the United States and its immigration history. Its process broadly associated cultural assimilation in which the melting of cultures and intermarriage of ethnicities were considered entities of this philosophy.

The viewpoint of the melting pot led to the birth of the competing philosophy, which promoted acculturation over assimilation. The scholars who held this viewpoint advocated that immigrants maintain their original culture, ethical identities, customs and values; however, they would also adapt to the culture of the new environment. This school of thought saw the philosophy of the melting pot to be forceful and overly simplistic in its view towards the understanding of culture and ethnicity. This group of scholars advocated a multicultural society that is inclusive yet aware of cultural and ethnic differences. Further, they saw the majority's ideal of attaining a homogeneous America as a romantic vision that would strike most modern observers as naïve and rather patronizing (Hirschman, 1983). Multiculturalists advocated that immigrants and minority groups should be integrated into US society with little stress and little pressure. This set the ground for the debate that went on through the last century and is not yet over.

The Foundations of the Melting Pot Philosophy

According to Hirschman (1983), the term 'melting pot' was first used by Ralph W. Emerson in the 1800s. However, the term only came to general usage after it was used in a play with the same name describing a fusion of nationalities, cultures and ethnicities in the early 1900s. The melting pot, as a philosophy of the dominant group, advocated the view by which people of different cultures, races and religions and ethnic backgrounds would come to form a homogeneous society that would become part of the larger multi-ethnic society. This was best exemplified by Robert Park, an influential figure from the University of Chicago, who developed the theory of assimilation concerning US immigrants while carrying out research work in urban Chicago communities (Hirschman, 1983).

In his theory of assimilation, Park (1950) introduced four steps to the race-relation cycle in the story of an immigrant: contact, competition, each group learning to accommodate the other, and, finally the immigrant group would learn how to assimilate into the dominant group's

ways of life. This view became the theme of the melting pot: that immigrants would give up the identities that connected them with their country of origin, absorbed the norms and culture of the United States, and were in turn absorbed into the dominant culture. Hirschman (1983) pointed out Park's assumption that the forces of change in modem societies would ultimately obliterate divisions based upon irrelevant criteria of language, culture, and race; this vision would result in democratic political institutions, and the industrial organization of modern society would then recruit and promote individuals on the basis of merit and not ethnic origin. With this vision in mind, the dominant nativist group worked to set polices that would meet this model of the melting pot.

The Migration of the Early 1900s

According to McGruder (2016), countless immigrants came to the US in the 1600s mainly to escape religious persecution or find fortune in the new land; between the 17th and 19th centuries, however, hundreds of thousands of African slaves were brought to the US against their will. And starting around mid-19th century there were significant Chinese immigration waves, which went from being tolerated, to engendering the first legislation restricting a particular ethnic group from immigrating: the 1882 Chinese Exclusion Act.

In the early 1900s, the United States saw massive numbers of European immigrants entering the country. According to Suárez-Orozco (2000), 8,798,386 of Southern and Eastern European immigrants, from Ireland and Italy for instance, arrived during the first decade of the 20th century. Even though these were not the kind of immigrants that Gordon (1961) identified as Anglo-conforming, or English and Protestant, the Act of the 1790 allowed them to enter the nation freely.

The massive number of new immigrants may have been unusual ingredients for the melting pot to readily absorb. However, at that time, immigrants were seen both as laborers that filled the gap in the workforce and as an economic boon that would lead to social growth. Gordon (1961) stated that, on one hand, these immigrants added to population numbers, worked on farms and in mines, and built the railroads; on the other hand, the poverty-stricken Irish Catholics and substantial influx of Germans became a source of anxiety to the overwhelmingly Protestant society.

Nonetheless, the melting pot proved large enough to accommodate these groups of immigrants. It may not have been right away, especially in the case of the Italians, but they were gradually accepted and became fellow "white" citizens. However, to be fully integrated they had to learn the English language, US work ethics, and other mannerisms. Schools like the Ford English School set out to teach these immigrants the English language in the name of making them better citizens, and protected them against the many pitfalls which lurked in the path of the unwary foreigners (Pozzetta, 1991).

Gordon (1961) mentioned that as far back as colonial times, Benjamin Franklin recorded concerns with German immigrants' slowness in learning the English language and especially with the establishment of their own native-language press. This type of behavior would of course contradict the dominant view of melting pot because Anglo-conformity demanded that these immigrant groups cast off their European skin, and gaze forward instead of dwell on their past (Gordon, 1961). Therefore, stripping them of their native language and cultural values were the first steps toward full memberships in the melting pot.

The philosophy of the melting pot also ran into trouble with trying to maintain the 'whiteness' of the dominant population. Italians were in fact not seen as white in the beginning, but eventually were absorbed into the existing culture. However, according to Gordon (1961), although Black Americans made up nearly one-fifth of the total population at the time, their predominantly slave status, combined with racial and cultural prejudice, barred them from serious consideration as an 'assimilable' element of the society. Furthermore, measures were even taken to fully guarantee that this undesirable population remain outside the melting pot. Hirschman (1983) talks about how legal barriers, including the denial of the opportunity to vote among many other essential citizenship rights, kept Black Americans in a state of powerlessness, a practice described by Myrdal (1964) as a moral dilemma between American ideals of equality and the practice of racial discrimination. Where Native Americans were concerned, Gordon (1961) stated that assimilation was out of the question: they did not want it since they had a positive need for the comfort of their own communal institutions.

These questions about who is or is not able to – or is desirable to – be absorbed into the American melting pot have indeed never been resolved, and they are debated afresh with every new influx of immigrants. In fact, as Young notes: "In this nativist vision, the time period to

which we return is one in which immigration is sharply restricted by national, ethnic, and religious criteria" (Young, 2017, p. 218).

The Philosophical Perspectives of Multiculturalism

Scholars who felt that the simplistic philosophy of the melting pot did not address or consider the cultural and ethnic differences of all those involved advocated the concept of cultural pluralism. Some concerned scholars in the 1920s introduced this concept of the preservation of differences and pluralism of cultures, as opposed to the melting pot vision (Rasmussen, 2008). Multiculturalists recognized the inherent value of different cultures and the need to preserve them; they asserted that assimilation could hurt minority cultures by stripping away their distinctive features. For example, teaching the English language for the purpose of stripping immigrants of their native language and cultural values was seen by this group as inimical of the future of United States (Hirschman 1983).

Gordon (1961) noted that World War I gave Anglo-conformity its fullest expression in the ideology of the Americanization movement: stripping immigrants of their native culture and attachments would make them Americans along Anglo-Saxon lines. The war was seen as the opportunity to speed up the dissembling and reassembling process into the melting pot. However, the ideology of a multicultural society gained momentum in the 1940s. Indeed, the "nation of immigrants" concept was used in the 1950s to showcase the US as a land filled with opportunities. Suárez-Orozco (2000) noted that the notion of conservative intellectuals seeking to safeguard Anglo-American cultural traditions was rejected by intellectuals on the left who embraced ideas of cultural pluralism. Indeed, multiculturalists claimed that the American mainstream was nothing more than an implicit oppressive mechanism that worked to subjugate those of minority groups.

Adepts of multiculturalism debated how best to approach the issues of immigration and national identity and laid the foundations for cultural pluralism. This, perhaps, may have come around full circle when Child (1943) and Lewin (1948) advocated acculturation as the strategic reaction of the minority in continuous contact with the dominant group. The psychologist Child (1943), when studying second-generation Italian Americans in New Haven, Connecticut, during the late 1930s, found that many Italian Americans lapsed into an apathetic identity state. The author found these populations to have loyalty to both identities. This view gave immigrants

and minorities several options with different motivations and consequences in which they could choose to acculturate into the dominant group.

As a result, a wide range of issues involving race, economy, education, and the right to vote had to be given consideration. The views of the dominant groups were that these types of race/ethnic divisions would eventually disappear, or at least be minimized in industrial society, and democratic political processes would eventually override the forces of prejudice and discrimination (Hirschman, 1983).

We know the immigrants of the early 1900s were absorbed into the boom of the industrialized age; however, toward the end of the first half of the 1900s, America was shifting from its industry-based economy to a competitive market system. Following World War II, therefore, there was a shift in the kind of workforce that the markets required and some softening in the melting pot requirements. The melting pot became, at a minimum, racially inclusive. But cultural pluralism was about to gain further momentum with the American Civil Right Movement and the enactment of the Immigration and Nationality Act of 1965.

The radical 1965 law abolished the old quota system based on national origins, and opened the way for new waves of immigrants of color, which had been barred from entering the country before then. According to Suárez-Orozco (2000), starting in 1965, a million new immigrants arrived in the United States every year until 1990; most of these were immigrants of color, the majority being from Latin America and Asia.

These were not the Irish or Italian white immigrants who arrived during the expansion of industrialization, and indeed Hirschman (1983) indicated that this change heightened the degree of racial antagonism overall. Hutchinson (1965) noted that from 1919 to 1950 there was a shift toward more skilled occupations among the foreign-born and their children. But it was not clear at the time how the arrival of these immigrants would affect the market, and therefore which philosophical frame – melting pot or multiculturalism – would prove a more useful lens, especially with regard to education and the workplace.

According to Suárez-Orozco (2000), it was no longer useful to assume that immigrants were joining a homogeneous society dominated by the middle-class, white, European American Protestants. The new immigrants of color were in fact reshaping the structures and foundation of the melting pot. It was this fundamental social shift that made schooling and education even more important for immigrants: education was a key indicator for socioeconomic achievement

as well as an investment that influenced subsequent social and economic mobility (Hirschman, 1983). In addition, according to Suárez-Orozco (2000), since the 1960s those coming to the US consisted of a mix of highly skilled and educated, along with low skilled immigrants. So, the melting pot assumption that held immigrants would do better in terms of schooling, health, and income only the longer they were in the United States was no longer valid.

Given this mix of backgrounds, immigrants tended to respond differently to the American way of life. On one hand, they did not need to be here a long time to do well, if they were highly skilled and highly educated. Others, however, may be poorly educated and unskilled, but still possess distinctive cultures and values that are complex and dynamic (Banks, 1999). Therefore, any forceful attempt in absorbing this immigrant group into dominant society may have led to what was known as acculturative stress. First noted by Redfield, Linton and Herskovits (1936), acculturative stress includes emotional reactions such as anxiety and depression. This was later theorized by Born (1970) and then Berry (1980) who found acculturative stress to be a significant problem for many immigrant groups.

The Challenges of the Two Competing Philosophies

The theory of the melting pot seems to fit less well for how immigration has looked like since the 1960s. Most of these immigrants come from Latin America, Asia and Africa, and, unlike the Irish, Italians, and Germans, they do not spread out across the country. The US Census Bureau's 2000 publication indicated that the majority of these immigrants settle in only a few states. For example, seventy-one percent of all recently arrived immigrants to the US reside in the metropolitan areas of California, New York, Florida, Texas, New Jersey, and Illinois. Although this way may be able, to some degree, lead to a 'melting-pot city', it by no means ensures a 'melting-pot country'.

Since new immigrant groups tend to settle in ways completely different than earlier ones, we have to ask if the new immigrants of color indeed are recreating the structures of Anglo-conformity. The reasons for these differences are not too difficult to imagine: crossing international boundaries leads to extensive life changes, including adapting to new cultural values, social rules, policies, and material environments; this can often be accompanied by a sense of loss in terms of careers, social ties, social status, and social identity (Tsai, 2006). This is perhaps more intensely the case for immigrants of color, than it was for previous European immigrants, as the change in environment can be much greater. Therefore, to complement for

these shortcomings and reduce their stress, these immigrants choose their settlement areas in ways that enable them to tap into existing support networks, leading to concentrations of various ethnic groups in only a few cities.

Suárez-Orozco (2000) noted that the US society is no longer, if it ever was, a uniform or coherent system. The immigrants of today, given their financial resources and social networks, end up gravitating toward very different sectors of the country. Given this reality, how can it be ensured that there is uniformity in the United State of America? It can well take several generations, if not longer, for these immigrants to completely blend into US culture. While the melting pot philosophy dominated, economic needs and economic pressure hurried ethnic integration; nonetheless, the process of alleviating pressure may have resulted into a society that is now more fragmented.

Prior to World War I, European immigrants were seen both as a strength and a source of prosperity, and the nation welcomed them with – mostly – open arms. This made it seem that the melting pot was real and accommodating; nonetheless, the concept of the melting pot has been criticized first for being slow to decide who was 'white enough' to be absorbed into the society, and later on for being unkind and racist to non-European immigrants. Indeed, perhaps the very foundational concept of the melting pot may be criticized directly, given that its vision of mixing various cultures as well as races was supposed to end up being, for the most part, a white Anglo Saxon culture.

It has been noted that since the 1960s most sociology and history research has increasingly overlooked the philosophical view of the melting pot in describing ethnic relations in the United Sates (Adams & Storther-Adams, 2001; Gordon, 1964; Glazer & Moynihan, 1970). Nonetheless, there have been some compromises between the two competing philosophical views discussed in this paper. For instance, this compromise is clearly seen in the use of English as the primary language in school, despite the importance of respecting students' first culture, and recognizing its equal importance to the adoptive (Goldberg, 1974).

Suárez-Orozco (2000) further noted that the progressive movement of multiculturalism is built on the Anglo-American culture and that its support for the equality of immigrant cultures made possible the further development of pluralistic ideas, to which the twentieth century espoused, as well as American cosmopolitanism. Yet there are still contradictions to be found in both schools of thought. The multicultural approach typically urges against the forceful

assimilation of immigrants, and often supports bilingual education and affirmative action; however, it is still unclear whether the end results desired are a relatively homogenous society. Also, the melting pot philosophy cannot be entirely dismissed either: as distinguished social scientists and others who advanced this field recognize, the common theme is that the immigrants of today can and will become Americans and they will enrich this nation's life, like so many before them.

The Scapegoating of Immigrants: Old Wine in a New Bottle

Using immigrant narratives to win elections, or blaming them for various local or national challenges is not a new phenomenon. Indeed, this is something that has been going on for over a century, and various groups of immigrants are by turns viewed with positive enthusiasm for their vibrant contributions, with distrust of their willingness to assimilate, or with downright rejection of their unusual backgrounds. Oftentimes, the legitimate challenges faced by many working and middle-class citizens have been weaponized against immigrants. Indeed, "socially disadvantaged groups, Betz suggests, are most prone to blame ethnic minorities and migrant populations for deteriorating conditions, loss of manufacturing jobs, and inadequate welfare services" (Inglehart & Norris, 2016 p. 11). Perhaps what is most notable in our current environment is the similarities with the nativist perspectives common around the turn of the 20th century, "particularly the focus on the purported inability of specific immigrant groups to assimilate, the misconception that they may therefore be dangerous to the native-born population, and fear that immigration threatens American workers" (Young, 2017, p. 217). Indeed, as Young (2017) notes, these ideas never really go away, but merely change from background to top of the agenda at various times, especially during economic downturns.

The immigrant demographic today is very similar to the US in 1920: 13.5 percent of all Americans today are foreign-born, a figure that stood at 13.2 percent in the early 20th century. And as in that earlier time, many doubt that the immigrants of the time could be assimilated into the main US culture. That is why now, as then, "politicians and the press frequently portrayed immigration as a threat to the nation" (Young, 2017, p. 218). The difference of course is that around the turn of the 20th century most immigrant groups were white Europeans. Currently however, most immigrants are Latinos, Asians and Africans. They are both documented and undocumented immigrants, and often their combined circumstances make it more difficult for them to assimilate.

Also notable at this current time is the reminder that many in the United States perhaps assumed that, regardless of previous immigration, the country would remain mostly white and Anglo-Saxon. Back in the early 1950s, Senator Patrick Anthony McCarran, a Democratic United States Senator from Nevada – who co-sponsored the 1952 Immigration and Nationality Act bill – argued that, assimilation (i.e., the ideal outcome) would only take place if the number of immigrants were kept in check and controlled by established 'old-stock' Protestant and Catholic Americans (Gerstle, 2017). Gerstle (2017) notes that the viewpoint of many white ethnics continues to be that all newcomers "assimilate to Anglo-Saxon ideals" (p. 330). Therefore, what we saw before and after the 2016 US election was not new, it was simply using immigrants as a scapegoat in the face of the domestic economic downturn. "In the past, much like today, politicians accused immigrants of maintaining distinct cultural norms, continuing to speak foreign languages and living in enclave communities" (Abramitzky & Boustan, 2017, p. 1). During the 2016 election, nominee Donald Trump focused heavily on immigration restrictions including building a wall along the US Mexico border, and ensuring that Muslims from some countries cannot enter the US (Rothwell, Diego-Rosell, 2016). And it was a lot of that type of populist rhetoric that was "especially appealing to lower middle class White people who felt disenfranchised and displaced" (Berlet & Lyons, 2018, p. 17).

Indeed, the economic hardship felt throughout the country does affect some groups more than others, and among those hardest hit are workers in low-wage jobs, those in cyclical industries, and poor whites living in areas with high immigrant concentrations. In addition, the current rhetoric does not only focus on anti-immigration policies, but also brings in traditionally left-leaning ideas of protecting various social benefits, such as social security, or economic priorities, such as infrastructure. Taken together, it is not hard to see why disadvantaged groups respond so well to harsh rhetoric that scapegoats immigrants and puts the blame of lost job opportunities and public services on them (Inglehart & Norris, 2016). However, in another similarity to other anti-immigrant times in our history, current talking points use fear and misinformation to turn feelings of dissatisfaction and marginalization into political drive (Daftary, 2018).

As previous sections of this paper have shown, immigrants both documented and undocumented help sustain our economy. Reston (2015) reported that immigrants give more to the US welfare system than they receive. For example, on earnings of $240 billion, they have

payed $90 billion in taxes and used only $5 billion in public benefits. Likewise, in its 2013 report, the US Chamber of Commerce found that although undocumented immigrants do not tap into the US welfare system, they do pay federal and state income, Social Security, and Medicare taxes. Further, Warren and Kerwin (2017) noted that almost a million undocumented immigrants own homes and pay mortgages.

Even so, many of those who connected with President Trump's immigration rhetoric have legitimate grievance. No country in this world will survive with uncontrolled boarders. The economy has steadily become more knowledge-based and global in nature. Well-paying manufacturing jobs that once made it possible for so many to live the American dream, can now be done either by automated systems, or by people living around the globe and being paid fractions of the salaries companies would have to pay Americans. It is also true that the United States does tolerate illegal immigration. No other country on earth has 11 million undocumented immigrants. However, this is not by accident. The US economy has learned to rely on both documented and undocumented immigrants to thrive. Undocumented immigrants, in particular, gladly preform many jobs that most Americans otherwise would not. Among others, they build our homes more cheaply and keep our grocery bills low, when compared to other developed nations.

Finally, as shown earlier, immigrants do effect wages and employment in the short run; so there is certainly validity to arguments about some job opportunities not being available to US-born Americans. However, at the end of the day, it comes down to supply and demand. Therefore, finding long-term solutions to these legitimate economic problems would require genuinely addressing the issue of supply and demand and looking at how the economy has been transformed; otherwise, immigrants will continue to be blamed for things far beyond their control.

Conclusion

From the above discussion, it would seem that advocates for the melting pot philosophy would like to see the United States as a nation of immigrants with strong nationalism, one people, one culture, and one language – English. However, it is also fair to say that the melting pot approach has shifted from previous goals of stripping immigrants of their identity on arrival. This may partly be due to occupational and workforce demands. There are some jobs that need to

be filled, and which will ordinarily not be filled by 'people within the existing melting pot'. Low skilled immigrants are often willing to take up those jobs.

The demographer Myers (2007) notes a couple of powerful demographic shifts at work. The large inflows of immigrants during the past three decades are seen with enormous levels of anxiety. This stems unsurprisingly from the fear of new and unwanted changes, especially to the nation's ethnic, social, and economic identities. At the same time, the retiring baby boom generation is draining the nation of highly skilled workers. Myers (2007) believes that the former shift can help solve the latter, as immigrants have the potential to fill the gaps forming in the workforce.

The question remains, however, whether the melting pot ideal still works for the changing US landscape. Where the US culture was once the force changing those who came to call it home, recent demographic changes and new waves of urban-bound immigrants are the ones who are in fact transforming the nation. Philosophers and sociologists may argue that the concepts of the melting pot mean little more than Anglo-conformity, which means that smooth assimilation would be nearly impossible for a majority of immigrants. Indeed, the study of culture is a complex undertaking. "Cultural values are emotion-laden, internalized assumptions, beliefs or standard that shaped how people we interpret our life experiences" (Merriam & Mohamad, 2000, p. 46). It gets even more complex if there exist a widely held assumption that 'cultural capital' is the culture of the dominant group in a society. Promoting the integration of immigrants into host communities may be more challenging when, in fact, there are no immigration policies and federal laws in place that explicitly support promotion of social, economic and civic integration in the US, despite the fact that the country is shaped by immigration (Gozdiak & Martin, 2005).

So does that mean the multiculturalism is the future of the US? On the one hand, Payan (2016) says that "many see the increased diversity that comes with immigration as a threat to national identity" (p. 1). On the other hand there is a definite cultural transformation happening in the US: younger and college-educated groups in particular are showing increased tolerance towards all sorts of diversity, including sexuality, LGBTQ+ rights, diverse family groupings, gender identity, diverse habits and ethical norms, and multicultural lifestyles (Inglehart & Norris, 2016).

Hirschman (1983) notes that education is an achievement in the socio-economic hierarchy as well as a resource that influences subsequent social and economic mobility. As such, immigrants' education is seen as the primary step toward full participation in American society. This may lead to immigrants becoming financially secure and fully participating in United States culture. However, this cannot be left to the democratic machine or market to figure it out. Let us remember that anti-immigrant fears at the turn of the 20th century drove forward legislation that sharply decreased the number of immigrants to the US for many decades to come. The current policy discussion seems to be lost in translation of these two philosophies. To be able to develop a policy that will be beneficial and lasting, the understanding of these to contrasting philosophies and their merits and demerits is crucial.

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DSS, Machine Learning, and Artificial Intelligence

David and Goliath Revisited:
How small investors are changing the landscape of financial markets.

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Abstract:

On January 12, 2021, a group of small investors coordinated a series of trades over the course of a few weeks in an effort to affect the positions of large hedge funds who short stocks. These large hedge funds were unaware of the tsunami that would overtake their short positions causing losses in the billions of dollars. A number of economic theories can provide insight into some of the activities of buyers; however, the retaliatory aspect of these small investors is new. The aim of this paper is to explore these actions using classical economics, behavioral economics and social coordination. Our aim is to collect and analyze stock market activity for stocks such as GameStop, AMC, KOSS, and Nokia, then retrieve the posts from Reddit to determine whether or not these activities could be predicted, as well as determine when a critical mass was obtained to successfully execute these stock trades.
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Introduction

During the last week of January 2021, news outlets were inundated with articles surrounding a number of stocks such as GameStop, AMC, and Nokia. Specifically, attention was paid to Gamestop in which the stock increased over 10,000% from its 52 week low in a matter of days (MarketWatch, Jan 29, 2021). This increase caused losses to a number of hedge funds including Melvin Capital which lost as much as 50% of its position (CNBC, Jan 29, 2021). The sudden spike in the price of Gamestop was repeated on a number of other stocks such as AMC, KOSS and Nokia.

The cause of the spike wasn't due to some unique valuation of the companies or change in the economic environment. The apparent financial revolt was engineered by a group of users on the social new network called Reddit. The Reddit forum r/Wallstreetbets was used to communicate and coordinate the activities of a number of small investors who were intent on changing the position of these stocks.

The aftermath of these positions has left traditional and institutional traders in shock at the massive losses. Significant pressure was placed on the trading platform Robinhood to suspend trading on a number of stocks. This action has had a significant backlash against Robinhood and large financial trading institutions, by smaller investors who believe their actions were legitimate and should in no way be inhibited. The larger traditional financial institutions and hedge funds were understandably upset at their large losses with no remedy available to recover. The situation has yielded an unprecedented standoff between smaller investors willing to potentially lose smaller amounts of money in order to cause massive losses in the billions to larger investors and hedge funds they feel have a disproportionate advantage in regulatory power and capital.

Our paper aims to analyze some of the causes of the situation and identify the events leading up to the fierce trading in January. By examining the subreddit r/Wallstreetbets and pulling the posts and exchanges we aim to examine the psychology behind the small traders, and explore

the behaviors. Using text mining and natural language processing such as sentiment analysis it should be possible to demonstrate the critical mass, when simple thoughts and posts translate into definitive action. Further, we aim to examine the trading information available and see when and how the critical mass was obtained to allow the trades to reach a point where the hedge funds began losing money, analyze their responses and the countervailing actions taken by the smaller investors. A number of economic theories can be used to explain the situation such as efficient market theory, countervailing power, rational choice, and game theory. We further aim to study behavioral economic theory which provides a unique framework of psychology and sociology in markets and auctions (Curtis, 2004). Finally, by bringing in additional theoretical foundations of psychology and information technology such as social exchange theory and self-efficacy, we can further examine how the collection of small traders was assembled and how they were embolden to act against larger seemingly more powerful hedge funds.

Literature review

In order to explain the phenomenon occurring in the market, it is important to provide a clear structure for the literature review. The review consists of three main sections. First, we review the relevant literature in classical economics and finance. This will help provide a strong foundation for understanding the market with respect to traditional auctions. Next, we review pertinent behavioral and psychological literature in order to connect the behavioral aspect of training and identify the differences between the large institutional investors and hedge funds juxtaposed to the small, and possible "activist" investor. Finally, we examine the literature around how the prospective information technology, specifically social media and social oriented websites not only aid in the behaviors but how they can accelerate the behavior and help achieve critical mass.

Economic literature

Financial markets are believed to be the most efficient way to provide liquidity and mitigate and distribute risk (Greenwood and Smith, 1997). This effect of the market is a cornerstone of economic theory. Power in economic markets has been well studied in the economic literature (Chirat, 2018). Unbalanced power in markets has two primary solutions, the power of competition, and regulation by the state (Rha and Widdows, 2002). Galbraith (1952) notes that the unbalanced power in a market can be "held in check by the countervailing power of those who are subject to it" . Buyers therefore can become stronger and can evolve in response to an aggregation of seller power, known as countervailing power (Galbraith, 1952). However, Hayek (1945) proposed in a prior paper, that market efficiencies occur naturally through the communication of information in the price of the market item. Hayek (1945) proposed that price is all that is necessary for information to be conveyed to other buyers and that power is balanced through pricing information. This notion that price can convey information is critical since information in financial markets generally occur through the price of the market item. Galbraith recognized some limitations to the theoretical application of countervailing power at the consumer level (Galbraith, 1952; Rha and Widdows, 2002). The belief of Galbraith was that countervailing power could not occur at a consumer or individual level since consumers lacked the ability to coordinate activity in the same manner that larger sellers could (Rha and Widdows, 2002).

Rha and Widdows (2002) anticipated how consumers could exercise countervailing power on the Internet. They believed that consumers could achieve a level of critical mass using internet technologies if consumers were organized and the communication between these buyers was simpler. Thus, the communication and coordination activity were required to

exercise countervailing power, both of which are easily found in social networking and social web activities such as the internet.

Information Technology Literature

The current use of Reddit to coordinate activity, form a group and decide on an action is a form of Group Decision Support Systems (GDSS). Decision theorists have shown that human decision making has evolved as technological changes have been made to overcome challenges and weakness in the normal decision making process (Rice, 1984). Generally, the deployment of technology should increase the productivity and effectiveness of decisions, since these technologies should make the decision making process more objective (Desanctis and Poole, 1994).

GDSS technology has been shown to improve performance in decision making and generate higher quality decisions (Desanctis and Poole, 1994). GDSS facilitates more anonymity among the group members thereby increasing the level of feedback and reducing a fear of retribution or ostracism by other members (Miranda, 1994). It has also been shown that the increased anonymity available from GDSS results in higher group productivity and more improved idea generation and better evaluation (Jessup and Tansik, 1991; Jessup et al., 1990). The subreddit r/Wallstreetbets is a classical example of an anonymous and highly collaborative decision making system. Users who can create pseudonyms and avatars in Reddit can effectively hide to a degree their personal activity and then act on a moment's notice in cooperation and coordination with other Reddit users.

Data, Textual Analytics and Methods

While a number of data sets are being collected, including stock price data, option price data and investor sentiment, this study also uses social media data for exploratory analysis. We used a preliminary collection of over 10 thousand tweets from Twitter on "Gamestop" to qualitatively sample public opinion on Gamestop trading. Extant research has supported this approach to managing information and identifying public sentiment across disciplines ranging from investing to pandemic management (Samuel, et al., 2020, 2020a). A textual analytics based word cloud summarizing and reflecting word frequency in the Tweets on Gamestop reveals an investments focussed audience, with other notable associated mentions of Robinhood and AMC (Figure 1).

The sample of Tweets showed a wide range of opinons and emotions, including predictions, politics, unrelated content, extension to global stock markets, humor and sarcasm:
"The GameStop thing appears to have completely broken people's minds", "Small investors flee Robinhood in wake of GameStop restrictions", "How r/WallStreetBets took down a hedge fund and rode GameStop stock to the moon", "Elizabeth Warren enters the GameStop fracas with open letter to SEC", "The Hedge Fund Genius Who Started GameStop's 4,800% Rally Now Calls It Unnatural, Insane, And Dangerous", Breaking down Reddit's battle over GameStop's stock" "i just wanted to say everything with GameStop is making me realize how I should have invested more time into our relationship... I treated it like a Game and I wish it never stopped. Anyways I wish the best for u I hope the relationship u in rn or bout to be In works out", "We got one at (drumroll, please) GameStop. Their site had it shipped and delivered within about a week. That was just post Christmas", "The GameStop scandal in USA is a warning signal of what could happen in Indian stock market. SEBI must renew guidelines for any (similar) future

eventuality in the Indian market so that common investors don't have to bear the brunt of the faults of trading platforms.", "AMC isn't saved yet and you really thing GameStop is going to survive? It's going the way of blockbuster eventually", "Most GameStop Stores Unaffected by Stock Surge, Except in Cleveland", "Robinhood Hit with Class Action Lawsuit for Trading Halt", "Lesson learned this week: Capitalism is not a gentle rain that rises the tide to lift all ships. Capitalism is a Cat. 5 hurricane. A few ships will rise & survive. The majority will barely tread water. Tragically, many will drown. #Fact #GameStop #wallstreetsbets #GeneralStrike", and **"The GameStop story....this has gotta be the greatest David vs. Goliath battle in many years.** *Hedge fund getting beaten at their own game. Amazing what happens when a few become many #gamestop #someonethinkoftheoligarchs"*

Figure 1: Gamestop Tweets Wordcloud

Discussion and Future Research

The authors of this paper aim to extend the existing research and focus on how Reddit, a form of GDSS, enables the small investors to out maneuver the hedge funds and effectively cause massive damage to their positions. It is not clear exactly whether the individual investors are either take a loss or be willing to take a loss, however by examining the discussion boards such as r/Wallstreetbets, we believe that the sentiment analysis will help provide a rich understanding of the beliefs of these users and their willingness to engage in such activity again. Extant research has demonstrated the feasibility of analyzing textual information facets and social media posts using machine learning, deep learning and other artificial intelligence

methods to extract meanings, study social media virality and estimate user performance and behavior (Garvey, et al., 2021; Samuel, et al., 2017, 2017a).

By researching these beliefs and behaviors it might be possible to predict the activities of these "Davidesque" investors, but also identify the motivations and learn how market efficiency plays a role in their activities. Using the data provided and advanced analytical techniques we aim to explore new areas of research for social media and how it impacts markets in general.

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Education, Curriculum, and Cases

A SIGMOID MODEL OF CORRELATION TO IDENTIFY BIAS IN STUDENTS' EVALUATION OF TEACHING

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Abstract

A common issue raised in evaluating faculty is that students do not fairly evaluate the professor's teaching effectiveness. The argument is that students are biased, and this bias is a direct result of the difficulty or the rigor of the course.

In this paper an alternative theory is proposed; the statistical relationship between a professor's student evaluation is not determined by rigor but is instead a reaction to grade inflation. This is shown in that overall grades are not significant in predicting the course evaluation, but the percentage of the traditionally *average* grade, a C, is.

This analysis investigates the correlation between student evaluations and grades in two ways; the common Pearson linear correlation, and since the range of evaluative scores and grade percentages are both constrained, a nonlinear sigmoid regression model.

KEYWORDS: Sigmoid Regression, Evaluations, Teaching

Introduction

The *Student Evaluation of Teaching*, commonly known by the acronym *SET* but called the *SRTE - Student Rating of Teaching Effectiveness* at Penn State - has been a staple of college and university courses for nearly one hundred years(Knight, 1928). While their use is ubiquitous, it has not been without controversy.

History

Concerns quickly arose about its use with its implementation as the Perdue Scale in the 1920s. Should the results be used as the single source of evaluation of a professor's teaching ability or should they be combined with other measures such as self and peer review? Is it appropriate to use

the SET for issues involving retention, promotion, or tenure?(Algozzine et al., 2004) And if not, how should they be used?(Abrami, 1989)

If the SET had been voluntary - meaning that a professor may use the results for self-reflection but they would remain confidential and not be used for any other purpose - then questions of their accuracy may have been moot. But the reality is that the SET is used in a manner similar to any corporate employee evaluation. Thus their validity is of vital importance.

Concerns about the SET's statistical accuracy were made from their onset, prompting H.H. Remming - the Perdue Scale's creator - to conduct statistical analyses to confirm its validity. Using factor analysis he claimed that the statistical results supported the conclusions of the scale and its implementation(Smalzried & Remmers, 1943). Further research began to address its shortfalls, suggesting changes to how the evaluations were performed and the interpretation of the results(Bendig, 1953)(Bendig, 1954).

Issues with the SET

A common faculty response of the use of SETs is that they are simply inaccurate; that students are incapable of measuring a professor's effectiveness. There are many variations of this. One is that students lack the experiential knowledge to accurately comment on teaching quality. Another questions if students are biased by any of several characteristics such as the professor's gender, the difficulty of the course, their own expectations, or perhaps just the level of the course.

Students' ability to evaluate The difficulty in studying ability is inherent in the purpose of the task. If the purpose of the SET is to measure the students' perceptions of their professor and the course then how can it be determined if these perceptions are incorrect? If this is accepted then it begs the question. There is no purpose to studying the accuracy of the responses since the the SET is simply an opinion census.

If it is accepted that the SET is limited to the students' feelings towards a particular professor then there is the fear that they could use the SET as a means of extracting revenge on a professor that they dislike. This sentiment is common enough that Penn State made the following statement

> "Avoid stating that SRTEs are used for P&T [promotion and tenure] or annual review. Not only does students knowing this make you more vulnerable, it also can send the wrong message, i.e. that you really don't care about student feedback, only that you get a promotion or raise."(McQuiggen, 2014)

The alternative to the students' inability is that the SET do provide an accurate measureme of the professors' abilities. Early studies of the SET did show a level of precision in that the responses that students made for a particular professor were consistent. But precision does not imply accuracy.

In the 1960s and 1970s several studies were made that supported that they were accurate. One such study, in which student evaluations were compared to peer reviews by colleagues, showed that student evaluations were much in line with those of the professors' colleagues(Seldin, 1979). But recent studies are casting doubt on these original results.

One aspect of the current research brings to light possible statistical bias in students' responses. The bias appears to be taking two forms; gender bias in how male or female students rate male and female professors, and also a perceptual bias based upon the perceived difficulty of a course.

Gender Bias While any form of bias is worrisome, gender bias is particularly pernicious if the evaluations are being used for any purpose other than introspection. In a recent study of gender bias it has been determined that first year male students give male professors a significantly higher number of excellent rankings than they do their female professors. This research presents results showing that this bias occurs across all common measurements in an SET, even items that are not subjective but instead absolute such as the time that it takes to return an assignment(Boring, Ottoboni, & Stark, 2016). Further the bias is inherent even when the student does not come into contact with the professor but only knows them through gender common names(Macnell, Driscoll, & Hunt, 2015).

Course Rigor Another common argument against the SET is that students give high evaluative scores to professors in courses that lack rigor - what might be considered an *easy* course. A more rigorous course - a *hard* course - would thus explain why a professor might have been rated lower than a colleague. This explanation can be extended to not only courses that are accepted as difficult, but to courses that students might only perceive as such.

Measuring a correlation between the difficulty of the course and a students' teaching evaluation is complicated by the means of measuring the rigor of the course. A common approach has been to compare the students' perception of the difficulty with their faculty evaluation. This has been conducted several times in different ways. If the SET includes a question about the difficulty of the course, as does the Perdue Scale, then the ratings can be compared.(Walker, 1974) But if they do not then an alternative must be found. One suggestion is to use a common online tool *RateMyProfessors.com*(*Rate My Professors*, 2017). Using this you could find the professor and create an aggregate score for the ability and difficulty. This has been done for a small group of professors in a single program(Constand & Pace, 2014). In this study it was determined that when the student perceives the professor to be difficult they rate them lower.

Grade Inflation The student's perception of rigor may take an alternative form - grade inflation(Stroebe, 2016). In this research arguments are presented to correlate the SET to grade in-

flation. The hypothesis is that professors are feeling the need to raise grades in order to raise their own student evaluations(Eiszler, 2002)(Babcock, 2010).

Measuring the correlation between grade - and by association grade inflation - can be done by making comparisons with the actual grades recorded for a course.

Methodology

A weakness in correlating students' evaluation of teaching and course rigor is in measuring the difficulty of the course. Previous attempts have used the students' perception of the course either through a question on the SET or through an outside source. But this creates a paradox; your goal is to measure student opinions on difficult courses by first asking them if the course was difficult. Such an attempt could add to confirmation bias. That is, once asked if the course was *hard* they change their rating of the professor to conform to that. Instead there should be an attempt to not collect the students' opinion on the difficulty of the course but measure the actually difficulty.

Letter Grade as a Measure of Difficulty

The most direct measure of the difficulty of a course should be the grades that the students earn in the course. Conventional wisdom is that if a course is difficult then the number or percentage of As, Bs, et al will trend lower while the number of Cs, D's and F's would be expected to increase.

As a regression model, the SET score can be explained as a function of the number of each grade awarded.

$$\text{SET} = f\left(A, A-, B+, B, B-, C+, C, D, F\right) \tag{1}$$

Using the actual count of each assigned grade will insert bias in that classes with a large enrollment will have a larger number of each grade than a similar course with a smaller enrollment. Even if the regression were performed on a single grade - for example the number of As - the model would be biased towards large classes. A large class must have a larger number of As than would a smaller class, thus the size of the class would influence any measure of the difficulty of the course.

There are alternatives. One is to add the class size as an explanatory variable, but to make it a numeraire in the model. In this way each grade is reflected as simply a percentage of those earned.

But what if class size is an influencer to the model but not a true measure of difficulty? That is, what if students simply prefer small - or large - classes? Before using enrollment an analysis should be performed to test the hypothesis that enrollment is not correlated to the SET.

Multicollinearity is another issue that will need to be addressed. It is obvious that the sum of the variables must be 1. Because of this the percentage of any particular grade will always be a linear combination of the other grades. As such any decrease in the number of occurrences would

require a similar increase in the others - a clear example of multicollinearity, and a serious issue in the hypothesis test of the significance of the explanatory variables.

Multicollinearity can be reduced by combining the grades into a single variable, in this case the common grade point average (*GPA*) using the standard 0 to 4 scale. With only a single explanatory variable the issue of multicollinearity is eliminated

But a second issue may occur as a result of the way in which the GPA is calculated. There are an infinite number of combinations of grades that will result in each possible value. For example, a class with two students who earned an *A* and an *F* would have the same grade point average as a course in which the two students each received *C*s. But these courses would probably be considered to be different.

So while the GPA will be used as an explanatory variable, a second set of models in which the percentage of each grade is used alone will also be evaluated.

Late Drops as a Measure of Difficulty

An alternative to the percentage of grades that students earn upon completion of the course is to key off of the percentage of students who dropped the course. Logic would say that students drop courses in a higher numbers when they fear a poor or failing grade. And while some may argue that SET ratings by students who late drop a course reflect a case of *sour grapes*, the question of a vendetta against a particular professor is moot since, at least at Penn State, any student who drops a course is unable to complete the SRTE for that course. Instead it would reflect the opinions of those students who remain in the course.

$$SRTE = f \text{ (Pct Late Drops)} \qquad (2)$$

Modeling

Using the results in the correlation tables several descriptive models could be formed with *SRTE* as the response variable. The most likely is expected to be

$$SRTE = f \text{ (Pct C)} \qquad (3)$$

but GPA and WD are also possible.

In each case a linear model could be used,

$$SRTE = b_0 + b_1 x \qquad (4)$$

but both the input and output are bounded variables. The output, SRTE, is bounded by 1 and 7.

For GPA the variable is bounded by 0 to 4. In each of the other two cases, WD and C the variables are percentages and are thus bounded by 0 to 1. The boundedness of the response variable - SRTE - suggests the use of a sigmoid function.

$$\text{SRTE} = \frac{A}{1 + e^{-b(x - x_0)}} + C \tag{5}$$

In the model to be used in equation 5, A is the scaling factor, x_0 the horizontal shift, and C is the vertical shift - in this case $A = 6$ and $C = 1$.

The coefficients of the model can be estimated using ordinary least squares on

$$\begin{aligned} \ln\left(\frac{6}{\text{SRTE} - 1} - 1\right) &= -b(x - x_0) \\ &= bx_0 - bx \\ &= b_0 + b_1 x \end{aligned} \tag{6}$$

where $b_0 = bx_0$ is a constant.

Results

Data was collected on the Student Response to Teaching Effectiveness (SRTE) evaluations that are collected by Penn State at the end of each semester. This version of the SET ask each student to evaluate the professor on a seven point Likert scale.

Exploratory Results

The aggregate score for each professor in Penn State Harrisburg's School of Science, Engineering, and Technology was then determined for the Spring and Fall 2015 semesters. In addition, the number of students that the professor taught during those two semesters and the number of each letter grade was recorded. In addition data on the number of students who had late dropped the courses was also tabulated.

The sample consisted of sixty-three professors. Thirty-five were tenure line faculty while twenty-eight were not part of the tenure track. During the time from which the data was collected they taught a collective 467 sections with a total of $10,266$ section-students.

The exploratory results in table 1 show that the data is reasonably symmetrical but with extreme values for each variable. This is obvious when looking at the number of sections and number of students variables.

Table 1: Course Data Per Professor for 2015

	Mean	**Median**	**Range**
Sections	7.41	7.00	$2 - 17$
Students	162.95	154.00	$18 - 357$
SET[1]	5.75	5.79	$3.10 - 6.88$
GPA	2.93	2.91	$2.12 - 3.68$

Correlation

Class size affects needed to be eliminated when calculating the correlation. For the number of students the correlation had a value of $r = 0.08$ with t-value of $t = 0.63$. The small t-value indicates that the hypothesis that the correlation is zero cannot be rejected, thus eliminating enrollment being a significant variable. At the same time it then became a reasonable choice as numeraire - converting all of the raw grades to percentages.

For the purpose of making predictions it is important to identify the explanatory and the response variables and their relationship. In this model it is clear that the response is the value of the student evaluation. There were several variations for the inputs to the model based upon the explanatory variables.

The remaining choices of variables were assisted by reviewing the correlation coefficients in table 2.

The strongest correlation between the students' evaluation score is with the number of C and C+ grades followed by the percentage of withdrawals (WD). An issue is the significance of these values. Testing against the hypothesis of $r = 0$, we find that the p-value is above the accepted level of $\alpha = 0.05$ so we cannot reject the hypothesis that the values of the correlation coefficient is zero - indicating no linear correlation.

An improvement can be made by reducing the number of possible grades. When the plus - minus grades are combined into the traditional A, B, C, D and F in table 3 the results for the percentage of C grades (combining C+ and C) decreases and also become a significant result. The correlation of the percentage of withdrawals (WD) with each combined grade may be significant but not relative for the model, for the sake of brevity it was not included in table 3.

The results in table 3 indicate that there is a significant correlation between the student evaluation and the percentage of C grades received. Using this it should be possible to create the regression model for the data. In keeping with the observation that the SRTE is bounded by 0 to 7 the sigmoid function was fit to the data.

This second table also shows the correlation between the explanatory variables. For each pair the linear association is non-zero and significant. This is clear evidence that a multivariable model would be impacted by multicollinearity between the input variables.

Table 2: Correlation Coefficients for Percentage of All Grades Received (with p-value for r = 0.0)

Variable	SRTE	GPA	A	A-	B+	B	B-	C+	C	D	F	WD
SRTE	1.00 (0.00)	0.11 (0.38)	0.13 (0.31)	0.01 (0.96)	0.18 (0.15)	-.05 (0.69)	0.04 (0.76)	-.22 (0.09)	-.21 (0.09)	0.03 (0.81)	-.05 (0.72)	-.18 (0.16)
GPA		1.00 (0.00)	0.79 (0.00)	0.55 (0.00)	0.42 (0.00)	-.02 (0.87)	-.20 (0.12)	-.51 (0.00)	-.77 (0.00)	-.81 (0.00)	-.80 (0.00)	-.58 (0.00)
A			1.00 (0.00)	0.14 (0.27)	-.03 (0.84)	-.22 (0.08)	-.39 (0.00)	-.52 (0.00)	-.59 (0.00)	-.52 (0.00)	-.44 (0.00)	-.35 (0.01)
A-				1.00 (0.00)	0.46 (0.00)	-.30 (0.02)	-.05 (0.67)	-.16 (0.21)	-.58 (0.00)	-.45 (0.00)	-.40 (0.00)	-.29 (0.02)
B+					1.00 (0.00)	0.05 (0.71)	0.23 (0.07)	-.26 (0.04)	-.62 (0.00)	-.33 (0.01)	-.38 (0.00)	-.20 (0.11)
B						1.00 (0.00)	-.18 (0.18)	-.17 (0.13)	0.26 (0.06)	-.13 (0.21)	-.27 (0.02)	-.23 (0.04)
B-							1.00 (0.00)	0.21 (0.10)	-.01 (0.95)	0.04 (0.78)	0.04 (0.78)	0.14 (0.29)
C+								1.00 (0.00)	0.38 (0.00)	0.26 (0.04)	0.27 (0.03)	0.19 (0.13)
C									1.00 (0.00)	0.46 (0.00)	0.45 (0.00)	0.31 (0.01)
D										1.00 (0.00)	0.64 (0.00)	0.47 (0.00)
F											1.00 (0.00)	0.70 (0.00)
WD												1.00 (0.00)

Predictive Model

Despite the observation that the only significant correlation was between the SRTE and the percentage of Cs - that is the percentage of $C+$ and C combined, it was decided to perform the regression on each of the combined letter grades as well as the professor's overall grade point average (GPA).

In each, the coefficients b_0 and b_1 of the sigmoid model were evaluated with measurements of their significance. As can bee seen in table 4 the only variable that continues to be significant is the percentage of combined Cs. The statistical significance of this variable actually increases with the non-linear sigmoid model.

The plots for each possible variable with its sigmoid function are included as figures 1 thorugh

Table 3: Correlation Coefficients for Pct. of Combined Grades Received (with p-value for r = 0.0)

	SRTE	A	B	C	D	F
SRTE	1.00 (0.00)	0.11 (0.38)	0.08 (0.52)	-.25 (0.05)	0.03 (0.81)	-.05 (0.72)
A		1.00 (0.00)	-.28 (0.02)	-.79 (0.00)	-.63 (0.00)	-.55 (0.00)
B			1.00 (0.00)	-.19 (0.14)	-.25 (0.05)	-.36 (0.00)
C				1.00 (0.00)	0.46 (0.00)	0.46 (0.00)
D					1.00 (0.00)	0.64 (0.00)
F						1.00 (0.00)

Table 4: Regression Coefficients for Grade Input Variables

Var		coef	t	(p-value)
GPA	b_0	-0.4805	-0.627	(0.533)
	b_1	$-.3345$	-1.288	(0.202)
A	b_0	-1.1685	-4.307	(0.000)
	b_1	-0.7478	-1.149	(0.255)
B	b_0	-1.1039	-2.950	(0.004)
	b_1	-1.1167	-0.984	(0.329)
C	b_0	-1.9185	-9.254	(0.000)
	b_1	2.4966	2.488	(0.016)
D	b_0	-1.4942	-9.155	(0.000)
	b_1	0.5555	0.270	(0.788)
F	b_0	-1.5151	-10.058	(0.000)
	b_1	1.2089	0.492	(0.625)

7. In each case the best fit line is

$$\text{SRTE} = \frac{6}{1 + e^{-b(x-x_0)}} + 1 \tag{7}$$

where $b = -b_1$ and $x_0 = b_0/b$

With the exception of figure 4 the independent variable is not significant and the data plot is only included to allow comparisons between the scatter plots. The best fit sigmoid curve for each shows this lack of significance with their nearly horizontal paths.

But figure 4 is different. In this data plot the significance of the sigmoid function is more pronounced. Evaluating the coefficients, the function becomes

$$
\begin{aligned}
\text{SRTE} \quad &= \quad \frac{6}{1 + e^{(b_1 x + b_0)}} + 1 \\
&= \quad \frac{6}{1 + e^{(2.4966x - 1.9185)}} + 1 \\
&= \quad \frac{6}{1 + e^{2.4966(x - .7684)}} + 1 \tag{8}
\end{aligned}
$$

The regression coefficients yield an exponential growth coefficient of $b = 2.5$ and a horizontal shift of $x_0 = -1.5$. As this is a sigmoid function, the positive growth coefficient indicates a decreasing function. This indicates that as the percentage of C grades increase the professor's student evaluation is expected to decrease.
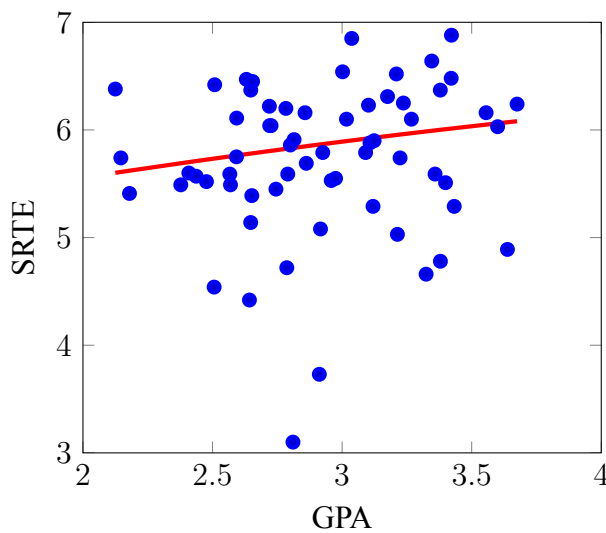
Figure 1: SRTE as a function of the class GPA
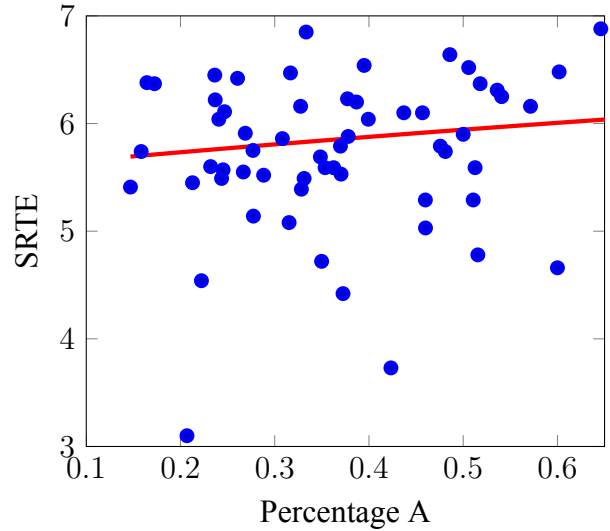
Figure 2: SRTE as a function of the Percentage of As

Conclusions

A common complaint from faculty is that their student evaluations do not accurately reflect their abilities. They argue that bias occurs in that the students are rating the rigor of the course not the quality of the professor. If the course is easy then the professor will receive a high rating. And as the difficulty of a class increases the professor's student evaluation of their teaching decreases. Or so says the conventional wisdom.

This theory was tested by creating a predictive model of a professor's student evaluation as a function of several expected measures of difficulty; course GPA, percentage of each specific grade
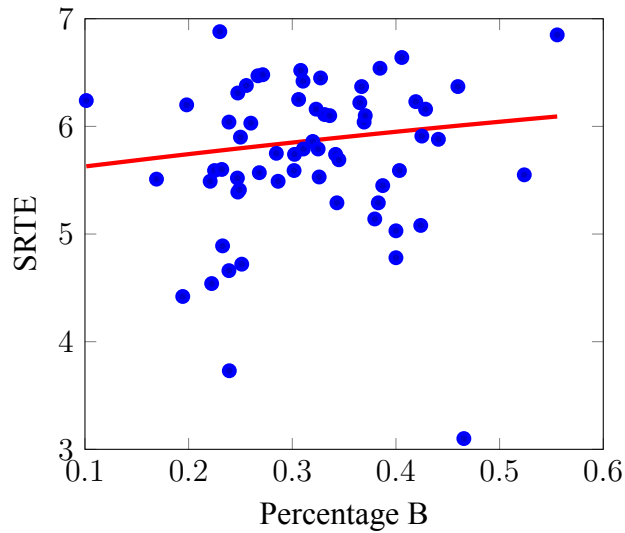
Figure 3: SRTE as a function of the Percentage of Bs
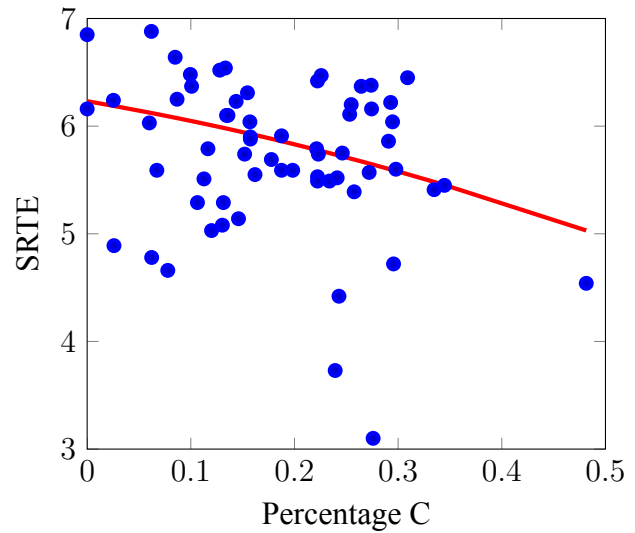
Figure 4: SRTE as a function of the Percentage of Cs
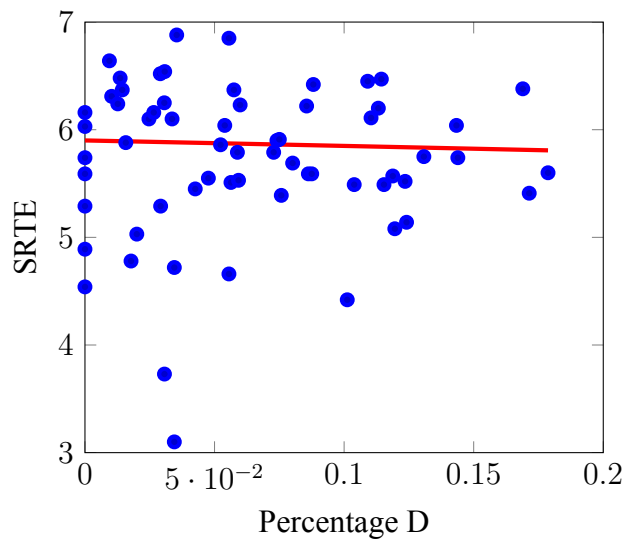
Figure 5: SRTE as a function of the Percentage of D
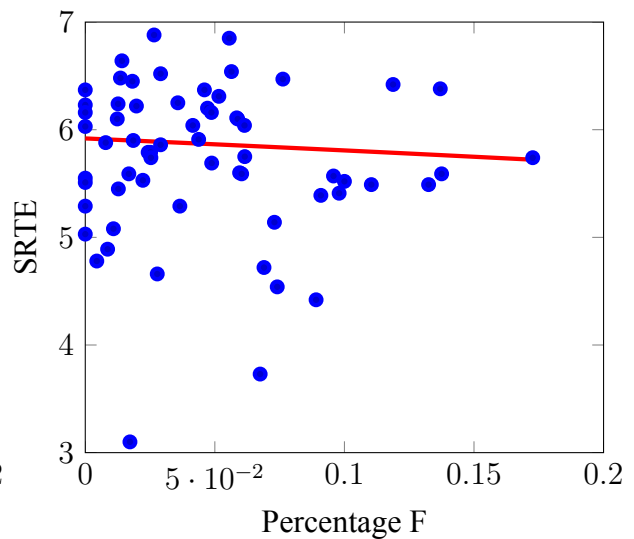
Figure 6: SRTE as a function of the Percentage of F

recorded, and the percentage of course withdrawals. Because of the bounded nature of student evaluations - at Penn State they use a seven point Likert scale - the model used a sigmoid function.

Using 2015 spring and fall semester data from the School of Science, Engineering, and Technology at Penn State Harrisburg regression models were used to model the response of the student evaluation of the professor - the *SRTE* - to various explanatory indicators of rigor. These explanatory variables were the overall course grade point average (*GPA*), the percentage of grades - *A*, *B*, *C*, *D*, *F*, and course withdrawals (*WD*).
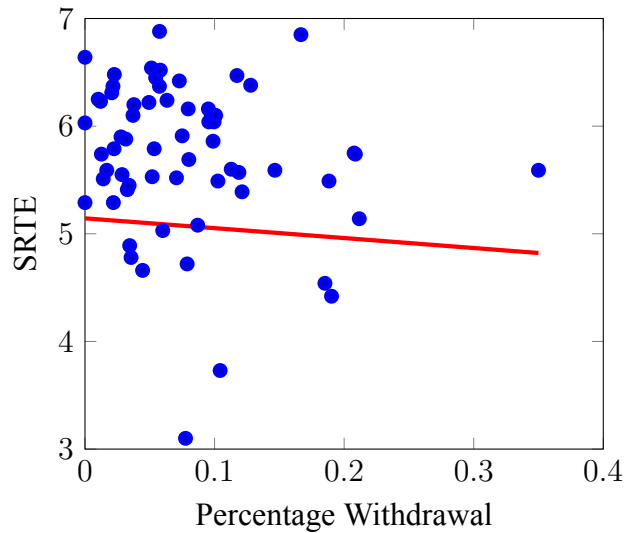
Figure 7: SRTE as a function of the Percentage of Course Withdrawals

With one exception, the results were clear - there was no statistically significant bias in the students' evaluations with respect to the course *GPA*, letter grade, or percentage of withdrawals. The one exception was the percentage of *C*s.

The results of the model indicate that the rate of change coefficient for the percentage of *C*s was significant with a p-value of $p = 0.016$. This can be interpreted in two ways.

Course Rigor

Since any student who drops a course is precluded from completing the *SRTE*, the *WD* students would not have the opportunity to evaluate the professor. Instead, of the students who remained the ones who found it to a challenge are those who at completion received a *C*. An issue with this lies in the lack of correlation of *A*s, *B*, *D*s, or *F*s.

If the percentage of grades were significantly correlated to rigor, it should be expected that the affect would have appeared in the other grades or be significant in the percentage of withdrawals. In each case it was not. There is a second possible explanation - grade inflation.

Grade Inflation

The significance of the percentage of *C*s in a course is more likely an indication of the expectation of the student with respect to their performance. With higher grades - *A*s and *B*s - the student expects to do well and the issue does not enter into their choices when evaluating the professor. On the opposite end of the spectrum students who receive failing grades may already be expecting a poorer grade. It is that middle position that becomes significant.

When the percentage of *C* grades increases the recipients may be coming from students who had begun the semester expecting an *A* or a *B*. When their grade is below their expectation - but not failing - they complete their course but show their disappointment in how they rate their professor.

If this is true - and it is currently an hypothesis without the additional data to support it - this would indicate that the issue is one not of vindictiveness on behalf of the student but instead an issue of grade inflation.

This confirms what is an understated issue with grade inflation. Students have come to expect high grades - or at least not below a *B* - and when they realize that they are not earning that grade they blame the professor(Ewing, 2012).

These results do not support that the variations in SET can be explained by the differences in the course difficulty as much as it should be credited to the disappointment in the expectations of the student. As to the original premise - that students exhibit bias in evaluating their professors - the grade inflation explanation supports the argument that SET results are biased but in this case not in the overt way of discipline or gender.

Additional forms of bias can be included into this study. Using this same regression approach questions of bias in discipline, gender, age, professorial rank, or course level can - and should - be studied as well.

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[1]SET statistics are calculated using grouped data

AN EXPLORATORY STUDY OF GRADUATE STUDENT PERFORMANCE IN A HYBRID CLASS

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ABSTRACT

Prior research on student performance with different content delivery formats shows mixed results and often occur across semesters, students and instructors. This study compares graduate business student performance in an operations management course for content delivered in a hybrid course where content delivery is both face-to-face and online to the same students by the same instructor in the same semester. Results demonstrate a significant difference in student performance and favor face-to-face content delivery.

Keywords**:** Hybrid, Graduate business students, Performance

INTRODUCTION

Administrators argue that online learning is the same or superior to those in the traditional face-to-face (FTF) classroom (Allen & Seaman, 2013); however, critics argue that online education does not replicate the learning that occurs in the traditional face-to-face (FTF) classroom due to intrinsic differences (Bejerano, 2008). Correctly or incorrectly, instructors assume that whenever they implement information technology in a classroom, it contributes to student learning (Peng, 2009). However, instructors should evaluate the various assessment activities used to evaluate student performance and enhance the learning environment to verify the relevance to students learning (e.g. Braunscheidel, Fish & Shambu, 2013; Fish, 2015, 2017; Santos, Hu & Jordan, 2014).   In general, when instructors enthusiastically embrace online education and carefully integrate assignments and course materials, the students embrace it as well (Arasasingham et al., 2011).

Many studies researched student performance in various educational formats: FTF, online and hybrid (e.g. Angiello, 2010, Cathoral et al., 2018, Ginns & Ellis, 2007; Love, Hodge, Grandgenett, & Swift, 2014; Metzgar, 2014; Olitsky & Cosgrove, 2014; Terry, 2007; Verhoeven & Rudchenko, 2013). In two different studies – one in an undergraduate managerial economics course (Metzgar, 2014) and another in an undergraduate microeconomics course (Verhoeven & Rudchenko, 2013) - student performance was lower in hybrid classes compared to traditional FTF classes. Contrastingly, in an introductory economics course, a change in student performance between online and FTF did not exist (Olitsky & Cosgrove, 2014). In yet another study, researchers found that student performance was higher for instruction that combined FTF lecture and online components than purely FTF instruction or purely online instruction (Angiello, 2010). In a study of graduate business student performance over a decade ago, student performance on class assignments delivered through FTF, online, and hybrid formats were the same (Terry, 2007). Additionally, the study found that graduate online students performed over 4% lower on the final exam than graduate students who learned material in FTF or hybrid delivery (Terry, 2007). Results are obviously mixed; however, most studies evaluate student performance across different instructors or semesters. A hybrid course, taught by *the same instructor* in the *same semester*, offered a unique opportunity to analyze student performance on content delivered FTF versus online.

Specific definitions for online, hybrid and FTF vary as technology continues to change and class include different, up-to-date technological elements. In this study, hybrid refers to content delivery through an 'every other week' format whereby the students participates one week in FTF content delivery and the next week in 100% online delivery. FTF content delivery refers to the traditional instructor lecture style where the students and instructors are in the same physical location at the same time. In FTF instruction, the instructor lectures and interacts with the students, answering questions and encouraging participation in real-time. Online delivery refers to all instructional materials being located online, such as instructor pre-recorded lectures that are passive and do not allow for real-time questioning.

This study seeks to explore the impact of different educational formats in a hybrid class - specifically online and FTF content instruction on graduate business student performance. The

specific research question is: *Did graduate students perform the same on content delivered in FTF and online?* Specifically, this study seeks to explore the following hypothesis:

H1: <u>Student Performance on FTF versus Online Content</u>: There is no difference between student performance for content delivered in the FTF and online environment.

METHOD

With increasing graduate business student demands to offer more online components in programs, an AACSB-accredited University in the northeast began the transition to a hybrid program in 2019. In the spring of 2020, prior to the pandemic, an instructor taught an operations management course as a hybrid course. By hybrid, the format for delivery entailed an 'every-other' week FTF session – online transition. The University prides itself on being a teaching University with small class sizes (average 17) and significant instructor-to-student interaction. Students typically regard the operations management course as 'difficult' as it includes qualitative and quantitative content that they do not have prior experience on. Topics covered (outlined here in the sequence they were covered) include introduction to operations management, process analysis, quality management and statistical process control, supply chain design and integration, layout design, forecasting, sustainability, capacity management, inventory management, operations planning, resource planning, Material Requirements Planning, scheduling, and lean systems. The same instructor taught two sections of the hybrid course. Prior to the pandemic shutdown, topics covered included introduction to operations through sustainability. Given the nature of the material, the instructor purposely chose the least mathematical topics for online education – process analysis, supply chain design and integration and sustainability. Over the first eight weeks of the course, the only mathematical techniques that the instructor reviewed included break-even analysis and preference matrices. Both of these techniques are very simple and not complex. Whether it was an online or FTF week, student expectations included reading the corresponding textbook material. The instructor conducted FTF classes in a traditional lecture format with student participation. For both online and FTF sessions, instructor handouts with an outline of the class were given to the students as the basis for their notetaking. For online weeks, the instructor posted videotapes online of the traditional lecture to the course learning management system (LMS). During online sessions, students listened to the videotapes and completed the course handouts – similar to their FTF class

sessions. Additionally, the instructor provided suggested problems with solutions to the LMS for each topic.

The graded requirements for the course included quizzes, homework assignments, individual assignments, a midterm and a final exam. The instructor administered 5 quizzes over the semester, with the 4 best scores counting toward a student's overall grade, and quizzes accounted for 25% of a student's overall grade. The student completed 10 online homework assignments that were administered through a notable textbook publisher with a focus on mastery through 3 tries on each problem, and the homework grade counted toward 10% of a student's overall grade. Students were required to complete 3 individual written assignments, worth 15% of the student's overall grade. A non-cumulative midterm and final exam were each worth 25% of a student's overall grade. Prior to the pandemic, the instructor administered three quizzes in class. They consisted of multiple choice questions, short answer questions and math problems. Students could not have any materials other than a basic calculator, and the instructor provided all formulas for testing. Quiz content include two weeks of material (one FTF session reviewed two weeks prior to the quiz and one online session reviewed online a week prior to the quiz). Each quiz took roughly 25 minutes to administer in-class. The midterm consisted of 30 multiple choice questions, 5 short answer questions and 6 mathematical questions. For this study, for content delivered through FTF instruction, there were 29 multiple choice questions, 6 short answer questions (18 points total) and 7 math questions (39 points total). For content delivered online, there were 15 multiple choice questions, 4 short answer questions (16 points total) and 2 math questions (8 points total). The instructor graded all quiz and exam short-answer and math problems, and awarded partial credit using a rubric for consistency between students. For purposes of this study, the instructor recorded the FTF and online question results for multiple choice, short answer and math questions for each student. Homework results were not included as the focus of the homework assignments was on mastery of the technique with multiple tries, 'hints' were given, and the event was recorded online versus in a classroom setting.

ANALYSIS

In the spring of 2020, COVID19 interrupted many lives – and the University switched to fully online following the eight week of classes. For purposes of this study, only the first eight weeks

of the course resulted in a FTF-to-online session comparison whereby the testing was the same for all students. Fifty-four students participated in this study – 25 students in one section and 29 in the other. The instructor gathered all question results and coded them as material reviewed FTF or online, and whether the question was a multiple choice, short answer or math question. Since the number of points for FTF and online were not equal, for comparison purposes, student scores were calculated as a percentage. As shown in Table 1, paired t-test analysis (two-tails) results showed a significant difference (p=.000) for student performance on FTF and online content. Students performed significantly better on average for content administered FTF (79.24) than online (70.98). In particular, they performed significantly better on short answer questions (.0210) covered FTF than online. The results show a slight significance for multiple choice questions (p=.0776). There was no statistical difference (p=.1666) on math questions between content covered in-class versus online.

Table 1. Comparison of Student Performance on FTF and Online Administered Content.

Question Type	FTF Average	Online Average	T-Test
Multiple Choice	75.48	72.1	.0776 **
Short Answer	69.01	63.80	.0210 *
Math	86.75	83.22	.1666
Total	79.24	70.98	.0000 *

$*p \leq .05$, $** p \leq .10$

DISCUSSION

Research regarding the effectiveness of different educational formats is mixed (e.g. Angiello, 2010, Cathoral et al., 2018, Ginns & Ellis, 2007; Love, Hodge, Grandgenett, & Swift, 2014; Metzgar, 2014; Olitsky & Cosgrove, 2014; Terry, 2007; Verhoeven & Rudchenko, 2013). These studies typically compared different students in different treatments. This study analyzed the *same graduate student* in both FTF and online treatments and their performance on content delivered in each method was tested simultaneously. The *same instructor delivered the material* in the *same semester*. Analysis revealed a significant difference in student performance between FTF and online delivered content and favored the traditional FTF method. The general results contrast another older study that showed no significant differences between FTF, online and hybrid in graduate business student performance (Terry, 2007) and the introductory economics course where no difference in student performance between online and FTF existed (Olitsky & Cosgrove, 2014). This is particularly interesting as the FTF material was administered two

weeks prior to the online material for quiz testing, and typically covered more difficult material that also required quantitative understanding of the topic.

With respect to the different testing formats, graduate students showed a significant difference in their performance on short answer questions and a slight significance on multiple choice, but not on mathematical questions. As for the lack of a significant difference in the mathematical performance, perhaps this result can be attributed to the fact that the easier mathematical techniques were reviewed online, and the analysis only included a few questions on online math content. Perhaps a longer study or online reviews covering more difficult techniques may have different results.

CONCLUSIONS

The results support significant difference in graduate student performance between FTF and online instructor administered content, and favor the traditional FTF administered format. It may also indicate that graduate students at this teaching institution may not be prepared for the rigors of online education at this time. Perhaps, following the pandemic and graduate students participation in 100% online education, results may be different as graduate students were forced to learn online.

Limitations. Due to the pandemic, student performance included results for only 3 quiz results and 1 midterm. Completion of the entire semester would have allowed a more thorough review of quantitative problems reviewed online versus FTF content.

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AN EXPLORATORY STUDY OF UNDERGRADUATE STUDENT PERFORMANCE IN MULTI-MODAL FORMAT

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ABSTRACT

This study explores undergraduate student performance in a multi-modal environment where students could self-select their educational method as 100% online or some level of face-to-face interaction. While average student performance for students who chose to attend at least one in-class learning opportunity performed better on graded assignments – particularly quizzes - than their online counterparts, students who completed the course solely online were not significantly different on overall performance, homework and exams than students who chose some in-class components. However, students who attended 75% or more of in-class opportunities performed significantly better on graded assignments than online students or students who attended less than 75% of in-class opportunities. The number of times that a student attended the FTF sessions appears to have an impact upon performance. The results have implications for education now and following the pandemic.

Keywords: Undergraduate students, performance, multi-modal

LITERATURE REVIEW

The pandemic dramatically changed education as online education became the foundation for teaching at the collegiate level. While administrators argue that online learning performance is the same or superior to those in the traditional face-to-face (FTF) classroom (Allen & Seaman, 2013), others argue that online education does not replicate the traditional FTF classroom due to intrinsic differences (Bejerano, 2008). Several studies highlight the need for instructors to evaluate online activities to verify their relevance to student learning (e.g. Braunscheidel, Fish & Shambu, 2013; Fish, 2015, 2017; Santos, Hu & Jordan, 2014). During the pandemic, since some college students did not wish to have a completely online experience, institutions and instructors

modified their courses to include in-class components. This study seeks to explore the impact of different educational formats - specifically online and online with face-to-face (FTF) components on undergraduate business student performance. Specific questions include: (1) Did online students perform the same as FTF students on graded assignments? and (2) Did the number of times a student attended a face-to-face session impact upon their performance?

In recent years, researchers have studied student performance in different educational formats – for example, online, hybrid, and 'web-facilitated' in comparison to traditional FTF courses. Definitions for these formats remain 'blurred' as technology continues to change and different technological elements become incorporated into classes. In this study, we refer to online learning as courses whereby everything is 100% online including all instructional and testing materials. Hybrid or blended courses offer a combination of FTF and online *instructional* time. 'Web-facilitated' courses include FTF classroom instruction supplemented by online materials such as the syllabus, PowerPoint presentations, taped lectures and handouts. Traditional FTF courses refer to courses taught in a face-to-face environment whereby all instructional and testing elements occur in the same physical environment.

Research regarding the effectiveness of different formats is mixed and still accumulating (e.g. Angiello, 2010, Cathoral et al., 2018, Ginns & Ellis, 2007; Love, Hodge, Grandgenett, & Swift, 2014; Metzgar, 2014; Olitsky & Cosgrove, 2014; Terry, 2007; Verhoeven & Rudchenko, 2013). The frame of reference with these comparisons is in contrast to FTF courses. For example, researchers in a personal health course at a public institution found that student performance in web-facilitated (with FTF components) and hybrid course delivery formats were similar in spite of student preferences for web-facilitated courses with more FTF interactions being preferred by students (Cathoral et al., 2018). Contrastingly, in undergraduate managerial economics courses, student performance was lower in hybrid classes as compared to traditional FTF classes and results indicated that complex courses may not lend themselves to hybrid formats (Metzgar, 2014). Contrastingly, in an introductory economics course, there was no change in student performance (Olitsky & Cosgrove, 2014), but in an undergraduate microeconomics course, student performance in a hybrid section was weaker than in a FTF section (Verhoeven & Rudchenko, 2013). Yet another study over a decade ago, researchers found that student

performance was higher for instruction that combined FTF lecture and online components than purely FTF instruction or purely online instruction (Angiello, 2010). In a study of graduate business student performance also performed over a decade ago, student performance on class assignments in FTF, online and hybrid formats were equivalent; however, students in online courses performed over 4% lower than FTF or hybrid students on the final exam (Terry, 2007).

Many of these studies involve different instructor comparisons or different student populations (typically across semesters or courses). The pandemic - and institutional requirements to offer a course as a 'multi-modal educational experience' - offered a unique research opportunity as student performance in the *same class* with the *same instructor* but different educational formats can be explored. The institutions reference to a 'multi-modal educational experience' required all materials to be available online (due to potential quarantining requirements and COVID contraction) but encouraged FTF components for students who desired it. This multi-modal requirement changed the frame of reference from prior to studies being FTF to the online experience as the frame of reference. Specifically, this study seeks to explore the following hypotheses:

H1:   Online vs FTF Component Inclusion: There is no difference between student performance for students taking the course solely online versus students who attend FTF sessions in addition to online.

H2:   Number of Times FTF: There is no difference in student performance for students who attend all FTF sessions versus students who attend fewer FTF sessions.

METHOD

At an AACSB-accredited University in the northeast due to the pandemic in the fall of 2020, the University required all classes to be offered as 'Multi-Modal'. By 'Multi-Modal', the University allowed students to self-select to attend classes in-person or online or both throughout the course, attendance could not be mandatory, and all materials were required to be available through online means. In other words, the courses were mainly online, but FTF elements were included. (Note this is a different form of hybrid than past studies as instructional elements were mainly online and supplemental elements were in the FTF classroom.) The University prides itself on being a 'teaching' University where class sizes are small (average 17), and the majority of

classes prior to the pandemic were FTF - not online. In the fall of 2020 the *same instructor* taught two sections of a junior-level operations management course. Since the course involves both qualitative and quantitative material that students do not typically have experience with, students regard it as a complex and difficult course. The topics that the course taught included an introduction to operations management, process analysis, forecasting, project management, linear programming, inventory management, quality management, facility layout, Material Requirements Planning, aggregate planning, capacity planning, and lean production. Twenty-two students enrolled in each of the two sections. For the first section, the in-class attendance ranged from 2 to 8 students for a session, while the second section in-class attendance ranged from 6 to 13 students for a session. (While there were no students in the second section that withdrew from the course, five students withdrew from the course in the first section.) While the class 'normally' would meet twice a week for 75 minutes, to avoid quarantining requirements for everyone in the class per state Department of Health requirements, each in-class session was limited to less than 60 minutes. In keeping with state Department of Health requirements for contact tracing, while not a component of the class, the instructor recorded student attendance for in-class sessions. The instructor offered 18 in-class sessions to each section over the semester.

In keeping with the 'Multi-Modal' requirements, the instructor pre-recorded all lecture Power Point materials and posted them to the course Learning Management System (LMS). In keeping with University recommendations, the majority of videos averaged 7-15 minutes in length. (The instructor subdivided lectures by content to meet the time requirements. Some mathematical problems took longer than 15 minutes and the instructor completed an entire math problem – regardless of how long it took – in a single videotape session.) The instructor provided a corresponding instructor developed handout for each lecture to students through the LMS. The handout required students to 'fill in' various sections as if they were sitting in class. Whether they attend the face-to-face class sessions or online, the instructor strongly recommended to a student that they listen to the lectures and fill in the notes. The instructor also provided suggested problems that corresponded to the textbook homework through the LMS. In order to keep the FTF classes 'value-added', the instructor did not repeat the lecture but gave a brief topic overview and with the students completed the suggested problems. All students – whether they attended a FTF class or not - were expected to listen to the videotapes, take notes and read the

textbook. The in-class overviews were brief, lasting 5-10 minutes and in-class students could ask questions in real-time about the material. Since advanced technology was not available in the classrooms, online students did not attend the in-class session through any means and in-class sessions could not be recorded.   For online students, solutions to the suggested problems went 'live' following the FTF sessions, and they were encouraged to contact the instructor with any questions that they had.

The graded course requirements included 9 online homework assignments (through a notable textbook publisher, 5% of overall grade), 9 quizzes that corresponded to the homework (23% of overall grade), and 3 non-cumulative exams (24% of overall grade each). The homework assignments were due the evening prior to the in-class quizzes and were graded by the textbook management system. A student had 3 tries on each problem as well as 'hints' and access to instructor assistance. In keeping with University requirements for testing during the pandemic, the quizzes and exams were only offered during the class time. Students who came to class could take the quiz in-class, while those online took it at the same time but online. Students had access to all materials during the quizzes and exams. FTF students did not have access to their cellphones or computers. The quizzes, each worth 10 points, consisted of multiple choice questions, a short answer question and a math question on the relevant material. Quizzes were timed in the classroom and online with 20-minutes allowed before a 5-minute grace period began. Online quizzes did not allow students to go back to a question and were randomized by section. The instructor wrote all quiz and exam multiple choice, interpretation and short answer questions and did not use the pre-provided textbook materials (as solutions are available to students via alternative means). For math problems, online students were required to enter the mathematical answer into the textbox during the quiz, and once the quiz was over, submit their corresponding handwritten work to a quiz Dropbox for credit. Credit for mathematical problems was only given if the Dropbox work corresponded to the answer in the textbox as the quiz was 'not an exercise in data entry into Excel'. With respect to the exams and given the state Department of Health 60-minute quarantining potential, all students were required to take the exams online. Each of the three exams were timed, consisted of 25 multiple choice, 4-5 short answer questions, an interpretation question, and 4-5 mathematical problems (that varied by student through different numbers). The instructor pre-set all testing so a student could not go

back to a question and randomized questions within each section (multiple choice, short answer, interpretation and math questions) between students. The exam math question requirements were the same as for quizzes as students were required to insert the answer into the textbox and submit their handwritten work to a Dropbox for credit. With respect to grading, the LMS graded the multiple choice questions based upon the pre-selected correct response. The instructor graded all exam and quiz short-answer, interpretation and math problems, and awarded partial credit using a rubric for consistency between students.

ANALYSIS

Following completion of the course, the instructor analyzed student attendance at FTF sessions. As shown in Table 1, student attendance varied.

Table 1. Number of In-class Sessions Attended

Number of Sessions Attended	Number of Students who Attended	Number of Sessions Attended	Number of Students who Attended
18	0	9	0
17	3	8	0
16	4	7	1
15	2	6	1
14	2	5	1
13	1	4	0
12	2	3	0
11	2	2	0
10	0	1	0

To address the basic question whether there was a difference in student performance given attending any FTF sessions or not, student performance on the graded material for students who took the class solely online versus those who attended at least one session FTF was analyzed using a two-tailed t-test. Twenty students completed the course completely through online means, while 19 students attended at least 1 session. As shown in Table 2, analysis revealed that student overall performance was slightly significant (p=.06) and quiz performance (p=.01) was significantly different between FTF and online students as FTF students performed better than online students on quizzes. While the average student performance for those who attended at least one in-class session was better than online students on homework and exams, a statistically significant difference in their performance did not exist.

Table 2. Face-to-Face vs Online Student Performance

Student Performance	FTF Average	Online Average	T-test
Overall	81.34	76.08	.06 **
Homework	93.41	90.31	.31
Quizzes	89.17	77.96	.01 *
Exam I	74.72	69.82	.19
Exam II	81.07	77.52	.25
Exam III	78.21	75.70	.51
Exams All	78.00	74.49	.21

*$p \leq .05$, ** $p \leq .10$

As shown in Table 1, there is a definite gap in attendance between the number of students who attended in-class sessions 7 times (38.9 % attendance) and 11 times (61.1% attendance). Given the course structure, one may surmise that students who attended less than 8 times completed the majority of their learning online. As shown in Table 3, comparing student performance for students who attended class 0 to 7 times (note that this includes online students) with those that attended class more than 10 times reveals statistically significant differences in overall performance ($p=.02$), quizzes ($p=.00$), and exam II ($p=.05$). (Note no students attended 8 to 10 sessions of the course in person.) The overall average on all exams ($p=.06$) and exams I ($p=.07$) were slightly significantly different between the groups. Homework and exam III was not significantly different between the two groups. Regardless of the graded item – and although it's not always statistically significant, FTF students who attended more than 10 times performed better than students who attended 0 to 7 FTF sessions times on all graded items. The number of times that a student attended the FTF sessions appears to have an impact upon their performance.

Table 3. FTF More than 8 Times vs Online & FTF Less than 8 Times Student Performance

Student Performance	Average FTF > 11 times	Average FTF<8 & OL	T-test
Overall	82.32	76.09	.02 *
Homework	92.64	91.25	.64
Quizzes	89.93	78.90	.00 *
Exam I	76.03	69.55	.07 **
Exam II	82.59	76.93	.05 *
Exam III	78.88	75.95	.35
Exams All	79.17	74.14	.06 **

*$p \leq .05$, ** $p \leq .10$

To explore the impact of student attendance further, students were grouped into three groups: attendance at more than 75% of in-class sessions (14 or more FTF sessions; Group #1), less than

75% attendance at in-class sessions (1 to 13 FTF sessions; Group #2), and online only (Group #3). There were 11 students who attended 14 or more sessions, 8 students who attended 1 to 13 sessions, and 20 students who did not attend any FTF classes. Various statistical testing results are in Table 4. Comparing students who attended FTF 14 times or more with solely online students (#1 v #3) showed significant differences in overall (p=.01), quiz (p=.00), and all exams (p=.03) – and particularly exam II (p=.03), as well as slightly significant for homework (p=.07). Comparing students who attended FTF 14 times or more with students who attended 13 FTF sessions or less (Group #1 v Group #2) was statistically significant for overall (p=.02), quizzes (p=.05), and all exams (p=.03) – particularly exam II (p=.02) and exam III (p=.04). Interestingly, comparing students who attended 13 or fewer session with online students (Group #2 v Group #3) did not reveal any significant differences between the groups; however, quizzes were slightly significant (p=.07). Since the differences between students coming to class 13 times or less and online students was insignificant, comparison between the students who came to class 14 times or more and the other two groups was performed. Results demonstrate a significant difference on every performance measure except exam I.

Table 4. Student Performance FTF 14 Times or More vs FTF 13 Times or Less vs Online

Student Performance	Group			T-Test			
	#1 (14+ FTF)	#2 (1 – 13 FTF)	#3 (OL)	#1 v #3	#1 v #2	#2 v #3	#1 v #23
Overall	84.23	77.36	76.08	.01 *	.02 *	.68	.00 *
Homework	95.64	90.34	90.31	.07 **	.20	.99	.04 *
Quizzes	91.62	85.8	77.96	.00 *	.05 *	.07 **	.00 *
Exam I	76.69	72.01	69.82	.10	.30	.63	.10
Exam II	84.84	75.89	77.52	.03 *	.02 *	.67	.01 *
Exam III	81.72	73.39	76.14	.11	.04 *	.46	.05 *
Exams All	81.08	73.76	74.49	.03 *	.03 *	.82	.01 *

*p ≤ .05, ** p ≤ .10

DISCUSSION

As noted in the literature review, research regarding the effectiveness of different formats is mixed and still accumulating. For most prior studies, the FTF environment was the frame of reference for comparison (e.g. Angiello, 2010, Cathoral et al., 2018, Ginns & Ellis, 2007; Love, Hodge, Grandgenett, & Swift, 2014; Metzgar, 2014; Olitsky & Cosgrove, 2014; Terry, 2007; Verhoeven & Rudchenko, 2013). The pandemic and radical change in course delivery methods

offer the opportunity to explore delivery formats from another perspective. This study adds to this research stream as online and online with FTF components are studied for a complex and difficult undergraduate business course. Only a slight significant difference on overall student performance between students taking the course solely online versus students with some additional FTF components exists. This result is different than the study over a decade ago that showed students performed better when online components were added to a FTF lecture than in pure FTF or pure online (Angiello, 2010). Notice that the point of reference is adding online to FTF instead of FTF to online as in this study. The general results are similar to another older study that showed no significant differences between FTF, online and hybrid in graduate business student performance, and students in FTF or hybrids performed better than online students on a final exam (Terry, 2007).

Hypothesis #1 was - and was not - held. While students who attended some sessions performed better on all graded material, the difference was not statistically significant. Quizzes were statistically significant. While the questions were the same, the method of taking the quiz was different. In-class quizzes were static – and what most students were accustomed to. FTF students could move between questions where those online were limited in their ability to move back to a question (to reduce cheating). However, as noted before, due to time constraints and Department of Health requirements (discussed previously), all students took the exams online – and experienced the same testing medium. While a statistical significant difference in their performance between the two groups did not exist, those students who experienced some FTF elements performed better on average than their online counterparts on exams. Therefore, the difference cannot be solely attributed to the different test taking method.

Our analysis explored the impact of a student attending more FTF sessions, and hypothesis #2 was not held for most performance metrics as students who attended more than 10 sessions FTF performed significantly better on overall performance and in particular, quizzes (and a slight significance on exams). Merely attending just a few FTF sessions did not significantly impact upon student performance.

Further analysis that divided the students into the three groups highlighted the significant impact attending more FTF sessions had on student performance. Results showed that the online group and lower attendance groups were very similar in their performance. *In other words, if a student did not come to class 'enough', there was not a positive benefit of coming to class over staying online completely.* This results implies that there is a 'threshold' of attendance that needs to be overcome for students to benefit from FTF sessions, and students adjust to teaching methods over time. For FTF students, those who attended class 14 times or more (Group #1) performed significantly better than students who attended less than 14 times (Group #2) on everything but homework and Exam I. With respect to Exam I, for many mainly FTF students Exam I was their first online testing experience and they struggled with the experience. By Exam II and III, students who attended more appear to 'reap' the benefits of the FTF experience as they performed significantly better than those that attended FTF less. Students who attended 14 or more times (Group #1) performed significantly better than other students (Groups #2 and #3) on graded assignments - except Exam I. Again, this result supports the difficulties that the students who attended 14 or more times may have experienced in the initial online testing format. Interestingly, homework was only significantly different between the groups when comparing the results for students who attended 14 or more FTF sessions versus the other students. Homework was essentially the same for all students as it was online, encouraged mastery, allowed for hints, and other sources to solve the problems. A potential conclusion is that through reviewing the suggested problems in the FTF sessions, students who came to the majority of classes *learned from the experience*. In this study, we divided and analyzed the results at two different FTF attendance points: (1) less than 8 and more than 11, and (2) less than 14 versus 14 or more. Student performance changed between these two studies as more graded assignments became significantly different between the two groups. Therefore, there appears to be a difference by attending more sessions but there is a question as to what *specific number* of FTF classes a student should attend that will make a difference in performance. Given the dataset size, there simply isn't enough data to firmly establish a specific attendance number. However, clearly there is an aspect of attending FTF that has a positive overall effect – particularly for students who come to more than 75% of available sessions.

CONCLUSIONS

While the general results do not support a significant difference between adding FTF components to online classes to improve student performance, deeper analysis shows significant differences as discussed in this study. This study demonstrates the strong impact that 'attendance' requirements for FTF components into mainly online classes can have on student performance. As the pandemic subsides, education will need to change to meet the current student body's perceptions and requirements regarding educational components. Instructors and institutions will need to address what education should 'look like' in the 21st century. *Limitations.* Due to the small class sizes, while meeting the general threshold of having at least 30 data points in order to draw relevant conclusions, when subdividing the dataset further, it becomes difficult to interpret the results due to the small subset sizes. Replicating this study requires much larger classes to draw appropriate conclusions.

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DESIGNING A LAB USING THE OPEN-SOURCE IDEMPIERE ERP SYSTEMS TO DEMONSTRATE THE INTEGRATION OF BUSINESS FUNCTIONS FOR VALUE CREATION

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Abstract

This paper is to describe a course innovation regarding the use of an open-source ERP system to integrate accounting, warehousing, and purchasing functions in the fundamentals of information systems class in a business school. First, relevant business activities and associated accounts are discussed. Second, how business activities and accounting are integrated is presented. Third, the detailed lab design and implementation are discussed. This lab may help faculty to effectively teach 1) the concept of the ERP system, 2) the integration of business functions using the ERP system, 3) the fit between business processes and ERP system functions.

Keywords: ERP, Business Process Integration, Lab Design, Fundamentals of IS

1. Introduction

An important topic in the fundamentals of information systems class in business schools is about creating value in business processes through using information systems (IS) (Venkatraman, 1997; Zammuto et al., 2007). While a few examples of business flow charts may help students with understanding the concept reasonably well, to apply an ERP system to demonstrate how multiple business processes can be integrated to help employees in different departments effectively and efficiently collaborate with each other for value creation could be more helpful with learning. Specifically, the key purposes of using an ERP system are to effectively teach the concept of ERP, the integration of multiple business functions, and the fit between organizational processes and enterprise systems (Davenport, 1998; Strong and Volkoff, 2010). To achieve these goals, a lab using the open source iDempiere[1] ERP system is designed.

2. Open Source IDempiere ERP System

As indicated on the web site of the iDempiere system it was founded in 2011 and " iDempiere is a

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[1] https://www.idempiere.org/, Accessed on January 11, 2021.

powerful, Tier II, open-source ERP/CRM/SCM system supported by a skillful community. The project focuses on high-quality software, a philosophy of openness and its collaborative community that includes subject matter specialists, implementors, developers and end-users." An advantage of using the open-source ERP system is the accessibility for all students with no additional costs. Further, while the functions of an open source EPR system may not be as many as those of proprietary ERP systems, it should be enough for the learning purpose. In addition, if students are interested in taking a look at the codes for the open-source ERP system, they can dive into the codes to customize the system so that they may develop a much deeper understanding of different components of an ERP system and experience with user-generated innovations (Baldwin and Von Hippel, 2011).

3. Business Activities and Related Accounts

In the ERP system, for each activity (except placing purchasing orders) in the purchasing and warehousing processes, relevant accounting records are generated to keep track of the information, money, and material flows. There are 8 different activities across the purchasing and warehousing functions including 1) placing purchase orders, 2) entering material receipts, 3) matching material receipts with purchase orders, 4) entering vendor invoices, 5) matching invoices with material receipts, 6) generating payments, 7) allocation of payments to different invoices, and 8) bank statement consolidation. The accounts that are used include such as 1) product assets (asset), 2) not invoiced receipts (liability), 3) inventory clearing (asset), 4) account payable (liability), 5) payment selection (i.e., unallocated payments, asset), 6) checking in transit (asset), and 7) checking account (asset).

4. Integration of Purchasing, Warehousing, and Accounting

Table 1 shows all the accounts used and the linkages among these accounts and reveals the information, money, and material flows that integrate activities conducted by employees in accounting, warehouse, and purchasing. After purchasing orders (as control documents) are entered in the ERP system, the warehouse department should expect goods being delivered. When warehouse employees process material receiving, they should enter material receipts as the control documents. Materials receipts are related to two accounts including product assets (debit, asset) and not invoiced receipts (credit, liability). Then, invoice processers in the accounting department should expect to receive vendor invoices which inform the firm of the payment they need to send

to the vendor. The invoices will generate accounting records with two accounts including inventory clearing (debit, asset) and account payable (credit, liability). Inventory clearing refers to the goods involved in the transaction and account payable indicates that the goods should be paid for in the future. Further, these goods should be matched with the not invoiced receipts (generated by entering material receipts). This matching process is completed by the activity named as Matching Invoices with Material Receipts (MR) and this process will generate accounting records including not invoiced receipts (debit, liability) and inventory clearing (credit, assets).

After invoices are entered into the system, employees in the accounting function should start to prepare payments and these payments will generate accounting records with checking in transit (credit, assets) and payment selection (i.e., unallocated payments, debit, assets). Obviously, there is a need for matching payments with invoices and this process is named as Allocating Payments to Invoices. When this matching process is completed, accounting records should be generated including account payable (liability, debit) and payment selection (i.e., unallocated payments, assets, credit). Through this allocation process, we can track which invoiced goods are paid and which invoiced goods are not paid yet. The last activity in business process flow is the bank statement processing. In the bank statement, records about when vendors transfer money from the customer company bank account to their own bank accounts are listed. After bank statements are entered into the system and completed, accounting records are generated including checking in transit (asset, debit) and checking account (asset, credit).

Figure 1 in the following clearly shows the integration of accounting records and business activities such as invoicing, payment, bank statement processing, warehousing, and purchasing. The money flow starts from the checking account, through checking in transit, payment selection, to account payable. The materials received stay in the warehouse as product assets. However, in order to connect the material flow with the money flow, the connection starts from the product assets, going backwards through both not invoiced receipts and inventory clearing, to the account payable.

Table 1: Accounts Used to Integrate Purchasing, Warehouse, and Accounting
(Note: the arrows represent the information and material flows)

Activities	Receiving Materials	Matching Invoices with Material Receipts (MR)	Entering Vendor Invoices	Allocating Payments to Invoices	Generating Payments	Bank Statement Processing
Debit	Product Assets	NIR (Not Invoiced Receipts)	inventory clearing	account payable	payment selection (unallocated payments)	checking in transit
Credit	NIR (Not Invoiced Receipts)	inventory clearing	account payable	payment selection (unallocated payments)	checking in transit	checking account

5. Lab Design and Implementation

In this section, the iDempiere ERP demo sites are provided. Further, steps to install the system into a local computer is presented. Then the lab design is introduced. Lastly, the detailed implementation steps are discussed.

5.1 System Installation

The iDempiere ERP system has online demo sites[2]. While we can use these sites directly, they may be slow and not good enough for efficient learning, especially when many students use the test sites simultaneously. It is recommended that iDempiere should be installed in a virtual computer in the cloud (such as AWS[3]) or in an ubuntu machine. The official installer is at https://wiki.idempiere.org/en/IDempiere_Debian_Installer. In addition, a senior iDempiere consultant developed scripts[4] to install the system automatically. The scripts do all the installation in about 20-30 minutes, including software components for both the iDempiere server and the database server.

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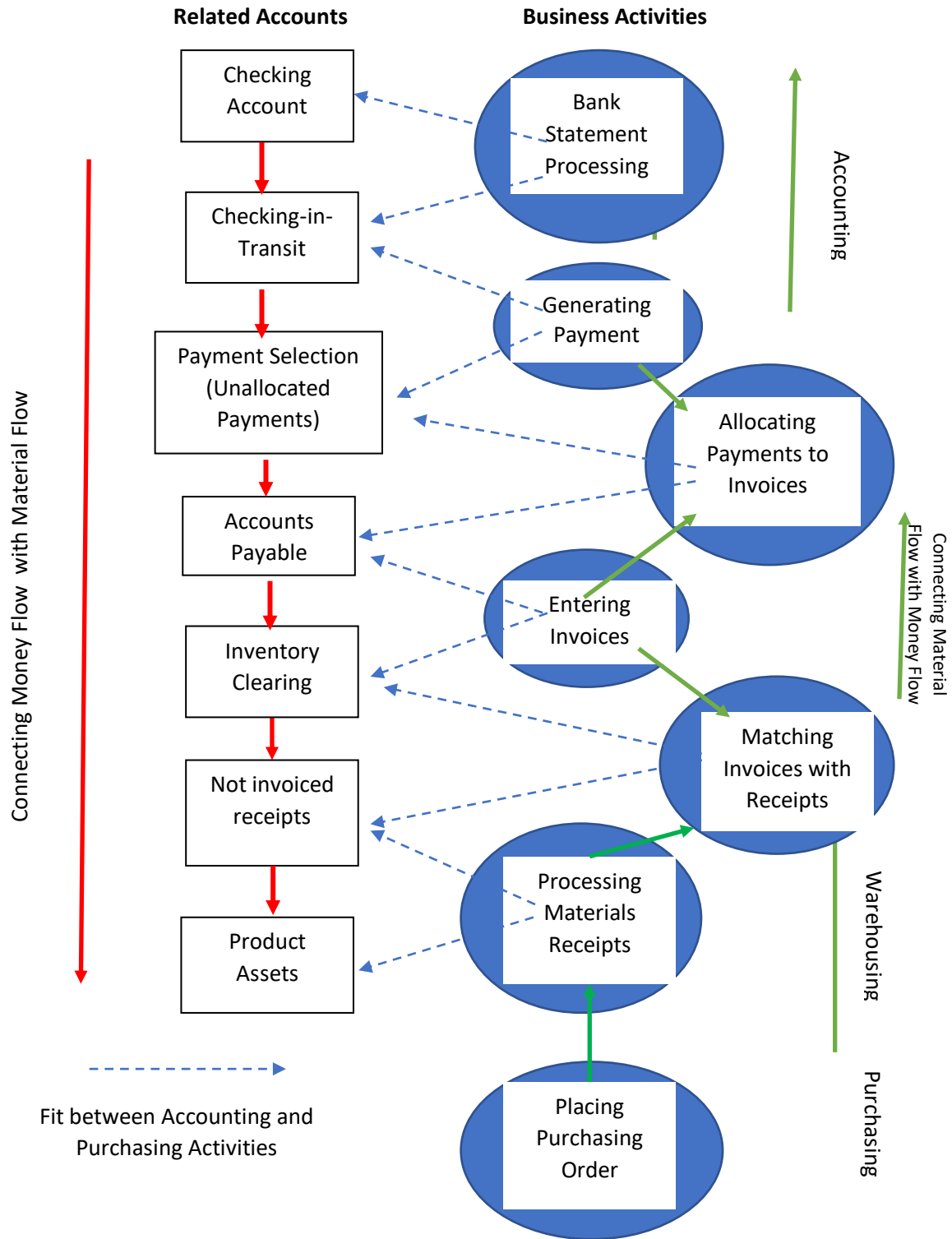
Figure 1: Integration of Purchasing with Accounting Supported by the iDempiere ERP

5.2 Lab Design

In this lab, 2 purchase orders and 2 material receipts are created. And the matching documents between line items in material receipts and purchase orders are examined. 2 invoices are created and matched with the line items of the 2 material receipts. 2 payments will then be created, and these payments are allocated to the invoices. Lastly, a bank statement is created, and it is matched with line items in the payment documents.

There are three key learning points. First, in this lab, students should develop a solid understanding that the relationships among purchase orders, material receipts, invoices, payments, bank statements may be one-to-one or one-to-many relationships depending on the business policies and industry regulations for the vendor and the customer firm. Second, students should be able to appreciate the value of using EPR systems in integrating various activities in the business. Third, students should appreciate the efficiency improvement by using the matching functions in the ERP system. While not many control documents are created in the lab, with a few documents in each category, students should be able to imagine that if there are hundreds of documents created and there is a need to match line items among different types of documents, the matching function in the iDempiere ERP system should be very helpful in making the process very efficient. Therefore, with the support of the ERP system, employees may spend more time with their core businesses or make more efforts in serving both internal and external customers. Consequently, value is created in these functions by using the ERP system.

5.3 Implementation of the Lab Design

There are 8 steps in the lab. Step 1 is to create 2 purchase orders (POs, Table2). The first order is to purchase 10 Elms trees and 20 Oak trees. The second order is to purchase 5 Patio Sets and 20 bags of fertilizer (Table 2).

Table 2: Purchase Orders

Purchase Orders	Line 10	Line 20
PO1	10 Elm Trees	20 Oak Trees
PO2	5 Patio Sets	20 Bags of Fertilizer

Step 2 is to enter material receipts (MR) (Table 3). The first MR records the receiving of 6 Elm trees, 11 Oak trees, 3 Patio Sets, and 12 bags of fertilizer. The second MR records the receiving of 4 Elm trees, 9 Oak trees, 2 Patio Sets, and 8 bags of fertilizer.

Table 3: Materials Receipts

Material Receipts	Line 10	Line 20	Line 30	Line 40
MR1	6 Elm Trees	11 Oak Trees	3 Patio Sets	12 bags of Fertilizer
MR2	4 Elm Trees	9 Oak Trees	2 Patio Sets	8 bags of Fertilizer

Step 3 is to match PO line items with MR line items (Table 4). 6 Elm trees and 11 Oak trees in the first MR are matched with the first PO lines 10 and 20. 3 Patio Sets and 12 bags of fertilizer in the first MR are matched with the second PO lines 10 and 20. For the second MR, 4 Elm trees and 9 Oak trees are matched with the first PO lines 10 and 20. 2 Patio Sets and 8 bags of fertilizer are matched with the second PO lines 10 and 20.

Table 4: Matching Material Receipts with Purchase Orders

Purchase Orders	Material Receipts	Nature of the Relationship
PO1 line 10	6 Elm Trees in MR1 line 10	One-to-Many
PO1 line 10	4 Elm Trees in MR2 line 10	
PO1 line 20	11 Oak trees in MR1 line 20	One-to-Many
PO1 line 20	9 Oak Trees in MR2 line 20	
PO2 line 10	3 Patio Sets in MR1 line 30	One-to-Many
PO2 line 10	2 Patio Sets in MR2 line 30	
PO2 line 20	12 bags of fertilizer in MR1 line 40	One-to-Many
PO2 Line 20	8 bags of Fertilizer in MR2 40	

Step 4 is to enter vendor invoices (Table5). The first invoice has 4 line items including: 5 Elm trees, 10 Oak trees, 10 bags of Fertilizer, and 2 Patio Sets. The second invoice has 4 line items including: 5 Elm trees, 10 Oak trees, 3 Patio Sets, and 10 bags of fertilizer.

Table 5: Vendor Invoices

Invoice	Line 10	Line 20	Line 30	Line 40
I-1	5 Elm trees	10 Oak trees	10 bags of Fertilizer	2 Patio Sets
I-2	5 Elm trees	10 Oak trees	3 Patio Sets	10 bags of fertilizer

Step 5 is to match invoice line items with material receipts line items (Table 6). The first invoice line 10 is matched with 1 Elm trees from the first MR line 10 and 4 Elm trees from the second MR line 10. Line 20 of the first invoice is matched with 1 Oak tree from the first MR line 20 and 9 Oak trees in the second MR line 20. Line 20 of the first invoice is also matched with 2 bags of fertilizer in MR-1 line 40 and 8 bags of fertilizer in MR-2 line 40. Line 30 of Invoice 1 is matched with 2 patio Sets in the second MR line 30. The second invoice line 10 is matched with 5 Elm trees in the first MR line 10. Line 20 of the second invoice is matched with 10 Oak trees in line 20 of the first MR. Line 30 of the second invoice is matched with 3 patio Sets in the first MR line 30. Line 40 of the second invoice is matched wit 10 bags of fertilizer in the first MR line 40.

Table 6: Matching Invoices with Materials Receipts

Invoices	Materials Receipts	Nature of the Relationship
Invoice-1 Line 10	1 Elm Tree in MR-1 Line10	One-to-Many
Invoice-1 Line 10	4 Elm Trees in MR-2 Line 10	
Invoice-1 Line 20	1 Oak Tree in MR-1 Line 20	One-to-Many
Invoice-1 Line 20	9 Oak Tree in MR-2 Line 20	
Invoice-1 Line 30	2 bags of fertilizer in MR-1 Line 40	
Invoice-1 Line 30	8 bags of fertilizer in MR-2 Line 40	
Invoice-1 Line 40	2 Patio Sets in MR-2 Line 30	One-to-One
Invoice-2 Line 10	5 Elm Trees in MR-1 Line 10	One-to-One
Invoice-2 Line 20	10 Oak trees in MR-1 Line 20	One-to-One
Invoice-2 Line 30	3 Patio sets in MR-1 Line 30	One-to-One
Invoice-2 Line 40	10 bags of fertilizer in MR-1 line 40	One-to-One

Step 6 is to enter two payments. The first payment has $1500 and the second payment has $840. Step 7 is to allocate payments to the two invoices (Table7). The first payment is matched with the first invoice and partially with the second invoice. The second payment is matched what is left in the second invoice.

Table 7: Matching Payments with Invoices

Payment	Invoices	Nature of the Relationship
Payment-1 $1500	Invoice-1 $1080; Invoice-2 $420	One-to-Many
Payment-2 $840	Invoice-2 $840	One-to-One

Step 8 is to enter the bank statement listing all the payments being deposited into the vendor's bank account. Lastly, the posted accounting records are not discussed here but the screenshots for all the steps for the implementation are presented in the Appendix.

6. Conclusion

In this paper, a lab is designed to demonstrate functions of an open-source ERP system. Specifically, the integration of purchasing, warehousing, and accounting activities are demonstrated. Related business documents includes 1) purchase orders (POs), 2) materials receipts(MRs), 3) documents for matching POs with MRs, 4) vendor invoices, 5) documents for matching invoices with MRs, 6) payments, 7) payment allocations, and 8) bank statements. The line items in these documents may have one-to-one or one-to-many relationships. These different relationships are useful to meet challenges in various industries with different shipping, payment, and invoicing policies. With this lab, students are expected to develop a deeper understanding of how ERP may create value through 1) supporting business process integration across multiple functions and 2) empowering employees in different positions to collaborate with each other effectively. In the future, as this lab is used in more classes, a survey study could be conducted to obtain students' feedback and assess its effectiveness. Further, the survey results may also be used to revise the lab design.

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Appendix: Screenshots for All the Steps in the Lab

1) Placing Purchasing Orders:

Purchase Order 800005 (purchasing 10 Elm Trees and 20 Oak Trees)

Purchase Order 800006 (Purchase 5 Patio Sets and 20 bags of Fertilizer)

2) Receiving Goods

Material Receipts 10000514

Receiving 6 Elm Trees, 11 Oak Trees, 3 Patio Sets, and 12 bags of Fertilizer.

Posted Accounting Records:

Material Receipts 10000515

Receiving 4 Elm Trees, 9 Oak Trees, 2 Patio Sets, and 8 bags of Fertilizer.

Posted Accounting Records

3) Matching Material Receipts with Purchasing Orders

Material Receipt 10000514 Matching with Purchase Orders

6 Elm Trees → Purchase order 800005 line 10

11 Oak Trees → Purchase Order 800005 line 20

3 Patio Sets → Purchase order 800006 line 10

12 bags of Fertilizer → Purchase order 800006 line 20.

Material Receipt 10000515 Matching with Purchase Orders
4 Elm Trees → 800005 line 10

9 Oak Trees → 800005 line 20

2 Patio Sets → Purchase Order 800006 line 10

8 bags of Fertilizer → Purchase Order Line 20.

4) Entering Invoices (vendor)

Invoice 10000012

Invoice for 5 Elm Trees, 10 Oak Trees, 10 bags of Fertilizer, and 2 Patio Sets.

Posted Accounting Records

Invoice 10000013

Invoice for 5 Elm Trees, 10 Oak Trees, 3 Patio Sets, and 10 bags of Fertilizer.

Posted Accounting Records

5) Matching Invoices with Materials Receipts
Invoice 10000012 Matching with Material Receipts
Invoice 10000012 line 10 → 4 Elm Trees in MR 10000515 line 10
Invoice 10000012 line 10 → 1 Elm Trees in MR 10000514 line 10

Invoice 100000012 line 20 → 9 Oak Trees in MR 10000515 line 20
Invoice 100000012 line 20→ 1 Oak Trees in MR 10000514 line 20.

Invoice 10000012 Line 20 → 8 bags of Fertilizer in MR 10000515 Line 40
Invoice 10000012 Line 20 → 2 bags of Fertilizer in MR 10000514 Line 40

Invoice 10000012 Line 30 → 2 Patio Sets in MR 10000515 Line 30

Invoice 10000013 Matching with Material Receipts
Invoice 10000013 line 10 → 5 Elm Trees in MR 10000514 10

Invoice 10000013 line 20 → 10 Oak Trees in MR 10000514 20

Invoice 10000013 line 30 → 3 Patio Set in MR 10000514 line 30

Invoice 10000013 line 40 → 10 bags of Fertilizer in MR 10000514 line 40

Posted Accounting Records:

The following are accounting records for the matching Invoice 10000012 with materials receipts.

The following are accounting records for the matching Invoice 10000013 with materials receipts.

6) Entering Payments to Vendors

Payment 7000002 with $1500

Posted Accounting Record

Payment 7000003 with $840

Posted Accounting Records:

Organization	Account	Accounted Debit	Accounted Credit	Product	Business Partner	Project	Campaign	Account Date	Period	PostingType
HQ	21300_Payment selection	840.00	0.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	11110_Checking In-Transfer	0.00	840.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
		840.00	840.00							

7) Payment Allocation

Two payments (700002 and 700003) are matched with two invoices (10000012 and 10000013)

Allocation	Business Partner	Order	Invoice	Payment	Charg Amount	Transactic Disc
1000004	Seed Farm Inc.	800006_12/23/2020	10000012_12/23/2020_1080 0	700002_12/23/2020_1500 00_-1	-1,080 00	
1000004	Seed Farm Inc.	800006_12/23/2020	10000013_12/23/2020_1260 0	700002_12/23/2020_1500 00_-1	-420 00	
1000004	Seed Farm Inc.	800006_12/23/2020	10000013_12/23/2020_1260 0	700003_12/23/2020_840 00_-1	-840 00	

Posted Accounting Records

Organization	Account	Accounted Debit	Accounted Credit	Product	Business Partner	Project	Campaign	Account Date	Period	Posting Type
HQ	21100_Accounts Payable Trade	1,080.00	0.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	21300_Payment selection	0.00	1,080.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	21100_Accounts Payable Trade	420.00	0.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	21300_Payment selection	0.00	420.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	21100_Accounts Payable Trade	840.00	0.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
HQ	21300_Payment selection	0.00	840.00		Seed Farm Inc.			12/23/2020	Dec-20	Actual
		2,340.00	2,340.00							

8) *Entering Bank/cash Statement*

Bank/Cash Statement lists two payments (checks deposited into the vendor's bank account)

Posted Accounting Records:

Organization	Account	Accounted Debit	Accounted Credit	Product	Business Partner	Project	Campaign	Account Date	Period	Posting Type
HQ	11100_Checking Account	0.00	840.00		Seed Farm Inc.			10/31/2006	Oct-06	Actual
HQ	11110_Checking In-Transfer	840.00	0.00		Seed Farm Inc.			10/31/2006	Oct-06	Actual
HQ	11100_Checking Account	0.00	1,500.00		Seed Farm Inc.			10/31/2006	Oct-06	Actual
HQ	11110_Checking In-Transfer	1,500.00	0.00		Seed Farm Inc.			10/31/2006	Oct-06	Actual
		2,340.00	2,340.00							

INCREASING THE PERCEPTIONS BY ENGINEERING AND INFORMATION SYSTEMS STUDENTS AS TO THE POTENTIAL OF STUDENTS WITH DISABILITIES THROUGH A DISABILITY FILM FESTIVAL FORUM

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Abstract

Colleges do not allow enough diversity of engineering and information systems students with people with disabilities. Engagement of students without disabilities does not include enough interactions with students with disabilities. The authors re-assess an annual extra-curricular film festival forum that is expanding the perceptions by engineering and information systems students as to the potential of higher-functioning people with developmental and intellectual disabilities (IDD). The authors of the paper find a continued favorable formation of the perceptions of the students as to the skills of engineering and information systems with disabilities and of non-students with disabilities. The paper will be beneficial to professors in schools of engineering and information systems considering engagement of students without disabilities in experiences on meaningful projects of technology with those with disabilities.

Keywords: community engagement, developmental and intellectual disabilities (IDD), disability film media, diversity, extra-curricular information systems programs.

Background of Paper

Disability is a characteristic of college diversity (Pearson, & Samura, 2017). From 57 million people (Kroeger, & Kraus, 2017), or 20% of the population, 11% of higher education students (United States Department of Education, 2015) - 56% female and 44% male students - are diagnosed as having disabilities. Perceptions by students without disabilities, especially of

higher-functioning (i.e. less impaired) people with developmental and intellectual disabilities (IDD), are flavored frequently however by deficiencies of the disabilities, not by the abilities of the students with disabilities (Goodley, 2011). Perceptions by engineering and information systems students without disabilities can be even flavored negatively of high-potential students with disabilities in schools of engineering and information systems (Lawler, Iturralde, Goldstein, & Joseph, 2015). Evaluation of people with disabilities is not infrequently formed from film portrayals that are prejudicial to those with disabilities (Vanderbilt University, 2020).

Cinema from Hollywood does not depict enough people with disabilities that are actual persons with disabilities. Less than 3% of popular films depict authentic people with disabilities. Less than 13% of the narratives of the authentic people with disabilities in these films is in consequential roles. Films depicting non-authentic persons with disabilities, such as *Million Dollar Baby*, *The Shape of Water* and *The Upside*, can be evaluated in "cannot do" negative perceptions, in stereotyping and stigmatizing if not victimizing higher-functioning persons with disabilities (Fisher, 2016). Engineering and information systems students can be influenced in negative perceptions, as to the potential of neuro-diverse people with developmental and intellectual disabilities elevated as inauthentic persons in an already existing 37% of the films (Rosenberg, 2016), given Hollywood interpretations of insignificance of persons with disabilities (Powell, 2018). Perceptions by students without disabilities can be further influenced negatively if they do not interface with students without disabilities (Keith, & Keith, 2020).

Films from independent media can be however influential in the "can do" depiction of people with disabilities (Appelbaum, 2019). Films from media, such as Sprout Film Festival, that are about the abilities, not the deficiencies of the disabilities, are counter-narratives in portrayals of authentic people with disabilities functioning, despite obstacles, like persons without disabilities. Films from other media, such as A&E Network (Heasley, 2019), and others (Kilgannon, 2020 and Leidermam, 2020), are further portraying positively persons with disabilities in a resilience of skills. Importantly, engineering and information systems students can learn from the independent media that higher-functioning students with developmental and intellectual disabilities, such as Autism Spectrum Disorders (ASD) and Dyslexia, are "ordinary", or outstanding as "savant", to be in inclusive settings on project teams with them (Lekan, 2009). Moreover, industry needs science, technology, engineering and mathematics (STEM) students with disabilities at high-spectrum, like students without disabilities (Austin, & Pisano, 2017).

In the paper, the authors re-assess an annual extra-curricular film festival forum that is influencing the perceptions by students without disabilities in a school of computer science and information systems, as to the potential of those higher-functioning types with disabilities.

Introduction to Paper

The paper re-assesses a continuing extra-curricular film festival forum in the Seidenberg School of Computer Science and Information Systems of Pace University. The forum is an outreach

program of the school with municipal non-profit organizations and New York University. For late winter 2020, the students without disabilities, for extra-credit grading in a community engagement course, reviewed best-of-class films from the independent Sprout Film Festival, for a forthcoming Celebration of People with Disabilities in Films Film Festival at Pace University 2020 (Figure 1 in Appendix) [changed to 2021 due to covid-19 pandemic], in a format as in previous semesters of studies (Lawler, Iturralde, Goldstein, & Joseph, 2015, Joseph, & Lawler, 2018 and Lawler & Joseph, 2020). The engineering and information systems students reviewed the films for impacts perceived from the narratives of authentic higher-functioning people with developmental and intellectual disabilities (IDD). In the films, the people with disabilities were presented as proper representations respectful of persons with disabilities.

The films in the festival forum focused on higher-functioning people and students with disabilities, in a diversity of narrative scenarios:

- *Ascent* is focusing on a female person with Autism Spectrum Disorders (ASD) inspiring despite obstacles other people with disabilities to hike a mountain;

- *Golden Sands* is focusing on an animated diversity of people with disabilities functioning as members of project teams;

- *Heart Eyes* is focusing on a female student with Down Syndrome in high school in love with an initially prejudiced student without disabilities and on the love and forgiveness of the female student;

- *Heart Over Body* is highlighting a football player with Cerebral Palsy functioning inspirationally to other players on a sports team;

- *In Your Dreams* is comically highlighting a male middle / high school student with Down Syndrome navigating the opportunities and the perils of romance;

- *Inside My Life* is highlighting a male student with Autism Spectrum Disorders negotiating perceptions ("retard") of Autism Spectrum Disorders in an informative performing arts scenario story;

- *Love, Trails and Dinosaurs* is highlighting a male student with Autism Spectrum Disorders who is negotiating his next steps to a university;

- *Love Till I Die* is highlighting issues of parents of middle / high school students with Autism Spectrum Disorders;

- *Meet Much, Jr.* is justifying optimism and pride of a middle / high school puppeteer student with Asperger Syndrome to be a success;

- *Real Kid* is justifying narratives of pride of those with disabilities; and

- *100% Myself* is justifying narratives of those with disabilities through prejudices of those without disabilities.

The films focused on narratives of peer "short stories" averaging 15 minutes per story, notable of productions from the Sprout Film Festival and other media projects. Few of the engineering and information systems students encountered the examples of higher-functioning players with disabilities, especially the endeavors of students with developmental and intellectual disabilities, in life or school, previous to the forum. Few of the students knew of the productions of the independent media, such as the Disability Visibility Project (Hung, 2018), prior to the forum.

Though the films formed the Celebration of People with Disabilities in Films Film Festival at Pace University 2020 (changed later to 2021 virtual because of the pandemic), the forum is a deliberate extra-curricular project for students without disabilities to learn more about the potential of people with disabilities. The more engineering and information systems students without disabilities learn about higher-functioning peer students with developmental and intellectual disabilities, the more respectful they may be of those with disabilities at all functioning spectrums (Saito, & Ishiyamia, 2005). The paper evaluates the impacts of the perceptions of the students without disabilities of those with disabilities from the film festival forum project, as in prior semester studies (Lawler, Iturralde, Goldstein, & Joseph, 2015, Joseph, & Lawler, 2018 and Lawler, & Joseph, 2020):

- Is the project facilitating engagement in the respect of the engineering and information systems students for people and students with disabilities?; and

- Is the project facilitating advocacy in the respect of the engineering and information systems students for people and students with disabilities?

In short, the authors of the paper re-assess the Celebration of People with Disabilities in Films Film Festival at Pace University 2020 (2021), as a program for inducing students without disabilities to learn more of the potential of people and peer students with disabilities in colleges and in life.

Focus of Paper

The focus of the paper is to re-assess the film festival forum as to impacts of the films on the perceptions by the engineering and information systems students as to the performance potential of people with disabilities. The factors for the model of study are engagement from the film narratives and advocacy from the film narrative stories of the 2020 forum, in the perceptions of

the students without disabilities, as in prior semester studies (Lawler, Iturralde, Goldstein, & Joseph, 2015, Joseph, & Lawler, 2018 and Lawler & Joseph, 2020):

Engagement from Film Narrative Stories –

Importance – Extent of impact from which the engineering and information systems students without disabilities perceived the film storytelling in proper representations of the potential of people and students with disabilities; and

Satisfaction – Extent of impact from which the engineering and information systems students without disabilities perceived the storytelling in furnishing satisfaction from the proper representations of the potential of those with disabilities.

Advocacy from Film Narrative Stories –

Self-Efficacy – Extent of impact from which the engineering and information systems students without disabilities perceived the film storytelling in furnishing a foundation for them to be advocates of people and students with disabilities; and

Sociality – Extent of impact from which the engineering and information systems students without disabilities perceived the storytelling in influencing a motivation for them to be involved proactively in public service for those with disabilities.

The findings of this paper can be helpful beyond the previous studies of the authors, as the inclusion of higher-functioning people with disabilities is increasing in the media (Heasley, 2020), and the inclusion of students with disabilities is increasing on projects with students without disabilities (Plotner, & Marshall, 2014). Finally, this paper can be important to professors in schools of engineering and information systems in further learning the potential of those with disabilities who can be included on teams with those without disabilities.

Methodology of Study

The methodology engaged n=18 engineering and information systems students without disabilities of the Seidenberg School of Computer Science and Information Systems and of Pace University in reviewing 11 films from the Celebration of People with Disabilities in Films Film Festival in the extra-curricular festival forum in late winter 2020.

Each of the films was previewed at the forum from Celebration of People with Disabilities in Films Film Festival director synopses by the first author of this paper, prior to the full playing of the productions to the students. Each of the films was anonymously reviewed by the n=18 students without disabilities, from the aforementioned defined factors of engagement – importance and satisfaction and advocacy – self-efficacy and sociality, on a pre-tested Likert-like instrument scaling of (9) – highest impact to (1) lowest impact survey. Each of the films were anonymously reviewed by a further n=5 people with disabilities from the municipal non-profit

organizations, on the instrument of survey. Each of the films was moreover qualitatively reviewed in an informal focus group (Krueger, & Casey, 2009), for post-playing reflections by the n=23 people and students, and the information was interpreted by the first author from guidelines in the literature (Neuendorf, 2017). The forum was moderated by the first author for full involvement by the n=23 people and students in a semi-structured session. The methodology was performed as in the prior studies of the authors (Lawler, Iturralde, Goldstein, & Joseph, 2015, Joseph, & Lawler, 2018, and Lawler, & Joseph, 2020).

The information from the n=23 participant people with disabilities and students without disabilities, on the finished instruments of survey, was interpreted quantitatively by the second author of this study, in the MAT LAB 7.10.0 Statistics Toolbox (Frankfort-Nachmias, & Leon-Guerrero, 2015).

Discussion of Findings

The consolidated findings from the festival forum in 2020 are indicating a continued favorable formation in the perceptions of the n=23 people with disabilities and students without disabilities. The consolidated n=11 films are indicating engagement (means = 6.23 / 5.00) – importance (6.23) and satisfaction (6.22) and advocacy (5.50) – self-efficacy (5.66) and sociality (5.34) impacts on the n=18 participant engineering and information systems students, as in Table 1a of the Appendix. The n=5 people with disabilities from the non-profit organizations are indicating engagement (6.52) – importance (5.16) and satisfaction (5.16) and advocacy (4.37) - self-efficacy (4.47) and sociality (4.27) impacts from the consolidated n=11 films, as in Table 1b.

The n=11 films individually are indicating favorability impacts generally, in the perceptions of the n=18 students without disabilities, as in Table 2.

Interesting are *Heart Over Body* (8.60 in engagement and 8.20 in advocacy), *Ascent* (8.40 in engagement and 8.10 in advocacy) and *Meet Much, Jr.* (8.30 in engagement and 8.50 in advocacy) that were the highest perceived reviewed of the films by the n=18 engineering and information systems students; and *Love, Trails and Dinosaurs* (2.80 in engagement and 1.80 on advocacy), *Love Till I Die* (3.50 in engagement and 3.20 in advocacy) and *Real Kid* (4.30 in engagement and 3.20 in advocacy) were the lowest perceived reviewed by the students, as in Table 2.

However, advocacy (5.50) – self-efficacy (5.66) and sociality (5.34) - is less in impacts from the n=11 films than engagement (6.23) – importance (6.23) and satisfaction (6.22) - in impacts, in the overall perceptions of the students without disabilities, as in Table 1. Though the n=18 engineering and information systems students are indicating positivity in respect to those with developmental and intellectual disabilities (IDD), they are not indicating equivalent positivity in proactively responding in service to those with disabilities. The findings might be flavored by the limited participation by students with disabilities prior to the forum on projects with the n=18 students without disabilities.

Nevertheless, the findings from the focus group in 2020 of the n=18 participant students without disabilities are indicating favorability perceptions in more personal reflections from the forum, as in Table 2. Few of the students knew of higher-functioning people with disabilities if not higher-functioning students with disabilities. The n=18 engineering and information systems students are evidently learning more regarding those with disabilities, which with more participation in a university with them they might be eventually more proactively responding in service to them.

The findings from the forum in 2020 are moreover notable in the continuing of the perceptions of positivity of students without disabilities from the forums in the prior studies (Lawler, Iturralde, Goldstein, & Joseph, 2015, Joseph, & Lawler, 2018, and Lawler, & Joseph, 2020), from which the findings from the forums in 2019 and 2020 are summarized in Table 1C.

The frequency distributions and correlations from the study are summarized in Tables 4 and 5.

In summary, the findings from the forum for the Celebration of People with Disabilities in Films Film Festival at Pace University 2020 justify the evolving of the extra-curriculum program for the engineering and information systems students without disabilities, in learning of the potential skills of those with disabilities.

Implications of Study

" … Dreaming Big … People with Disabilities Are … [An] Essential Fabric of Society …Treat People Like People" (Serres, 2019)

An immediate implication from the findings is disability is a diversity of people with potential. Expectations from the engineering and information systems of higher-functioning people with disabilities that they did not know as peers are higher in the impacts of the program (Marks, & Bayer, 2019). Knowledge of people and students with developmental and intellectual disabilities (IDD) as peers is important in inclusion in interactions with people and students without disabilities (Keith, Benetto, & Rogge, 2015). Festival films from the forums fulfill the function of knowledge in informing the engineering and information systems students of higher-functioning people with disabilities as peers with the potential to be also engineering and information systems students. The findings facilitate feasibility for inclusion of people with disabilities with prerequisite skills to be students in schools of engineering and information systems.

Another implication from the study is the feasibility for inclusion of increasing the influx of students with disabilities as an initiative of professors and students without disabilities. Festival forums are important in influencing the perceptions by the engineering and information systems students of the potential of the people with disabilities. Nevertheless, inclusion of higher-functioning students with developmental and intellectual disabilities in schools of engineering and information systems is an inevitable initiative of "I believe in diversity" outreach to this population. Inclusion is insured if professors and students in schools of engineering and

information systems are involved in piloting proactively recruitment of skilled students with disabilities. The findings imply an inclusion initiative in the institution of the university.

The final implication of this study is that inclusion of students with disabilities is an initiative not only of schools of engineering and information systems but also of the university. Festival film forums, as in this paper, are a limited proposition if not integrated with other inclusion programs of the university (Kimball, Friedensen, & Silva, 2017). Counseling Centers in Offices of Disability Services, Divisions of Diversity, Equity and Inclusion and Offices of Assistive Technologies (Wehmeyer, Tasse, Davies, & Stock, 2012) are requirements to service students with developmental and intellectual disabilities. Engineering and information systems students might be even mentors on mutual projects of technology to those disabilities. The findings imply an initiative beyond the forums for the Celebration of People with Disabilities in Films Film Festival at Pace University 2020 – a first step – for students with disabilities in schools of computer science and information systems of the university.

Limitations and Opportunities in Research

The findings are from a limited number of participant people and students from a limited number of organizations and schools. The films could include more people and students with disabilities beyond developmental and intellectual disabilities (IDD). Though the films focused less on engineering and information systems players with disabilities, they could include more higher-functioning players in engineering and information systems roles. The findings are important nevertheless in increasing the involvement of engineering and information systems students without disabilities with kindred skilled students with disabilities. Optimistically, the initiative of outreach to likely skilled students with developmental and intellectual disabilities can be a mission for professors and students in schools of engineering and information systems.

Conclusion of Paper

The paper is altruistically an argument for changing the perceptions of engineering and information systems students as to people with disabilities. The findings are a foundation for increasing inclusion of higher-functioning students with disabilities in schools of engineering and information systems. From annual extra-curricular film festival forums, the authors of this paper are continuing to find favorability of impacts from the perceptions of the students without disabilities, as to the potential of higher-functioning people and students with developmental and intellectual disabilities (IDD), from the present study and from re-assessing prior studies. The inclusion of skilled students with disabilities is indicating to be a program for schools of engineering and information systems in an institutional proposition in a university. In conclusion, this paper is an answer for professors desiring inclusion of students with disabilities and of non-students with disabilities on mutual projects of technology with students without disabilities, in an initiative of disability rights.

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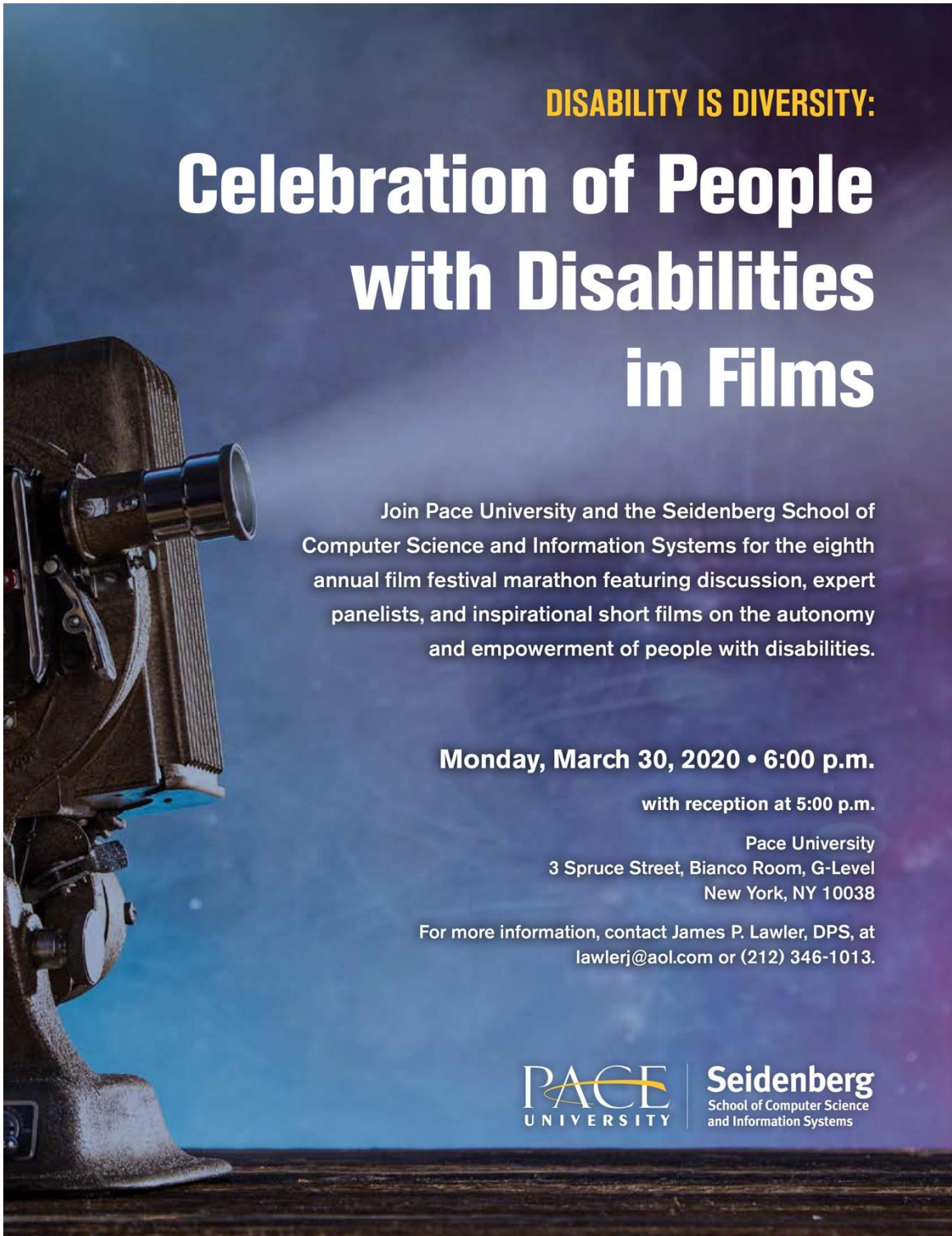
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Acknowledgements

Appendix

Figure 1: Celebration of People with Disabilities in Films Film Festival 2020

Table 1a: Perceptions of Engineering and Information Systems Students (n=18)

Festival Forum 2020

	Means	Standard Deviations
Engagement from Films	6.23	2.89
- **Importance**	6.23	2.88
- **Satisfaction**	6.22	2.90
Advocacy from Films	5.50	3.27
- **Self-Efficacy**	5.66	3.18
- **Sociality**	5.34	3.36

Legend: (9) – Highest Impact – (1) Lowest Impact from Film Ratings of Students

Table 1b: Perceptions of Persons with Disabilities (n=5)

Festival Forum 2020

	Means	Standard Deviations
Engagement from Films	6.52	2.62
- **Importance**	5.16	3.53
- **Satisfaction**	5.16	3.53
Advocacy from Films	4.37	3.67
- **Self-Efficacy**	4.47	3.60
- **Sociality**	4.27	3.77

Table 1c: Perceptions of Engineering and Information Systems Students

Festival Forums 2019 (n=29)* **and 2020** (n=18)

	2020		2019	
	Means	Standard Deviations	Means	Standard Deviations
Engagement from Films	6.23	2.89	7.38	2.056
- **Importance**	6.23	2.88	7.38	2.040
- **Satisfaction**	6.22	2.90	7.37	2.074
Advocacy from Films	5.50	3.27	6.16	2.815
- **Self-Efficacy**	5.66	3.18	6.63	2.530
- **Sociality**	5.34	3.36	5.70	3.007

*Lawler, & Joseph, 2020

Table 2: Perceptions of Engineering and Information Systems Students (n=18)

Festival Forum 2020 – Films

	Engagement		Importance		Satisfaction	
	Means	**Standard Deviations**	**Means**	**Standard Deviations**	**Means**	**Standard Deviations**
Ascent	8.40	1.00	8.30	0.90	8.40	1.10
Golden Sands	5.50	2.30	5.50	2.30	5.40	2.30
Heart Eyes	8.20	1.00	8.10	1.00	8.10	1.00
Heart Over Body	8.60	0.90	8.50	1.00	8.70	0.80
In Your Dreams	5.00	2.20	5.00	2.20	5.00	2.20
Inside My Life	8.00	1.80	8.00	1.90	8.00	1.90
Love, Trails & Dinosaurs	2.80	2.30	2.90	2.40	2.80	2.30
Love Till I Die	3.50	3.30	3.60	3.40	3.40	3.30
Meet Much, Jr.	8.30	0.90	8.30	0.90	8.30	0.90
Real Kid	4.30	2.60	4.30	2.70	4.30	2.50
100% Myself	5.80	2.50	5.90	2.50	5.70	2.50

	Advocacy		Self-Efficacy		Sociality	
	Means	**Standard Deviations**	**Means**	**Standard Deviations**	**Means**	**Standard Deviations**
Ascent	8.10	1.10	8.00	1.20	8.20	1.10
Golden Sands	4.00	2.90	4.20	2.80	3.80	3.00
Heart Eyes	7.20	2.00	7.30	1.70	7.00	2.30
Heart Over Body	8.20	1.50	8.40	1.10	8.00	1.90
In Your Dreams	3.90	2.70	4.20	2.80	3.60	2.70
Inside My Life	7.40	2.40	7.50	2.20	7.30	2.70
Love, Trails & Dinosaurs	1.80	2.30	2.00	2.50	1.50	2.10
Love Till I Die	3.20	3.00	3.40	3.00	3.00	3.00
Meet Much, Jr.	8.50	1.00	8.50	1.00	8.50	1.00
Real Kid	3.20	2.80	3.30	2.80	3.10	2.90
100% Myself	5.00	2.70	5.30	2.60	4.80	2.80

Table 3: Perceptions of Engineering and Information Systems Students

Festival Forum 2020 – Reflections (Reviews) **of Students** (Sample)

Student (Major)	**Film**	**Reflections** (Summary)

Computer Science	*Ascent*	"Great Story … [Character] Never Gives Up … What [He Goes] Thru …"
Engineering	*Golden Sands*	"Fun to Watch"
Engineering	*Heart Eyes*	"Biases … Highly Moving"
Engineering	*Heart Over Body*	"Great Story … If I Can Do It, Everyone Can Do It … "
Engineering	*In Your Dreams*	"Exposing Frequent Problems [of Those with Disabilities] … Funny …"
Engineering	*Inside My Life*	"Emotional … Energy [of Person] Is Strong … Expressions of 'Retard' Heartrending … Forces You to Be for [Those with Disabilities] … Great Story"
Information Systems	*Love Till I Die*	"Inspirational"
Information Systems	*Love, Trails & Dinosaurs*	" … Inspirational Story …"
Information Systems	*Real Kid*	" ... Daily Life … Down to Earth Story …"
Information Systems	*100% Myself*	" … Expected to Be 100% Myself by Myself … Motivating "

Table 4: Frequency Distributions of Participant (n=23) **Perception Ratings in Study**

Festival Forum 2020

	Engagement		Importance		Satisfaction	
Rating	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
0	49	9.7%	25	9.9%	24	9.5%
1	10	2.0%	5	2.0%	5	2.0%
2	0	0	0	0	0	0
3	45	8.9%	21	8.3%	24	9.5%
4	0	0	0	0	0	0
5	79	15.6%	38	15.0%	41	16.2%
6	13	2.6%	6	2.4%	7	2.8%
7	120	23.7%	64	25.3%	56	22.1%
8	17	3.4%	11	4.3%	6	2.4%
9	173	34.2%	83	32.8%	90	35.6%

	Advocacy		Self-Efficacy		Sociality	
Rating	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
0	88	17.4%	40	15.8%	48	19.0%
1	11	2.2%	4	1.6%	7	2.8%
2	0	0	0	0	0	0

3	55	10.9%	26	10.3%	29	11.5%
4	2	0.4%	1	0.4%	1	0.4%
5	79	15.6%	41	16.2%	38	15.0%
6	7	1.4%	2	0.8%	5	2.0%
7	103	20.4%	58	22.9%	45	17.8%
8	10	2.0%	7	2.8%	3	1.2%
9	151	29.8%	74	29.2%	77	30.4%

Table 5: Correlations of Participant (n=23) **Study**

(Kendall's tau_b Correlations)

Festival Forum 2020

	Engagement	**Importance**	**Satisfaction**	**Advocacy**	**Self-Efficacy**	**Sociality**
Engagement	-	-	-	0.767*	-	-
Importance	-	-	0.915*	-	-	-
Satisfaction	-	-	-	-	-	-
Advocacy	-		-	-	-	-
Self-Efficacy	-	0.785*	0.773*	-		
Sociality	-	0.756*	0.753*	-	0.917*	

*Correlation is significant at the 0.01 level (2-tailed).

TEACHING ONLINE IN THE BUSINESS DISCIPLINES: FACULTY TIPS FOR SUCCESS

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Abstract

Faculty at institutions of higher education find that online instruction is no longer optional. In midst of the spring 2020 COVID-19 pandemic, all face-to-face classes were forced online. Faculty need to deliver high-quality instruction in various disciplines through online synchronous and/or asynchronous modes. These case studies offer examples from which faculty may draw upon to improve their teaching practice. Using the multi case method, we share our experiences within the online environment of classes that moved unexpectedly mid-semester from face-to-face to online modality due to COVID-19. The abrupt switch from face-to-face to online learning required instructors to adjust their pedagogical approaches and also to adjust social and managerial approaches and application of technology. This paper offers best-practices recommendations based on cases occurring during the COVID-19 pandemic.

Keywords - Business instruction, Management, Accounting, COVID-19, Online teaching during pandemic

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Introduction

In March 2020, over one thousand colleges and universities in the United States closed their campuses and transitioned online to slow the spread of COVID-19, impacting at least fourteen million students (Hess, 2020). This article focuses on our experiences and lessons learned as faculty in a single academic division of a small, liberal arts college in New York City.

Our institution is a commuter college in a busy, mixed-used neighborhood. It is located within blocks of major public transportation stops on six subway lines and thirteen bus routes, and is just a few minutes from the Brooklyn Bridge by car. The college was founded in the 1850s in the Franciscan Catholic tradition and moved to its current location in 1960. Nine years later, it became co-educational. It is a private, non-profit institution that offers three Associate's degree programs, forty-one Bachelor's degree programs, four Master's degree programs, and two five-year Bachelor's/Master's program.

In fall 2018, our college enrolled 2,413 students. Approximately 97 percent of these students were undergraduates. Ninety-two percent were New York State residents; 36 percent identified as White; 24 percent as Latino/Hispanic; and 19 percent as African-American/Black. Four percent were international students, and 61 percent were female. Thirteen percent of undergraduates were age twenty-five and older (National Center for Education Statistics, 2018). The school is a faith-based institution with a social justice mission. A recent study of economic mobility among college graduates (Aisch *et al.*, 2017) indicates that 69 percent of our students come from lower-income families, and the college ranks 13th out of 578 selective private colleges in overall mobility index, which is defined as "the likelihood that a student...moved up two or more income quintiles" (The New York Times, n.d.).

The Management Sciences division is multidisciplinary and offers courses in accounting, business, business analytics, business law, entrepreneurship, finance, human resources, information technology, management, marketing, project management, and sports management. All four co-authors taught online or hybrid courses prior to the spring 2020 semester.

Teaching Online

Online education—the process of delivering and receiving systematic instruction across distance enabled by digital media—has been growing rapidly (Cook and Grant-Davis, 2017). Advances in technology and connectivity have been key drivers in the evolution and adoption of

online education. The 2018 Babson Survey Research Group (Allen and Seaman, 2018) study reports that enrollments increased for the fourteenth straight year in 2016, with over 30 percent of higher education students taking at least one online education course. Growth, however, was uneven across institutions of higher education. Public institutions grew by 7.3 percent, private non-profit institutions by 7.1 percent, while private for-profit institutions had their distance enrollments decline by 4.5 percent. (Seaman and Seaman, 2019).

Faculty feel increased institutional pressure to bring courses and programs online to keep ahead of competition. Pressure also exists from developers of hardware and software who are anxious to see their products adopted, regardless of whether theory suggests the products' adoption or the tools are appropriate. Online education entails two key complementary components: online teaching and online learning. Online teaching focuses on the delivery of instruction and online learning with the receiving of instruction. In online education, both are necessary for goal achievement and each component has its unique pedagogical approaches and challenges. The focus of this article is on online teaching.

Teaching online means conducting a course partially or totally via technology—either on the Web or by way of a mobile app. Online teaching style should be aligned with appropriate pedagogy and not dictated by available software (Cook and Grant-Davis, 2017). Courses may also follow one of several online educational modalities: hybrid or blended, synchronous or asynchronous modes. Hybrid or blended modality combines face-to-face instruction with online activity (McGee and Reis, 2012). In synchronous course delivery mode, interaction occurs online at the same time while in asynchronous mode there is no real-time interactions among the course participants (Oztok *et al.*, 2013). Each modality represents a unique set of challenges and opportunities that need to be considered when choosing the delivery mode for a specific course (Friðriksdóttir, 2018). In spring 2020, during the COVID-19 pandemic, by order of health officials (NY State Department of Health and others around the country) that choice was narrowed to two possibilities: synchronous, or asynchronous with all courses meeting only online (O'Keefe *et al.*, 2020; Segares *et al.,* 2020).

Opportunities and Challenges

Preparing to teach online presents faculty with both excitement for the opportunities of online environment and anxiety with the challenges it presents. As instructors we have taught

online and share examples from our experience. Here are some of the opportunities and challenges we encountered and are frequently reported by online instructors (Hartman *et al.*, 2007; Mansbach and Austin, 2018).

Opportunities with online teaching include:

- *Convenience and flexibility.* Teaching online offers more flexibility to teach during non-traditional class times as well teaching from anywhere Internet access is available.
- *Increased student engagement and learning.* All students are required to participate in discussions and work through problems, generating a richer pool of ideas and solutions. Students also have more time to reflect and respond to questions, resulting in researched and more in-depth responses (Ko and Rossen, 2017).
- *Inclusive venue.* The online environment provides a comfortable venue for self-motivated students more likely to start a conversation, but also a place where shy students are more comfortable to participate in course activities and discussions leading to an inclusive and richer discussion overall.
- *Large target audience base.* Instructors reach a broader student population than would be possible otherwise through online teaching. Interacting with and between students from a greater demographic and regional pool enhances the students' and instructor's learning experience.
- *Efficiency.* Instructors find increased efficiency as some rote tasks may be automated. Time savers include quiz graders in most learning management software (LMS).

Challenges associated with online teaching include:
- *Technical.* Both instructors' and students' knowledge and comfort in the use of technology is varied. Suitable software may not be available or installed (Sebastianelli and Tamimi, 2011). When reliable access to the Internet is not available, these challenges increase.
- *Pedagogical.* There is a need to re-envision course goals, activities, and assessments to assure pedagogical soundness of the course and related activities (Bailey and Card, 2009; McQuiggan *et al.*, 2015). Faculty must facilitate discussions while building a community of learners to minimize the potential feelings of isolation in the online environment by making the course space a welcoming place (Miller, 2014).

- *Administrative.* Instructors may experience lack of resources and support staff for administering and monitoring electronic-based assets.

- While teaching online presents many opportunities and challenges, there are ways to address most of these challenges to have a successful online teaching experience (Darby, 2019).

Roles and Responsibilities of Online Instructors

Putting a course online means more than merely uploading a course outline and course slides to your institution's learning management software. Heuer and King (2004), drawing on the experiences of online teachers participating in an online professional development course, identified four key roles and responsibilities of online instructors: pedagogical, social, managerial and technical. Each of these roles and responsibilities encompass a variety of activities and decisions that need to be considered when adopting a class for online instruction (Bork and Ruchs-Ahidiana, 2014).

Under the pedagogical role and responsibility, instructors need to create discussions focusing on critical concepts, principles, and skills for the course topic and assure appropriate level and types of activities consistent with the discipline (Bhagat *et al.*, 2016). Fostering a friendly, social environment to promote students' learning and sharing, the instructor is acting as the social coordinator of the course (and of the discipline at large). In a managerial role, the instructor is responsible for clarifying discussion objectives, setting timelines, and enforcing procedural rules to ensure students' learning and enable successful course completion. An additional responsibility of the online instructor is technical, making students comfortable with course technology tools as wells as serving as the first-line tech support for any technical glitches students may experience.

Transitioning to Online During the COVID-19 Pandemic

As colleges around the United States began to transition online in March 2020, faculty received confusing and often conflicting messages from their own institutions, education organizations, and popular media. Some encouraged professors to simplify and do less. Students and faculty alike were grappling with the impact of COVID-19 in their communities and changes to homelife (Gewertz, 2020, Kamenetz, 2020). Others encouraged faculty to take advantage of the opportunities inherent in increased student accountability and interaction (Iwai, 2020).

Instructors who were teaching online for the first time were easily overwhelmed by the number of resources and options available. Many retreated into positions of comfort by simply transitioning their courses into synchronous video conference lectures, while others redesigned their curricula to adapt lessons and projects using best practices.

Institutional Support for Online Teaching

The college under study convened an online task force including faculty and administrative staff in 2017. Among the task force's findings were that the college had steadily grown the number of online and hybrid course offerings and that there was increased student demand for such courses. With a large population of working, commuter students, many colleges elected online and hybrid courses for scheduling flexibility. One recommendation that emerged from this task force was for the college to implement an online faculty certification course. The online faculty certification course was developed during the 2018–2019 academic year and was implemented as a pilot during summer 2019 prior to the COVID-19 pandemic. This course built upon existing technical training provided to faculty by the Information Technology Services department throughout the year, including multiple workshops on the learning management system.

At the same time, the college began to develop proposals for fully online degree programs. At the start of the 2019–2020 school year, college administration announced that faculty who planned to teach online or hybrid courses would be required to successfully complete the online faculty certification course. The online faculty certification course was delivered as an asynchronous course and focused primarily on the technical, managerial, and social roles of the instructor, though pedagogical resources were included. The co-authors participated in the course and received certification. Each co-author has taught online or hybrid courses for three to twelve years at a total of eleven institutions.

Transferring Content from Face-to-Face Format

Transferring content from face-to-face to an online environment can be particularly challenging for quantitative and demonstrative disciplines. Content created for face-to-face classes should not be the same as the content required for online delivery. While learning objectives and goals can be maintained, the delivery should be altered to accommodate a different setting.

Instructors must evaluate course content and how it can be translated to maintain the same effectiveness online. For example, some instructors will lecture for their entire class session. This can involve lecturing for up to three hours in one sitting. In a face-to-face classroom, this style is enhanced by including student engagement, discussions, in-class assignments, or other learning activities. Instructors who transition this format online will quickly lose their audience. Anecdotally, instructors debate whether the average student attention span is eight seconds or up to twenty minutes. Others have questioned whether modern technology has a negative influence on students' ability to focus. A recent study (Prezi, 2018) indicates that millennial attention span is, in fact, evolving due to new technologies. Prezi's 2018 State of Attention report notes that the key to maintaining attention span is concise and compelling content. As such, many instructors have turned to microlearning when teaching online.

Microlearning is a teaching strategy that uses shorter learning units mixed with interactive learning activities. Some examples are watching a shortened lecture video, listening to a podcast, participating in a discussion post, or submitting a visual assignment. Many corporations are shifting towards microlearning as well (Baer, 2020). Overall, due to the absence of an in-person instructor and fellow classmates, a change in pedagogy should be considered when transferring content from face-to-face courses to the online environment. This can be particularly difficult for instructors who are required to transfer content within a short window, as we did during the COVID-19 pandemic, as well as those who present course material through problem solving and/or demonstration.

Case 1: Professor "A" Transfers Content Online

Video lectures are a visual tool that can be used to effectively deliver course matter online. Consider shorter, microlearning sessions, broken up by topics or subtopics. Short videos allow students to remain engaged while also providing a reference library when completing assignments and studying for exams. There are several video recording tools available, including Screencast-o-Matic and Microsoft PowerPoint. Regardless of the technology you use, it's important to accept that you are not required to be a camera professional. Students appreciate instructors who bring life experiences, personality, and even humor to the classroom. Continue to behave in your videos as you would in person. If you make a mistake while recording, work through it professionally.

This eliminates some of the stress of being in front of the camera and hopefully make your content more "binge-worthy."

Web whiteboards can also be useful for quantitative measures. As an Accounting professor, I often use a whiteboard to illustrate problems. In an online environment, I continue to do the same. With a web whiteboard, I can still demonstrate the problem to students. Some examples of this are AWW. If the functionality this tool is cumbersome to use, consider writing out problems and taking pictures of each step, or using video to capture problem steps.

Remember to stay connected with your students. The social role is especially important when a face-to-face class transitions to the online setting mid-semester. It is crucial to maintain a connection with students. This is important for building community, responding to comments and questions, and troubleshooting issues early. Students may find the rapid transition to online difficult. They may be facing personal challenges in addition to managing a new learning platform. During the COVID-19 pandemic, both faculty and students were required to adapt to drastic changes. Offering social interaction can help ease the transition. Video conferencing apps such as Zoom, Microsoft Teams, and Skype enable "face time" with students in an online environment. Many of these applications have built-in tools to generate feedback from students, such as polling questions, reactions or emojis, and chat forums. It is best to utilize these features to continuously assess the content that you are providing and how it is being perceived by the student.

Remember that no work environment is perfect. As a result of COVID-19, I was required to teach live courses and host meetings with students while watching my three-year-old son at home. This is just one of the many challenges faculty and students faced during this transition. Among the other challenges that existed were the limited access to appropriate technology, essential workers or caretakers having limited time for classwork, dealing with job loss and insecurity, and adapting to teaching and/or learning online for the first time. Maintaining a connection with one another, despite the challenges that may have been encountered, was vital to understanding how course content was being translated to students and in managing their overall success. By cultivating active communication between faculty and students, we built camaraderie and a sense that we were all in this together.

Incorporating Teamwork and Social Interaction

Group projects induce dread in most college students, and many students will resist group projects, often citing the ubiquitous defense "I work better alone." Faculty understand the many difficulties students face in effectively working in teams, including problematic or conflicting teammate schedules, bossy teammates, teammates who "ghost" on projects, uneven workloads or skillsets, disparate views of quality work, and personality conflicts. However, as faculty, we also understand and advocate for the best learning outcomes of groups projects, such as fostering emergent professionalism, productive collaboration, appreciation of diverse perspectives, and problem solving using a pooled skillset.

Group projects are challenging in a face-to-face modality, but group projects within online courses create additional layers of complexity for both students and instructors. The reasons students select online courses further exacerbate existing issues surrounding group work with the added potential of no in-person contact between team members, which can be a significant detriment to group dynamics and cohesiveness. Self-selected teams are unlikely in an online modality. Instructors are tasked with assembling a virtual group who needs to work cohesively and rapidly in far-from-ideal circumstances (Ekblaw, 2017).

Case 2: Professor "B" Consciously Uncouples Group Projects

In this section, we will share the experience of transitioning a group project-based course using face-to-face modality to an online modality during the COVID-19 pandemic. The change to course structure was driven by the need to accommodate students' unique circumstances and to maximize student success. The challenges faced by students included limited or inconsistent access to technology, scattering of teammates across a wide range of time zones, and illness or forced quarantine.

The additional challenge of group work in an online environment is understood by the faculty prior to the beginning of the course and the instructor will inform and prepare students once the course begins. As face-to-face courses abruptly changed to online delivery due to COVID-19, we did not have the benefit of time or preparation to effectively transition our students from in-person groups to online groups. However, with the semester half completed, we needed to quickly assess the modality shift's impact on a team's effectiveness and cohesiveness when an unanticipated and abrupt change in course delivery occurs.

Here, we share the journey and method of transitioning a group project-based course from face-to-face delivery to online modality. After receiving group project checkpoints that were of far lesser quality then pre-COVID checkpoints, or incomplete submissions, or no submits, I began a week-long dialogue with the students in the class. Based on discussions with students, via video conferencing, phone, text messaging, and/or email, I realized that students were facing severe challenges in completing their group project, which was a semester-long, multi-deliverable, high stakes assessment worth 45% of their final grade. In an effort to respect student choice and promote self-efficacy (Brooman *et al.*, 2015), I created a poll for students to vote on whether to eliminate the group projects and transition to individual assignments or to continue with the group project. The results of the poll were an astounding 100% vote for eliminating the group project and for new additional individual assessments to be assigned.

To put a positive "spin" on this significant change, I called this process "conscious uncoupling," a term coined by Katherine Woodward Thomas in 2009 and famously used by Hollywood uber-couples to describe their respective divorces. Ms. Thomas' method is based on a five-step process and I modeled the approach accordingly (Figure 1).

5 Steps to Conscious Uncoupling Class Teams

New challenges to successful group work due to COVID-19:
- Limited access to technology
- Different time zones
- International students quarantined for up to 15 days upon returning home

5 Steps
1) Receive post-COVID group deliverables that are not comparable to pre-COVID and concerned emails from students;
2) Review group dynamics and resources of each team;
3) Schedule Zoom Meeting and offer students option to dissolve group;
4) Post a student poll and have a nearly unanimous vote- students have new learning opportunity by taking ownership of the decision process;
5) Revamp course on LMS portal to include only individual assessments.

Figure 1: Five Steps to Conscious Uncoupling Class Teams
Source: Adapted from Thomas, 2009.

Revamping the remaining course assignments and ensuring each would help students meet the course's student learning outcomes was time consuming, but afforded students the ability to successfully complete the course and earn comparable final grades to their mid-semester grades.

Additionally, empowering students to make their own collective decisions provided an extra learning opportunity. Out of a class roster of 24 students, seven students sent individual emails of thanks for allowing the class to take ownership of the decision.

Managing Grading and Interaction

Like students, faculty also faced challenges in managing their schedules during the rapid shift to online learning during the COVID-19 pandemic. Grading and providing feedback are aspects of the online teaching experience that can place significant demands on instructor time (Barnard and Sweeder, 2020; Gibbs and Taylor, 2016), even during a typical semester with a planned course delivery structure. Structuring grading, feedback, and related interactions within the online course environment allow faculty to maximize their roles as social coordinator and manager by increasing the available time for individual interaction with students and group engagement.

Student learning is enhanced with feedback (Gibbs and Taylor, 2016), but providing feedback quickly enough to allow students to incorporate it can prove challenging (Barnard and Sweeder, 2020). By providing intensive feedback early, students can adjust as the semester continues to improve their understanding and their grades.

Case 3: Professor "C" Structures Grading and Feedback

In order to ease the transition to an online setting, I generally schedule time in the first two weeks of online instruction for providing more detailed comments to all students, including directive feedback and recommendations for future assignments. As the course progresses, I manage my time investment differently. During the COVID-19 pandemic, I focused on providing more individualized and detailed grading feedback only to students who were struggling during the later weeks of online instruction.

By grading assignments, discussion boards, and quizzes in batches, I was able to provide general feedback to the entire class on concepts that were confusing or well understood by many, or highlight interesting or controversial discussions, using announcements, pages, or discussion posts in the learning management system. Collective feedback allows the faculty to maximize both the manager and social roles, as it can be used to create a shared experience for students while minimizing the time required for individual responses.

There are times, however, when individual feedback is most appropriate, even if it is time consuming for the instructor. Information about campus resources is important to highlight in multiple places in an online course environment. This became even more critical during the pandemic when resources were switched from face-to-face to online delivery. By creating a comments file, I was able to copy and paste commonly-used comments such as referrals to online campus or internet resources for citations, reminders about academic policies, and the like into emails, messages, announcements, and individual assignment feedback to students.

As in the face-to-face classroom, faculty should also consider their own preferences and technological proficiency. Use the resources within your learning management system or other tools to provide feedback using your preferred methods. Feedback should not be restricted to written form, especially if it is not your preferred communication style. Use audio or video recording, or graphic mark up of documents using annotations in your learning management system, to provide feedback efficiently.

Another way I minimized grading time was by structuring course grading intentionally. This requires faculty to invest time upfront to understand the technical capabilities of the learning management system, or to find other tools that allow for dynamic grading and interaction. As I transitioned my face-to-face courses to an online setting and updated existing online courses during COVID-19, I simplified and reduced grading touchpoints. Most learning management systems include features that allow faculty to manage how assignments are graded. I opted to grade all discussion board posts as "complete or incomplete," which required less grading time than providing a letter or numerical grade. Similarly, I reduced the number of assignments that required grading by collapsing several related activities into one graded assignment.

Conclusion

The spring 2020 semester presented interesting challenges for online teaching. Unfortunately, it is likely that these challenges may not be unique. Many colleges are planning for another wave of COVID-19 infections during the 2020–2021 school year based on predictions of public health experts (McNeil, 2020). Our own institution expects all faculty to complete the online faculty certification course during summer 2020 to prepare for possible disruptions to face-to-face or hybrid course delivery in the fall semester or to support faculty inexperienced with online teaching to gain the confidence to build better courses.

Our cases of transitioning content online, consciously uncoupling teams, and structuring grading and feedback provide suggestions for optimizing the faculty managerial, social, pedagogical, and technical roles during a pandemic, or in general, to deliver quality courses to students. We hope you find these suggestions and resources helpful to you in your own online teaching journey.

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THE HEALTHCARE HACKATHON: AN UNDERGRADUATE EXPERIENTIAL IMMERSION IN ENTREPRENEURSHIP & HEALTHCARE

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Abstract

There is a deficit of comprehensive, evidence-based health and entrepreneurship undergraduate interdisciplinary curricula to empower students to resolve or "hack" complex health issues and to create radical new solution-driven products. This article explores the Healthcare Hackathon, a learning innovation designed to develop entrepreneurial thinking and mindset in healthcare management undergraduate students as they explore the innovation, creation, and delivery of solution-driven products. The concept, evolving from IT hackathon theory and based in Bloom's Taxonomy teaching pedagogy, has been demonstrated for five consecutive semesters with over 120 student-created companies and healthcare products. Students gain invaluable skills in communication, decision-making, and development of their products while researching the industry, grappling with budgetary limitations, and enhancing conceptual business acumen. The guideline for the creation of the business plan is the U.S. Small Business Administration template. Students report increased self-understanding, deeper respect for experiential learning, and higher articulation of objectives and business deliverables. The culminating Healthcare Hackathon event is a curricular, co-curricular, and extra-curricular event that engages the campus community to enhance the student experience. Students engaged in the Healthcare Hackathon leave the course engaged, empowered, and motivated in future healthcare and entrepreneurship opportunities.

Keywords

Introduction

The Healthcare Hackathon is a semester-long curricular activity that culminates in a required course for healthcare undergraduate management majors at a small, faith-based liberal arts college. The Hackathon was embedded as a learning innovation into an existing course and has been iterated over five semesters. The conceptual idea for the Healthcare Hackathon follows the model of traditional Informational Technology (IT) hackathons, wherein users work collectively to resolve complex problems. The Healthcare Hackathon was developed as a curricular innovation by a professor in the healthcare management and health promotion department. Over time, it came to include other faculty who incorporated the culminating event as a co-curricular activity in courses in different disciplines. As a large-scale event involving students, faculty, and staff on a commuter campus, the Healthcare Hackathon also helps to build campus community. This learning innovation is flexible enough to adapt to fit curricula in other disciplines or as an extra-curricular event for different campus environments.

The field of Health Education is the study of assessing the health needs of a population and designing appropriate interventions (National Commission for Health Education Credentialing, n.d). The Leading Health Indicators from Healthy People 2020 (United States Department of Health and Human Services Office of Disease Prevention and Health Promotion, n.d.) are a national set of objectives that the Healthcare Hackathon uses within the framework of "hacks" to be resolved with action-oriented entrepreneurship opportunities. According to Lyndon et al. (2018), "healthcare hackathons are being increasingly used as a model for cross-disciplinary collaboration and learning."

Health educators are the future of health entrepreneurship. They are tasked with questioning current principles, practices, and values, guiding interventions and inventions, developing programming, and designing large-scale improvements in public health.

Entrepreneurship is a major component to effectively scaling and distributing healthcare solutions, and training in entrepreneurship provides flexible pathways for interdisciplinary work that is beneficial to students and the public health problems they seek to "hack." Notably, Green and Kreuter (1999) stated "health education is any combination of learning experiences designed to facilitate voluntary actions conducive to health." Students engaging in the Healthcare Hackathon take on the role of creating products to change health outcomes through a diversity of innovative solutions. The hackathon terminology is now ubiquitous in health professions

pedagogy and for example, Bhandari and Hayward (n.d.) have collected a database of over 190 health hackathons globally in a variety of settings.

Entrepreneurship and Learning Theories

The concept for the Healthcare Hackathon emerged from IT hackathon theory, which is itself rooted in Bloom's Taxonomy. The Healthcare Hackathon develops entrepreneurial thinking and the entrepreneurial mindset through pedagogical approaches based on action learning, social learning, and entrepreneurship pedagogy. It serves to increase student involvement in extracurricular activities in alignment with student development theories and best practices for engaging first-generation college students. Students identify the Healthcare Hackathon as a classroom adaptation of the popular show "Shark Tank." Becker et al. (2019) recommended this approach as an alternative process to traditional academic pedagogy, particularly because it focuses on translating public health knowledge into affective, sustainable, and scalable solutions in entrepreneurship.

A hackathon brings people from diverse backgrounds together for problem-solving sessions that are organized around intense, short-duration competitions where teams generate innovative solutions. The hackathon model integrates collaboration, idea-generation, and group learning by bringing together different stakeholders in a mutually supportive environment (Uffreduzzi, 2017). Hackathons are often more traditionally found in coding and engineering models. The Healthcare Hackathon offers interdisciplinary problem-solving for resourcing solutions. This approach offers action-oriented, inter-professional, and cross-pollination of health and entrepreneurship. In the pedagogy of health professions, hackathons have been adopted in nearly 200 settings (Bhandari & Hayward, n.d.) as terminology and an approach to solving complex health issues while involving diverse stakeholders.

Bloom's Taxonomy

Benjamin Bloom's Taxonomy of Educational Objectives, known more widely as Bloom's Taxonomy, been used by educators for curriculum, content, and assessment development for over sixty years (Seaman, 2011). The original Bloom's Taxonomy is a hierarchical codification of cognition that includes six levels: knowledge, comprehension, application, analysis, emphasis, and evaluation (Milman, 2015). When it was revised in 2001, several important changes were made. The category nomenclature shifted from nouns to verbs; it became a "two-dimensional framework consisting of the 'knowledge dimension' and the

'cognitive process dimension,'" (Milman, 2015); and the highest levels were transposed (Milman, 2015; Seaman, 2011). Using the revised Bloom's Taxonomy, "create" is the highest-level cognitive process, following remember, understand, apply, analyze, and evaluate (Milman, 2015).

As a culminating activity in a required course for healthcare management majors, the Hackathon assesses each student's ability to "create," which builds upon the cognitive processes developed and assessed in previous coursework. In order to create, students must remember, understand, and apply concepts from earlier courses (such as the social determinants of health, the structure of the U.S. healthcare delivery system and social marketing frameworks); analyze an existing health problem; and evaluate the currently available solutions before developing their own solutions. The creation process allows students to ideate several potential solutions using design thinking as a methodology. Students develop their entrepreneurial thinking skills and mindset through collaboration with classmates and reflecting on their process of discovery and value creation. They build resilience through the iteration of ever-improving variants of their solution.

Entrepreneurial Thinking and the Entrepreneurial Mindset

Entrepreneurial thinking is "a mindset that emphasizes recognizing opportunity and … challeng[ing] existing assumptions to generate value in innovative and creative ways" through "championing new products, lending expertise to social innovations, or institutionalizing entrepreneurial activities within an organization's systems and processes" (Patel and Mehta, 2016, p. 518). The major principles of entrepreneurial thinking are collaboration, value-creation, resilience, and discovery-driven (Hynes et al., 2016; Patel and Mehta, 2016; Neck et al., 2014). Entrepreneurial thinking can be learned through continuous, non-linear, and experience-based processes that encourage students to disrupt routines and reflect on successes and failures (Hynes et al., 2016; Neck et al., 2014).

The entrepreneurial mindset encompasses a set of attitudes, skills, and behaviors that enable students to succeed academically, personally, and professionally (Jabeen et al., 2017; McGrath and MacMillan, 2000). These include initiative and self-direction, risk-taking, flexibility and adaptability, creativity and innovation, critical thinking, and problem-solving. While mainstream business media decries the negative impact of business education on entrepreneurial thinking and mindset, an interdisciplinary, liberal-arts education has been

associated with developing the nonlinear thinking skills that are required for entrepreneurial success (Vance et al., 2012). Using an iterative process that includes understanding the problem, developing ideas, creating a solution, and testing the solution (Von Kortzfleisch et al., 2013) is one way to encourage the development of entrepreneurial thinking skills and the entrepreneurial mindset (Patel and Mehta, 2016; Val et al., 2017).

Social Learning and Entrepreneurship Pedagogy

Social learning is defined as "learning that is facilitated by the observation of, or interaction with, another individual" (Hoppitt and Laland, 2013). During the Healthcare Hackathon, student learning is not limited to experiencing results from their own actions; learning is enhanced through observation and critique of fellow classmates (Robinson et al., 2016). Consistent feedback and accountability are critical to creating authentic and realistic entrepreneurial experiences (Neck et al., 2014; Hynes et al., 2016). Some students grapple with forming an "entrepreneurial identity within the education setting" (Donnellon et al, 2014, p. 492). Social interaction, feedback, and engagement with stakeholder's support students in constructing an entrepreneurial identity (Donnellon et al, 2014).

Similarly, Neck et al. (2014) argue that experiential learning activities lead to "enhance[d] development of entrepreneurial competencies and performances" (p. 15). Significantly, the Healthcare Hackathon serves to activate the skills and attributes of the entrepreneurial mindset within students. Further, the experiential curriculum of the Healthcare Hackathon aligns with the social- and practitioner-based concepts of entrepreneurship pedagogy (Neck et al., 2014; Shepherd and Gruber, 2020) and most relevantly with entrepreneurial practitioner-based concepts within the healthcare field (Jackson et al., 2016; Rees, 2017).

Context and Learning Innovation

The context of this learning innovation is a liberal arts college in the Franciscan Catholic tradition located in an urban, mixed-use neighborhood in New York City. Founded in 1859 as the first private school in the Brooklyn diocese, the institution moved to its current location in 1960 (St. Francis College, n.d.) and became co-educational in 1969 (St. Francis College, 2007, p. 8). It is a private, non-profit institution (National Center for Education Statistics, n.d.) currently offering three Associate's degree programs, forty-one Bachelor's degree programs, four Master's degree programs, and two five-year Bachelor's/Master's program (St. Francis College, 2016-2018, p. 20). In Fall 2018, the college enrolled 2,413 students; approximately 97% of these

students were undergraduates. Ninety-two percent were New York State residents; 36% identified as White, 24% as Latino/Hispanic, and 19% as African-American/Black; 4% were international students; and 61% were female. Thirteen percent of undergraduates were aged 25 and older (National Center for Education Statistics, n.d.).

Healthcare Hackathon: An Overview

The Healthcare Hackathon is a semester-long curricular activity embedded in a 2000-level course for health care management majors. The course, Decision Making for Healthcare, is required for majors and is typically offered every spring. The course experiences a low level of withdrawals and failures due to the intensive faculty mentorship component of the class. Health care management is one of the ten most popular majors at this college. Students enter this major through a variety of pathways, including after matriculating at the college as a first-time freshman; as transfer students seeking a quick pathway to graduation because this major has a low number of departmental requirements; and as internal transfers from clinical- or science-oriented health majors such as nursing, biology, or radiologic science. Some students in this major are passionate about joining the healthcare industry, while others seek to appease parents who expect them to pursue a professional pathway that leads to work within healthcare (which is the industry with the largest employers at both the city and state level).

The student learning objectives for this course are to:

- Identify a health-related problem, research industry solutions, and research evidence-based health data to develop a market-driven and science-based solution.
- Create a product-driven solution for a health-related issue.
- Demonstrate comprehension of context for both healthcare and entrepreneurial industry professional standards.
- Evaluate, integrate, and apply appropriate concepts from industry- and science-based sources to create a cohesive and persuasive marketing plan.

Learning Innovation

The Healthcare Hackathon is contextualized in both health and entrepreneurial contexts and requires the connectedness of finding real solutions for real health problems. The Healthcare Hackathon is embedded in the Decision Making in Health Fields course; no student leaves the course without understanding the steps to entrepreneurship, the deep value of health industry research, and how the students themselves are catalysts for social change. Here the application of

experiential project-based learning proves significant to the success of the projects while also enhancing learning and engagement. Experiential project-based learning is student-centered; it is where the "lecturer becomes an enabler, encouraging and motivating students to do more than they could do before, and to challenge their ability to tackle and respond to problems . . . noting that the most creative solutions are usually the ones that were unforeseen (Hynes et al, 2016, p. 79).

The Hackathon was developed with a student-centric focus. The student is the driver of the solution and exemplifies the benefits of social learning. Students choose their own health problems and become self-regulated learners with intrinsic motivation. This allows them to become prepared for complex decision-making problems in future life and work environments. Learning about innovation can often be invisible and devalued work. The Hackathon project allows students to leave the class with a tangible product that they created. The deep level of ownership that occurs during the four months is palatable years after graduation, as alumni highlight their product or company in their portfolios after graduation.

The Healthcare Hackathon is immersive, flexible, and experimental, as students are steeped in health- and industry-related research in order to conceptualize the health problems facing their communities and develop a solutions-based resource. Students are required to revisit and iterate on ideas until they are tangible, deliverable, and scalable. They will have periods of discovery, periods of failure, and periods of success. The learning is meaningful because it introduces the student to interdisciplinary thinking across healthcare, entrepreneurship, marketing, communications, and business sectors. The student is given permission to float between each discipline to enhance their strengths, developing new learning pathways and creating marketable assets for their professional journey.

The Decision Making in Health Fields course uses an in-depth workshop approach to management problems in healthcare delivery and culminates with the Healthcare Hackathon event. The emphasis is on case study and an experiential method of problem solving. Specific case studies are used in class to illustrate problem-solving and decision-making techniques of practical use to healthcare professionals. Interpersonal skills and teamwork are developed through collaborative activities.

The students engage with the Healthcare Hackathon as a curricular, co-curricular, and extracurricular activity all within a social learning context. Students enrolled in the course

experience the summative presentation of the Healthcare Hackathon as the culmination of their curricular activities. Healthcare management and entrepreneurship students in other classes, who act as peer judges ("consumers") for the summative presentation, experience the Hackathon as a co-curricular activity and benefit from the supplemental and complementary learning opportunity. Students from outside the healthcare management and entrepreneurship disciplines, faculty in other departments, and staff participate as peer judges at the summative presentation and experience the Hackathon as an extracurricular activity that serves to develop a learning community centered around healthcare and entrepreneurship.

Through these curricular, co-curricular, and extracurricular activities, students engage in social learning through application of the iterative process. Students learn that continuous improvement through feedback and analysis is critical to creating product-driven solutions for healthcare issues and entrepreneurial achievement.

Conceptual Design & Growth Over Years

Before piloting the idea of an innovation space for healthcare entrepreneurs, the college faculty held focus groups with students and alumni involved in healthcare management and health promotion. Healthcare management and health promotion majors, as well as other health science and allied health majors, are housed within the Biology department at this college. When the Healthcare Hackathon was initially conceived, the healthcare management major was in its reinvention stages after a faculty transition, and students and alumni were eager to see the possibilities. The Hackathon was modeled after other problem-solving events with students finding solutions for problems by "hacking" the answer.

During this iteration of the class, the Healthcare Hackathon was embedded from the first day of classes to the last. The objective was to "hack" the student, while finding deeper solutions to large-scale health issues. Students devoured the idea of being in control of a solution, even when faced with the challenging limitations of funding, timing, and their understanding. The objective to "hack" the student was to truly test their decision-making process; the end-product itself was secondary. Every class started with a thirty-second pitch by each student. A midterm assessment included an "elevator pitch" where students literally pitched their entrepreneurial concepts to strangers on an elevator.

The collaboration of two professors, two departments, and students who completed the course previously helped to develop accurate, appropriate, and achievable learning objectives as

the Hackathon evolved. The culminating activity was an event wherein the entire campus community was invited to see students present their health-related projects as individuals or teams within a pitch-a-thon format. This activity was the culmination of facilitated research and student development to create wellness products, nutrition services, and resources for aging populations. The event culminated with three projects receiving financial prizes for the best pitch, the most actualized and solidified business plan, and the strongest marketing plan.

Faculty sought to develop the Hackathon experience by engaging current students in health sciences majors and the entrepreneurship minor, prospective health sciences majors, and the overall campus community. Students completed a mock business plan using the U.S. Small Business Administration (SBA) template which added an additional layer of complexity. Students were more grounded in actualizing financials, including the cost of prototyping, purchasing power, and other funds that might be needed from an investor.

The practice of presenting thirty-second pitches in each class session continued, and three full practice pitches were added to the course. Students developed pitches, business plans, and an entrepreneurial concept as an individual or a team. Faculty observed many challenges within the group dynamics as students navigated the stressors of creating a company. These difficulties were used as learning moments. The theory of immersion learning (Serdyukov, 2017) requires students to engage in the all-consuming decision-making process of the creation of their own entrepreneurial dream within healthcare.

How the Healthcare Hackathon Works

The Healthcare Hackathon works by allowing upper-level undergraduate students to focus on resolving a healthcare dilemma through innovation, research, and entrepreneurial problem-solving. The healthcare industry requires innovators, problem-solvers, and those who think way beyond the proverbial box. This assignment was designed as a core curricular component for a required course in healthcare decision-making. The students are informed of the assignment of the first day of classes and have an intense four-month period to ideate, create, and deliver a healthcare product. The guidelines for the assignment are simple: dream big solutions for small health-related problems; create a business plan using the template of the US Small Business Administration; and deliver a strong pitch to both consumers and investors with a full marketing plan and a prototype.

Results and Lessons Learned

Over the past five years, the Healthcare Hackathon has grown from a class-wide event to an institution-wide event. Students and the campus community are excited to see the "next big idea." Allowing students to craft a product with independence is a culminating opportunity that offers a diverse group of challenges. Students understand the decision-making as an iterative sequence of many steps, not a linear process. This natural teamwork, and orchestration of team playing, demonstrates leadership in action. Students who participate in the Healthcare Hackathon develop cross-disciplinary interests and become more driven and engaged in their own learning.

Learning outcomes for entrepreneurship-infused education are effectively enhanced by experiential approaches. Innovation is the key focus of the Decision Making in Health Fields coursework and requires students to lead the ideation, development, and delivery of conceptual projects. The Healthcare Hackathon project fosters a creative environment where students can grow and develop their entrepreneurial mindset. The project-based, experiential, student-centered, and student-driven components of the Hackathon can be adapted to improve the learning outcomes of course work in a wide range of disciplines. The format of the can be extended to other academic areas including criminal justice, psychology, information technology, film studies, fine arts, education, and finance.

Conclusion

The impact of the Healthcare Hackathon is an authentic learning experience leading to mastery of entrepreneurial competencies and the development of real-world problem-solving skills. The Hackathon is a novel educational approach to teaching foundational skillsets to undergraduate students through an immersive project. Deeply rooted in Bloom's Taxonomy, the cognitive development within students immersed in the Healthcare Hackathon requires advancing, even when you do not have all the solutions. Embedding Social Learning Theory within the Healthcare Hackathon motivates students to continuously seek to resolve complex problems. Problem-solving and experiential opportunities are transferable to many educational disciplines and environments. Experiential learning bestows students with a passion to grow their Hackathon resolutions into continuous learning opportunities.

Overall, the Healthcare Hackathon is successful because it has created new opportunities for interdisciplinary collaboration, leaning on the resources of several academic departments. The benefactors of this synergy are the students who engage in this semester-long project.

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THOUGHTS ABOUT THE CLOUD COMPUTING IN BUSINESS MASTER'S PROGRAM

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Abstract

This paper is to develop a curriculum for a master's program in cloud computing from the perspective of a business school. It intends to stimulate discussions about how a cloud computing master's program may be developed in a business school with more emphasis given to business and management.

Key Words: Cloud Computing, Master's Program, Curriculum, Business School

Introduction

As cloud computing is becoming increasingly adopted to improve organizational agility (Liu et al., 2018) and integrate supply chains (Novais et al., 2019), firms start to realize that a key determinant for their successful adoption of cloud computing is technology readiness (Oliveira, et al., 2014). This means that companies should hire people with necessary skills to implement cloud computing, leading to demand for colleges to develop cloud computing programs to educate students so that they are ready to work for those companies in various industries when they graduate from colleges.

This paper is to develop a curriculum for a master's program in cloud computing inside a business school. First, the need for talents in the overall IT industry is presented and then the labor demand in the cloud computing field is also discussed. It is clear from these discussions that the market for training in the field of cloud computing has huge potentials. Second, a few sample master's programs and post graduate certificate programs in the field are presented. Third, a curriculum for the cloud computing in business master's program is developed to stimulate discussions. This

curriculum comprises of 4 groups of courses including the prerequisite, the foundation, the core, and the elective courses. In total, 10 courses are required for graduating from this program.

Market for the Master's Program in Cloud Computing in Business

For the overall IT industry, the 2020 Global Knowledge (GK) IT Skills and Salary Report[1] (surveyed 9505 IT professionals worldwide including 3930 IT professionals in North America) indicates that 1) 80% of IT managers would approve formal training which is an increase of 36% year over year, 2) IT professionals received an average raise of $12,000-$13,000 if they obtained new skills and/or certifications last year, 3) with skills gap, each IT professional may lose up to 520 productivity hours, and 4) 69% of IT managers have more than one open position they could not fill[2]. As such, the market for IT training is surely growing.

In particular, GK report also indicates that 29% of the respondents believe that cloud computing is the second most difficult hiring area. Indeed, training cannot keep up with the cloud adoption rate. Firms need cloud architects, developers, administrators, and other experts specialized in areas such as cloud based big data analytics, AI and machine learning, systems and solution architecture, and DevOps. In addition, the 2020 GK report shows that for professionals working with cloud computing, their average salary is $153,655 in North America and 6 out of the 10 top certifications IT professionals plan to pursue are cloud computing certifications sponsored by top providers such as AWS or Microsoft Azure[3]. Therefore, a master's program in cloud computing in business may have a huge potential to recruit working professionals from various industries.

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Sample Master's or Graduate Certificate Programs in Cloud Computing

A simple google search shows that there are some universities with cloud computing management master's or graduate certificate programs. These programs are technology oriented or a mix of technology and management. 5 sample programs are presented in the following.

1. Northeastern University offers a Graduate Certificate in Cloud Software Development[4] in its computer science department. This program is technology oriented.

> The program "provides students of all backgrounds with the foundational skills needed to pursue a career in cloud computing. Through a four-course program that emphasizes hands-on, industry-facing experiential learning … you'll gain the technical ability, exposure, and experience to work on any cloud computing platform, as well as the career-building resources to put you on the fast track in this growing field." – from its web site.

2. University of Maryland Global Campus offers the Master of Science in Cloud Computing Architecture Program [5]. This program is a mix of both cloud computing technology and management with more emphasis on cloud computing technology.

> "The Master of Science in Cloud Computing Architecture at University of Maryland Global Campus is designed to equip you with the technical and management skills to effectively design, operate, and maintain cloud computing systems and help organizations transition to cloud-based solutions." – from its web site.

3. George Washington University offers an online Master Program in Cloud Computing Management[6]. The overall purpose of the program is to help students to lead cloud and business transformation. The key areas covered in this program include: 1) cloud applications architecture, 2) computer architecture and design, 3) big data and cloud computing, 4) applied machine learning for engineers, and 5) cloud migration strategy. This program is a mix of technology and management.

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[4] https://pages.northeastern.edu/STEMCERTG-CLSDPSCH2020-05_LPFA.html, Accessed on January 14, 2021.
[5] https://www.umgc.edu/academic-programs/masters-degrees/cloud-computing-architecture.cfm, Accessed on January 14, 2021.
[6] https://onlinecybersecurity.seas.gwu.edu/online-masters-cloud-computing-c/, Accessed on January 14, 2021.

"The online Master of Engineering in Cloud Computing Management is a multidisciplinary degree that prepares graduates to manage the unprecedented complexity of business cloud computing systems and services. The program combines knowledge of cloud computing systems and architecture, business process, management, security and data analytics — preparing students to solve challenges related to cloud migrations …" – from its web site.

4. Stevens Institute of Technology offers a master's program in Enterprise & Cloud Computing[7]. The program has 4 core courses including: Enterprise and Cloud Computing, Distributed Systems and Cloud Computing, Enterprise and Cloud Security, Mobile Systems and Applications. This program is highly technology focused.

The program "is intended to educate high-end IT professionals with an interest in enterprise and cloud computing. Cloud computing has revolutionized the management of information technology (IT) resources by businesses and enterprises, providing greater scalability and manageability over traditional approaches, but introducing serious challenges with respect to security and privacy." – from its web site.

5. The University of Texas at San Antonio offers a graduate certificate in cloud computing[8]. The certificate is supported by the College of Engineering, the College of Business, and the College of Sciences. It requires 4 courses (12 credits hours) including one entry course Cloud Computing for Business, two courses from one of the available tracks (Applications, Security, or Infrastructure), and an Independent Study in the field of Cloud Computing[9]. This certificate is a mix of technology and management with more emphasis on technology.

"This certificate is designed to provide a common framework for cloud computing, as well as allow for specialization in specific areas, such as, cyber security, cloud infrastructure and applications in cloud." – from its web site.

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[7] https://www.stevens.edu/schaefer-school-engineering-science/departments/computer-science/graduate-programs/enterprise-cloud-computing-masters-program/curriculum-overview
[8] https://business.utsa.edu/programs/graduate-certificate-cloud-computing/, Accessed on January 16, 2021.
[9] https://catalog.utsa.edu/graduate/business/informationsystemscybersecurity/#certificatestext, Accessed on January 16, 2021.

Curriculum Development for the Cloud Computing Master's Program in a Business School

While all the sample cloud computing programs are more-or-less engineering oriented, the purpose of the curriculum that is developed here is to stimulate discussions about how to establish a cloud computing program in a business school (with more emphasis given to business and management).

The program may have 10 courses with 4 groups of courses including the prerequisite, the foundation, the core, and the elective courses. First, it may have 1 Statistics course as its prerequisite. Second, this program may require 3 foundation courses including 1) Fundamentals of IS, 2) Database Management, and 3) Computer Networks. These courses are the foundation for students to take the core and elective courses and the MIS program in business schools should normally have these courses developed already. Third, 4 core courses focusing on cloud computing in business may be developed as the following:

1. Fundamentals of Cloud Computing: this course focuses on various fundamental web services in cloud computing. These services may include such as different types of cloud-based storages, virtual machines, Lamdas, data streaming, visualization, messaging, continuous deployment, etc.

2. Enterprise Systems Theory and Practice: this course is built upon the fundamentals and focuses on solution architectures which integrates various cloud services to achieve business goals (e.g., analyzing social media streaming data and continuously monitoring IOT data). Further, related research articles (e.g., Garrison et al., 2015) could be discussed in class to improve students' theoretical understanding of challenges in cloud computing management.

3. Big Data Technologies in Business: this course focuses on the application of big data technologies in business. These technologies may include such as distributed storage systems (e.g., Apache Hadoop File System) and parallel computing engines (e.g., Apache

Spark). The Amazon Elastic Map Reduce (EMR)[10] service could be used in class. Further, business examples and management research articles related to big data analysis (e.g., Shi and Wang, 2018) could be used to make the learning process more meaningful for business students.

4. Machine Learning in Business: This course focuses on application of various machine learning techniques in business. Amazon SageMaker[11] and Rekognition[12] could be used in teaching this course. Business applications such as face detection and analysis could be used to make the learning process interesting for business students. Further, related research articles (e.g., Mori et al., 2012) could be discussed.

Lastly, 3 elective courses should be required. These courses may cover topics such as Knowledge Management, Information Visualization, and Data Mining. Understanding of these topics may help students better apply various cloud services in different business scenarios.

Conclusion

This paper is to develop a curriculum for a master's program in cloud computing in business. The market for the cloud computing training is analyzed and sample programs are presented. Most of these programs are in colleges of Engineering or a collaboration between engineering and other disciplines. The proposed curriculum is from the perspective of building this program inside a busines school. It is my hope that this paper may stimulate discussions regarding how a cloud computing master's program could be developed in a business school.

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[10] https://aws.amazon.com/emr/, Accessed on January 16, 2021.
[11] https://aws.amazon.com/sagemaker/, Accessed on January 16, 2021.
[12] https://aws.amazon.com/rekognition/, Accessed on January 16, 2021.

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Healthcare Analytics and Services Management

Analysis of Mental Health Symptoms and Unemployment Rate During the COVID-19 Pandemic

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Abstract

The pandemic originating in China in 2019 has caused billions of people's lives to be affected as a result. With school closures, shelter-in-place protocols, and other protective measures, daily life has drastically changed for many. The increased pressure of adapting to these changes, figuring out how to not contract COVID-19, and worrying about others who were infected can psychologically distress people. Examining data about the percentage of people with anxiety, depression, or either type of symptom nationally and for each state in the United States, it can be determined if mental health has been affected during the pandemic. On the national level, the differences in demographics such as race, gender, age, and education level will be analyzed. Maps of the United States are constructed to see how the percentage of symptoms for each state is changing from May to October 2020. Circle graphs categorizing the states into their respective time zones are also examined. Data on unemployment rate, one measurement researchers believe has changed in 2020, from April to October in 2019 and 2020 for each state is also gathered to determine if the rate is different from 2019 to 2020 and throughout the 2020 year. Nationally, the general trend of mental health symptoms is slightly increasing over time from May to October 2020. The results for unemployment rate follow what researchers expected in that the rate is higher in 2020 compared to 2019.

Keywords: unemployment rate; mental health; COVID-19 pandemic

Introduction

COVID-19 is a continuous, infectious disease originating in China that is transmitted through droplets of saliva or nasal discharge when someone infected coughs or sneezes. Common symptoms include having a fever or dry cough, while severe symptoms include loss of speech and shortness of breath. While COVID-19 is not as contagious as other diseases, such as SARS, COVID-19 has particularly spread so quickly due to how long it can take for symptoms to appear and that a significant percentage of those affected are asymptomatic. People around the world vigorously watch the number of COVID-19 cases daily to understand the virus's presence. However, there is little knowledge about how COVID-19 and its implications on daily life affect mental health [1] [2].

Due to the contagiousness of COVID-19, daily life has drastically changed, causing various aspects of human life to be altered. A study analyzing crime data from Indianapolis and LA found that domestic violence incidents had drastically increased, possibly connecting to shelter-in-place orders forcing individuals to stay home more often than before [3]. There have also been surges of xenophobic tweets against the Chinese about the virus's origin or blaming the group for the virus's spread [4]. More people than ever are working from home, resulting in the roles of "employee" and "caretaker" becoming less structured [5]. The COVID Stress Scales (CSS) even found that 28% of individuals had elevated anxiety and 22% had significant depressive symptoms. The CSS has concluded that fears of the dangerous and spreadability of COVID-19, fears of social and economic consequences, xenophobia, compulsive checking, and traumatic stress symptoms such as nightmares can be predictors for psychological distress [6].

In this report, the percentage of people with possible anxiety and depression symptoms in the United States on the national level and by each state will be examined from April to October 2020. The average percentage for each month and the entire duration of the survey will be analyzed to see if changes in anxiety and depression occurred. Data on unemployment rate from April to October for 2019 and 2020 was also gathered to examine if the rate has significantly changed for the different years and to understand if unemployment rate is connected to mental health status.

Data Collection

The data utilized for this report includes data from the Household Pulse Survey conducted during Phase 1 and 2, or from April 23rd to June 21st, 2020, and August 19th to October 26th, 2020. The data was produced by the United States Census Bureau, the National Center of Health Statistics (NCHS), and other federal agencies. The survey contained questions about experiences with employment status, food security, housing, health care, and education within the past seven days to collect information about how the social and economic effects of the pandemic have impacted Americans. The data recorded is the percentage of adults with possible anxiety, depression, or either anxiety or depression symptoms associated with generalized anxiety disorder and major depressive disorder based on the participant's responses. Throughout the rest of this report, the category for either anxiety or depression symptoms will be referred to as either symptom type. For Phase 1, the data is gathered in intervals of about one week span, while Phase 2 is organized into intervals of approximately two weeks span [7][8].

Within the Household Pulse Survey data, national percentages of people with anxiety or depression symptoms were categorized according to gender, race, age, and education level; the overall national average was recorded as well. The two genders recorded were female and male. Each age bracket represents around ten years of consecutive ages, starting with 18 years of age. The last age bracket compasses everyone 80 years old or older. Education has four different categories that represent people who did not graduate high school, did graduate high school, have some college experience or an associate degree, and those with a bachelor's degree or higher. The different categories for race include Asians, Whites, Blacks, Hispanic or Latinos, and other or mixed races.

The data about the unemployment rate in the United States was obtained from the Wolfram|Alpha Knowledgebase, which also collects data from various external sources. Unemployment rates for each state were manually extracted from the WolframAlpha website for each month, April through October, in the years 2019 and 2020. The rates are in decimal form rather than percent form and rounded to the nearest tenths place.

Methodology

All graphs created and all analysis performed were through the Tableau Software, an interactive data visualization program compatible with various data files. For the unemployment rates, the data for each month of each year had to be manually pasted and sorted into a single Excel file before analysis could begin.

Graphs of National Demographics

For each demographic, age, race, gender, and education level, a line graph of the percentage of adults with symptoms throughout the entire survey duration was constructed where each line represents a category in that specific demographic. Another line representing the general national average was also included in the line graphs. One line graph was created for each symptom type, anxiety, depression, or either, for each demographic. Another line graph illustrating the average percentage of all three symptom types collectively was also constructed for each demographic to graph the general trend of the mental health symptoms over the time span. In total, 16 graphs were made. The break period from July 2nd to August 16th was not pictorially depicted to have continuous lines.

Average Symptom Percentage by State

To provide more insight into the overall trend of symptoms for each state, each state's average percentage of symptoms was calculated for each month and the entire survey duration. Due to the data being collected weekly or biweekly, the average for each month might be computed using different amounts of data points or include time spans not in that particular month. For example, the average for May consists of the time frames from April 23rd to June 2nd, or five percentages. Meanwhile, the average for July includes the time frames from July 2nd to July 21st, or three percentages. The average for the months August and September, or the time frames from August 19th to September 28th, were combined due to how little data points were available for each month. The average for June includes the time frames from June 4th to June 30th, and the average for October consists of the time frames from September 30th to

October 26th. The average of April is not included, as only eight of the thirty days in April were accounted for. This process was done for anxiety, depression, and either type of mental health symptom.

Graphs of the United States were then constructed containing the average percentage of symptoms for each state. One map was created for each symptom type for each month, May, June, July, August and September, or October, and the entire time span. In total, there were six graphs per mental health type and eighteen maps altogether. The average for each state was depicted through color. The quantitative color key used starts at 17.00, or the floor of the lowest minimum average percentage of any symptom type, and ends at 47.00, or the ceiling of the highest maximum average percentage of any symptom type. Instead of a continuous, monochromatic color key, the color key used consisted of ten uniform bins transitioning from green to red in a reverse rainbow fashion. In Tableau Software, this color scheme is the reverse of Red-Green-Gold Diverging. The first bin was the darkest green and represented states with average symptom percentages between 17.00 and 19.99. The next bin is a lighter green representing percentages from 20.00 to 22.99. The pattern continues until the tenth and last bin, which is darkest red and illustrates percentages from 44.00 to 47.00.

Categorizing by Time Zones

One other analysis technique explored through the Household Pulse Survey dataset was organizing the data into time zones. The time zones considered were Pacific (PST), Mountain (MST), Central (CST), and Eastern Standard Time (EST). States not within the listed time zones, such as Alaska, are placed in the miscellaneous category. Generally, most states are only within one time zone and can be easily classified into that respective time zone. However, for states that use different time zones in separate counties, the time zone is determined by which is implemented in the most counties. For example, the western part of South Dakota is in MST while the eastern part is in CST. Using the criteria previously explained, South Dakota would be classified as being in CST due to the numerous counties that use it.

With each time zone being labeled as a different color, a comprehensive circle graph was constructed for the survey's entire time span. Each circle represents the symptom percentage for

a particular state in that respective time frame. Each symptom type, anxiety, depression, or either, was graphed separately.

Plotting the Unemployment Rates

Similar to the average percentages of anxiety, depression, or either symptom type, graphs of the United States were constructed for each state's unemployment rate. One map was created for each month, April through October, and the average unemployment rate from April to October for each year, totaling sixteen graphs. The average unemployment rate for the entire time span, or from April to October, was manually calculated. The unemployment rate for each state was depicted through color. The quantitative color key used starts at 0 and ends at 0.33. The ending point is 0.33 instead of the decimal representation of the ceiling of the highest unemployment rate in the dataset, which is 0.31, because having an appropriate amount of uniform cells was preferred. Instead of a continuous, monochromatic color key, the color key used consisted of ten uniform bins transitioning from red to black. In Tableau Software, this color scheme is Red-Black-White Diverging. The first bin was the darkest shade of red and represented states with unemployment rates between 0% and 3.30%. The next bin is a lighter red representing percentages from 3.31% to 6.59%. The pattern continues until the tenth and last bin, which is the darkest shade of black and represents percentages from 29.7% to 33.0%.

Results

All graphs produced through the methods explained in the Methodology section are presented in Appendix A. Figure A1 contains all the national line graphs separated by demographic for the either symptom type. Figure A2 has the maps for the symptom percentage of the either symptom type for most of the states in the United States from May to October 2020. Figure A3 is the circle graph of the symptom percentage produced for the either symptom type where the states are categorized by their respective time zones. Finally, Figures A4 and A5 are the maps of the unemployment rate for most states in the United States. While Figure A4 has the average rate from April to October for both 2019 and 2020, Figure A5 contains maps of the rate for April, May, and October of both years.

Nationwide Symptom Percentages

Generally, the line graphs for each symptom type generated similar-looking results. Hence, the line graphs of the average percentage for all symptom types collectively will be analyzed to better understand the general trend of anxiety and depression symptoms nationally.

For most categories of each demographic, there is a steady increase in the percentage of symptoms from May 7th to July 7th, 2020. Some lines that did not follow this general pattern were the age category 80 years old or older, the race categories Asian and other or multiple races, and the education category, Less than a high school diploma. Most categories have a peak in the percentage of symptoms at the time frame July 16th through July 21st. However, from July 21st to August 31st, the percentage seems to decrease steeply, then steadily increase for the remainder of the time for almost all categories. One of the only categories that did not follow this general trend was 80 years old or older.

For the age demographic specifically, one general trend is that the younger the individual, the more likely they are to have symptoms. The categories 18 to 29 years old, 30 to 39 years old, and 40 to 49 years old are also above the national average. The percentage of symptoms for each of these categories was between 30% to 48% for the entire survey duration. The maximum percentage is 47.23%, seen from July 9th to July 14th and July 16th to July 21st, and was found in the 18 to 29 years old category. The line representing the age group 50 to 59 years old almost consistently has the same percentage as the national average. Both these lines increase or decrease at consistent rates and are in between 29% and 36%. The line for 60 to 69 years old is relatively consistent as well, staying in between 21% and 29% throughout the entire duration. Finally, the age groups 70 to 79 years old and 80 years old or older have the lowest percentages of any other age group throughout the entire line graph. Both lines are in between 11% and 21.5% throughout the duration. The lowest percentage over the whole graph is 11.33%, seen from May 7th to May 12th, and was found in the age group 80 years old or older.

Throughout the entire duration of the survey, females have a higher percentage of symptoms than the national average and males. Nationally, the percentage is around 28.5% and 36%. The line representing males stays about 25.5% and 32.5%, and the line representing females remains around 32% to 39%. None of the lines ever interact with each other.

Generally, the order for races with the lowest to the highest percentage of symptoms is the following: Asians, Whites, Blacks, Hispanic or Latinos, then mixed or other races. The percentage for Whites and Asians were below the national average for the entire duration. The line representing Blacks was above or approximately around the national average, while the lines representing Hispanics or Latinos and mixed or other races were always above the national average.

For the education demographic, the general trend is that the higher the amount of education, the lower the percentage of symptoms. However, the lines representing Some college/associate degree and High school diploma or GED are almost consistently overlapping with one another, making these categories virtually experience the same percentage of symptoms. The line for bachelor's degree or higher is always below the national average, while the line for High school diploma or GED is either slightly above or around the national average. The line for Some college/associate degree is somewhat above the national average, while the line for Less than a high school diploma is above the national average. None of the categories have percentages below 30% except for Bachelor's degree or higher, which has a maximum of 30.03%. The only category to have percentages above 40% is Less than a high school diploma, which has a maximum of 42.57%.

Symptoms Percentages by Specific State or Region

To better understand the general mental health status for anxiety and depression symptoms for each state or specific regions of the country, the maps for the either symptom type were analyzed further in this report.

For almost every single map for the either symptom type, whether it depicted the average percentage for a particular month or the entire duration of the Household Pulse Survey, the states with the highest percentages were mostly along the Pacific Coast or Mexican Border. Meanwhile, North Central states or states along the Canadian border generally had some of the lowest percentages. For the eastern area, the states are almost consistently the same color, or within 32% and 38%, for the entire duration. In the Southern area, Louisiana has the highest average percentage when comparing the color displayed for that state to the other Southern

states for almost the entire time frame. In the map for the averages for May and July, Louisiana is the same color as other states next to it.

Generally, the percentage of symptoms increases from May to June, exceptionally rises in July, decreases in August and September, then slightly increases again in October. However, the minimum percentage of symptoms around the 26% to 29% mark seen by multiple states in May are generally becoming less frequent as time continues. Fewer states are also green, or between 17% and 32%, in the August, September, and October maps compared to the maps for May and June, or before the spike in increased percentages happened in July. Some notable states with considerably low percentages throughout most of the maps were Minnesota, North Dakota, South Dakota, Nebraska, and Iowa. Some states with the highest percentages are California, Oregon, Nevada, New Mexico, Mississippi, Louisiana, and Florida.

Symptoms Percentages by Time Zones

Unfortunately, no definite conclusions could be drawn from the circle graphs constructed for each symptom type. There is no defining pattern to how the colors appear in the graph, nor a pattern to what the percentage of symptoms are for each time zone. A state in a particular time zone can have the highest percentage in the country, yet another state in the same time zone can have the lowest percentage. However, one observation made was that the state with the lowest percent for most time frames is in CST for all symptom types.

Comparing Unemployment Rates from 2019 to 2020

Comparing the maps of the average unemployment rates between April and October for each year, almost every state had an increased unemployment rate from 2019 to 2020. While the average unemployment rate for every state is between 2.3% and 6.2% for 2019, every state's average unemployment rate is between 5.0% and 18.0% for 2020. The three states that were below 6.59% for both years were portrayed with the darkest shade of red in 2019, then the next second darkest red, or the second bin, in 2020. Each of the three states had their average rate increase by 0.02 to 0.04 from 2019 to 2020. Two of those three states, North Dakota and Utah, had some of the lowest unemployment rates for several months and in the averages for 2019 and

2020. Other states, such as California, Florida, New York, Massachusetts, had their average unemployment rate increase by anywhere from 0.05 to 0.11 from 2019 to 2020. Nevada even had an increase of around 0.13 for its average rate from 2019 to 2020. Every state in the United States experienced an increase in its average unemployment rate from 2019 to 2020, whether that change was minimal or substantial.

Observations from the average rate maps can be similarly seen in unemployment rate maps for April 2019 and 2020. Each state in the April 2020 map is in at least one bin higher than for the April 2019 map. For April 2019, each state is within the first or second bin, while no state is within either bin for 2020. Some states with the largest increases from April 2019 to 2020 include some near the Great Lakes, Vermont, New Hampshire, and Michigan. Nevada once again experiences the most significant growth in its unemployment rate, going from 0.040 in April 2019 to 0.3010 in April 2020. One observation made about all the maps portraying the unemployment rate in 2019, whether for one month or the average from April to October, is that each state is the color of the first or second bin, meaning that the unemployment rate is between 0.0% and 6.59%. The maps for April 2019 and April 2020 are similar to the maps for May 2019 to May 2020, but with less drastic increases. More states have a lighter red shade rather than a light gray color, signaling both that the rise from 2019 to 2020 was not as high as it was for April and that the unemployment rate is decreasing in some states from April to May 2020. Michigan and Nevada are the only states colored in a shade of black with a decrease of around 0.03 for Michigan and approximately 0.05 for Nevada from April to May 2020.

For the continuing months in 2020, most states' unemployment rates are decreasing with less being portrayed as a shade of black over time. While the map for May 2020 only had one state in the second bin, that number has been increasing for each month after where over half the country is in that bin in October 2020. While the maps for each month in 2019 compared to 2020 are not quite the same, they do become less dissimilar when looking from months earlier in the year to months later in the year.

Discussion

National Conclusions

With the sustainable effects COVID-19 has had on the United States and the entire world, it is not surprising that mental health has been changing as a result. Several stock markets have crashed in late March 2020, more people have been exposed to stressful social media information since the pandemic began, and social-distancing policies preventing face-to-face communication are only some of the numerous effects of this pandemic [4] [9]. In terms of race, researchers have found that African Americans and other minority or low-income groups tend to be more adversely affected by the virus compared to other races. For the race demographic line graph, the result that Blacks have a higher percentage of symptoms than some other races agrees with that finding. Researchers have also found that health status outcomes can differ widely among various racial, ethnic, and socioeconomic groups, especially for chronic conditions. The race demographic line graph illustrates that each race's percentages are not vastly similar and can even vary by around 20% for some races in specific time frames. Therefore, the results obtained match with the researcher's findings [10].

When conducting more research in the future, more background information should be found on why females are more likely to experience anxiety or depression symptoms than males. Another perspective could be discovered by researching into why the percentages are higher for younger adults and people with less education. One possibility to explore is that individuals with less experience in the workforce are less likely to obtain jobs, increasing the likelihood of financial burden and gaining fewer skills in a particular profession during the pandemic. Data about the percentage of anxiety and depression symptoms nationally during the 2019 year would also help understand how mental health has changed from before to during a world-wide pandemic or if a significant change did occur. One dataset that can be utilized can be seen in [11].

Conclusions about Certain Time Periods

In both the national demographic graphs and the United States maps showing the percentage of symptoms of a specific symptom type for each state, it was observed that the percentage of symptoms spiked exceptionally in July, or more specifically, July 16th through July 21st. Since the Household Pulse Survey asked questions about the previous seven days, COVID-19 events occurring between July 1st and July 14th, 2020 were investigated to see if elevated distress could result from these events. Some notable events found during the first half of July include warnings about fraudulent COVID-19 treatment products, warnings about companies selling hand sanitizer containing methanol, the increase in false-positive results from a particular COVID-19 test, and several states reversing reopening plans after cases skyrocketed [12] [13] [14]. While distress could have occurred due to the listed events, the cause of the spike in percentage is still unknown. For future research, COVID-19 related events that could have caused the sharp decrease in the percentage of symptoms from July 21st to August 31st could be investigated.

Conclusions about Certain States and Time Zones

Although no definite conclusions could be made from the circle graphs categorized by time zone, several observations have been made that could fuel future research. One is that most states with the lowest percentages of anxiety, depression, or either symptom type are in CST. Reviewing the results from the United States maps on each symptom type and the circle graphs, some states with the highest symptom percentage in the country were Oregon, Mississippi, Nevada, and Louisiana. Background information about why these specific states have some of the highest symptom percentages in the nation or why certain states have some of the lowest percentages can be obtained in the future. Other information, such as which states have a sudden increase or decrease in percentage during a specific time frame and possible reasons why, could be explored as well.

Unemployment Rate Conclusions

Not only has the average unemployment rates from April to October in 2019 and 2020 have shown that some change has occurred to the rate, but also that the rate has been improving over time from April to October 2020. However, methods to prove if the changes in the rate were statistically significant have not been performed. Despite not implementing these methods, it is still probable that the change in the unemployment rate has affected the percentage of anxiety, depression, or either type of symptom. After all, decades of research have shown that unexpected unemployment is connected to psychological distress and adverse physical effects. It is also possible that the unemployment rate has increased due to harsh working conditions or increasing demands, which could cause someone to quit, or the rising number of layoffs [5]. In the future, other factors could be explored to examine if these factors contribute to the change in the percentage of symptoms. Some factors to consider are homelessness rates, the housing market, poverty rates, the number of COVID-19 cases, and the crime rate.

Acknowledgements

Appendix A
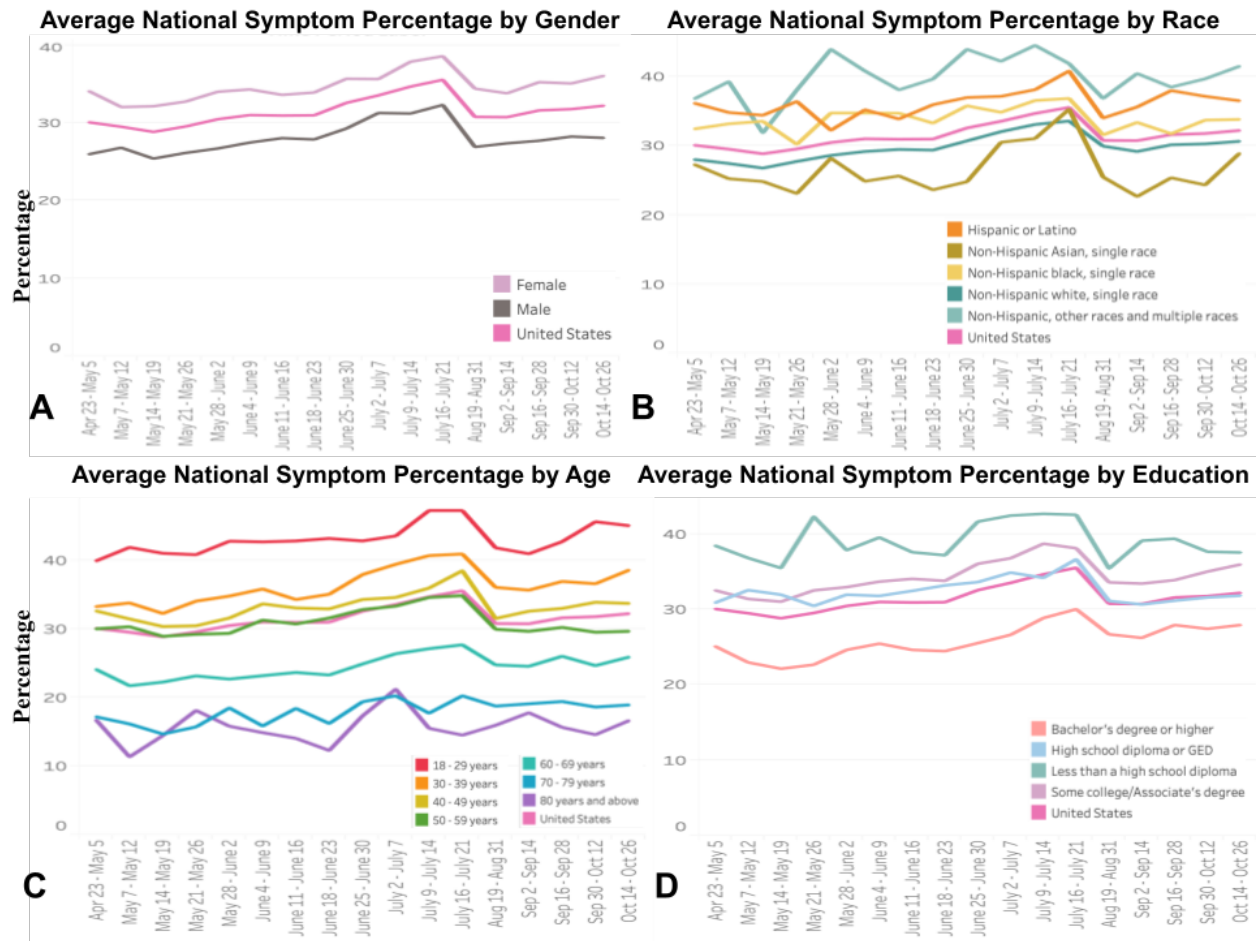
Figure A1. The national symptom percentage for the collective average of all symptoms types, anxiety, depression, or either, organized by certain demographics. Each line graph represents a different demographic, (A) gender, (B) race, (C) age, and (D) education level.
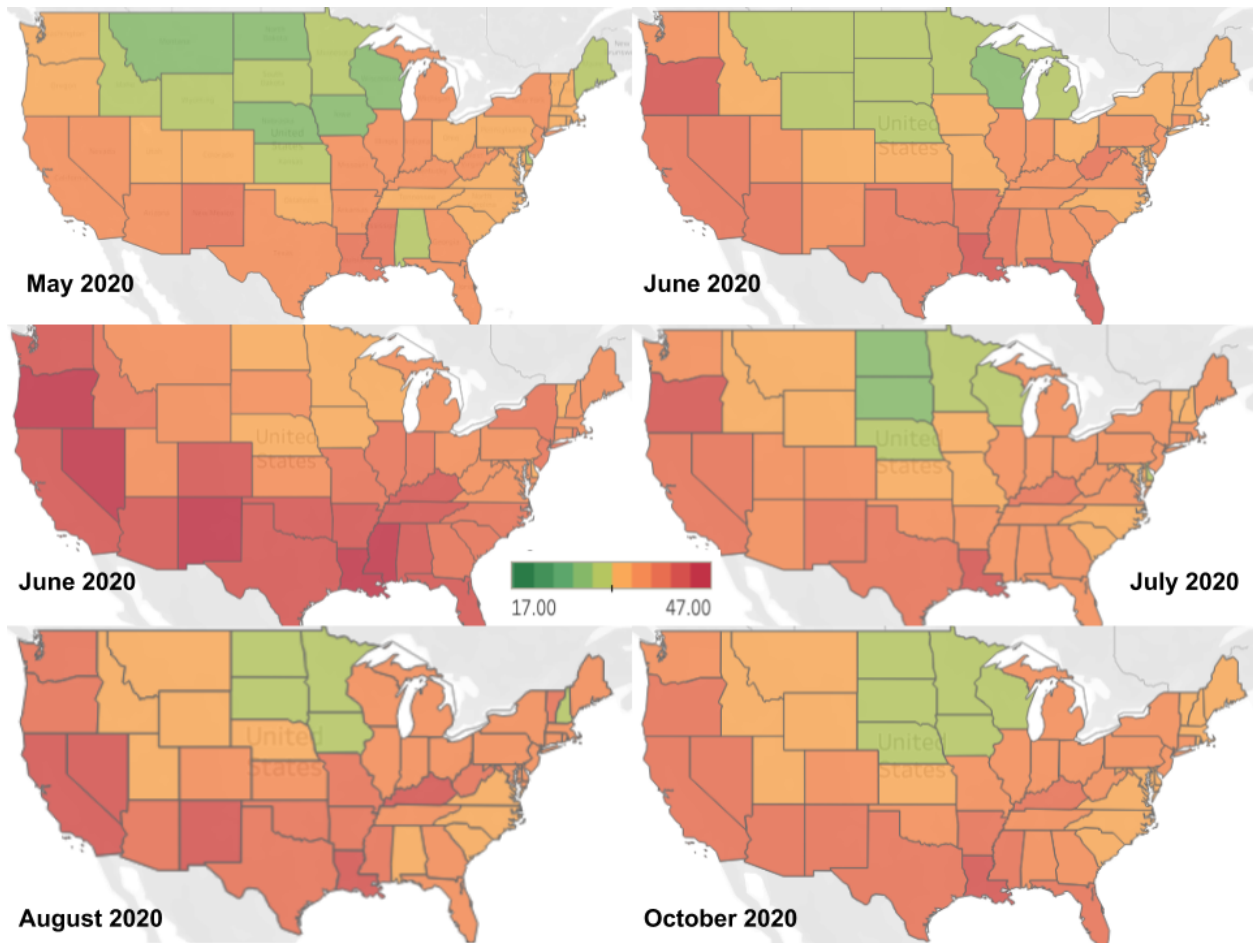
Figure A2. The symptom percentage of the either symptom type for most of the states in the United States for a specific month and year. The month and year for a particular map is on the left of the diagram except for the map pertaining to July 2020, which is labeled on the right.
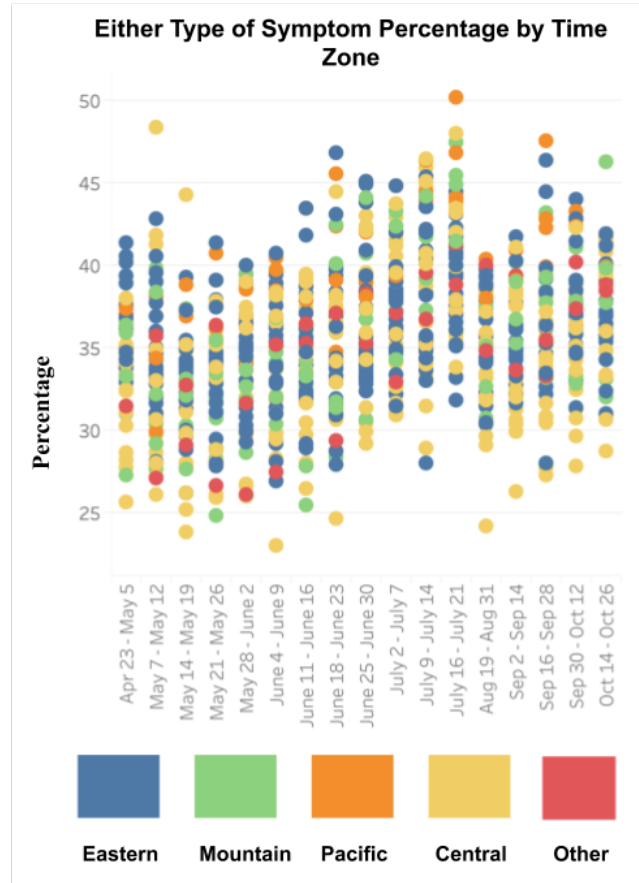
Figure A3. The circle graph of the symptom percentage of the either symptom type for each state in each time frame. Each state is categorized by its respective time zone. For states that use different time zones in separate counties, the time zone is determined by which time zone is implemented in the most counties.
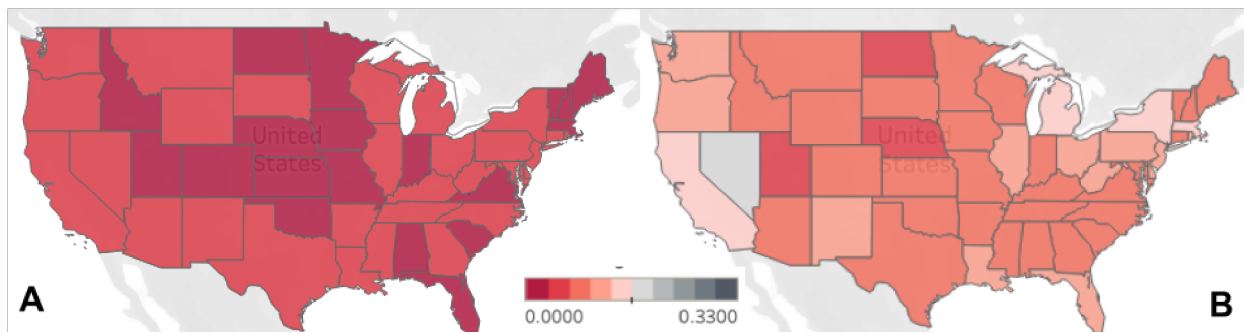
Figure A4. The average unemployment rate for most of the states in the United States for the months April through October. (A) The averages for 2019. (B) The averages for 2020.
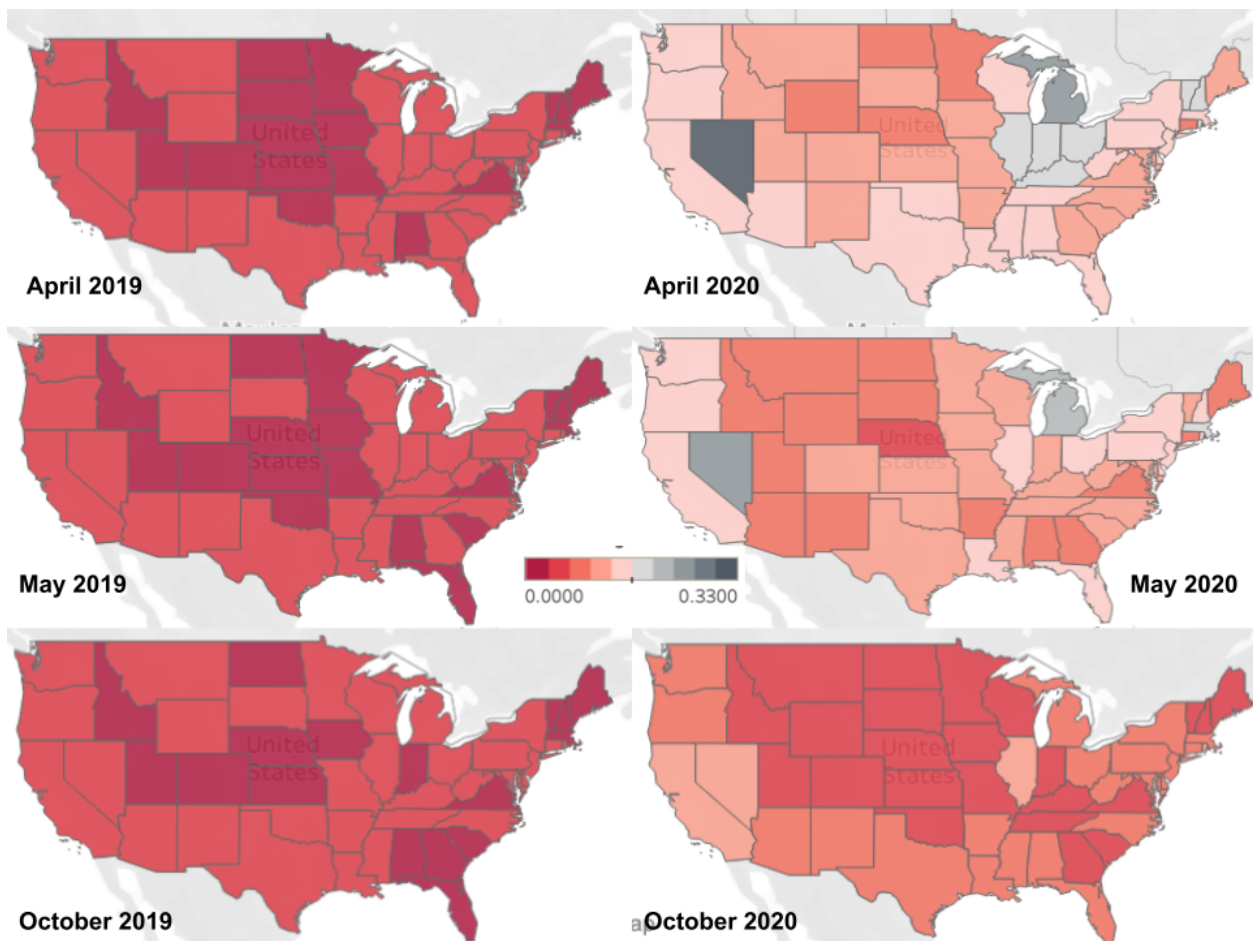
Figure A5. The unemployment rate for most of the states in the United States for a specific month and year. The month and year for a particular map is on the left of the diagram except for the map pertaining to May 2020, which is labeled on the right instead.

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POTENTIAL DRIVERS OF RACIAL DISPARITY IN PRENATAL HEALTHCARE

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ABSTRACT

We analyze potential drivers of racial disparity in prenatal healthcare and draw a connection to the importance of mental health. Our statistical analysis on the disparity of the quality of prenatal care between Non-Hispanic black and Non-Hispanic white women is inconclusive. However, we can determine with statistical confidence that a disparity exists between the stressors of mental health on Non-Hispanic black and Non-Hispanic white mothers.

KEYWORDS
Prenatal care, mental health, racial disparity

INTRODUCTION

The Coronavirus disease, commonly known as COVID-19, has made American citizens across the country painfully aware of the socio-economic and racial division in institutional healthcare. As of the year 2020, minority demographic groups are disproportionately affected by this sickness (Stokes, et al., 2020). While our paper does not attempt to address the entire medical industry, it does focus on some of its most vital facets. This paper analyzes the potential drivers of racial disparity in American prenatal healthcare from 2000 to 2011 and explores the practice's connection to mental health. The paper focuses on the differences in birth outcomes, the onset of prenatal care (PNC) and mental health in Non-Hispanic black mothers and Non-Hispanic white mothers. This focus led us to two hypotheses. The first hypothesis states that there was no discrepancy in the quality of prenatal care in the United States between Non-Hispanic black and Non-Hispanic white women from the years 2000 through 2011. Although we did find that black mothers report higher rates of infant mortality, low birth weight and late/no prenatal care than their white counterparts, our proportion tests did not prove this difference between the two racial groups to be statistically significant. Our second hypothesis addresses these women's mental health, stating that Non-Hispanic black women and Non-Hispanic white women in the United

States experienced mental health stressors, anxiety and depression equally from the years 2000 through 2011. In regards to this hypothesis a statistically significant difference between the two racial groups was found across the mental health variables with white mothers experiencing more anxiety. This finding was further extended when the mental health variables were combined using a Principal Component Analysis. From this statistical analysis, it was found that black mothers experience significantly more stress than white mothers.

LITERATURE REVIEW

Racial Disparity in Prenatal Care

It is difficult to overstate the size and significance of the United States medical industry. In 2018, U.S. healthcare spending reached $3.6 trillion, which translated to roughly $11,000 per person that year (Centers for Medicare & Medicaide Services, 2019). There is a wide array of practices conducted within American medicine, but arguably the most fundamental is care during pregnancy. Prenatal care is among the most utilized methods of preventive health care in the United States (Alexander & Kotelchuck, 2001). It comes as no surprise that expectant mothers tend to seek professional guidance to help navigate the complexities of their unique pregnancies and have come to rely upon these vital resources designed to assure their children are delivered safely.

While pregnancy itself is universal, the quality of healthcare associated with pregnancy is not. There are well documented disparities in birth outcomes between minority and non-minority women (Gennaro, Melnyk, O'Connor, Gibeau, & Nadel, 2016). Using outcomes such as normal birthweight as measure of success in this regard, women of color are at an alarming disadvantage. Minority women are subject to a higher proportion of negative birth outcomes with respect to non-minority women (Lu, et al., 2010). The Centers for Disease Control and Prevention has acknowledged the racial disparity in prenatal care between Non-Hispanic black (i.e.: black) and Non-Hispanic white (i.e.: white) women by quantifying their birth outcome ratios. Table 1 displays how black women experience infant mortality 2.1 times as often as their white counterparts, low-birthweight 3.8 times as often, and malformations 1.4 times as often (Ely & Driscoll, 2019).

Table 1: *Infant Mortality Statistics from 2017*

Birth Outcome	Black : White Ratio
Infant Mortality	2.3
Low-Birthweight	3.8
Malformations	1.4

Source: Ely & Driscoll (2019)

There are several drivers which potentially dictate this racial disparity in prenatal care, but there are two which have been deemed noteworthy by numerous academic literary sources. Firstly, minority women receive disproportionately lower quality service at medical institutions, and secondly, minority women experience a higher degree of anxiety (Culhane & Goldenberg, 2011). Focusing on this first driver of medical service, doctors themselves have been noted to approach different demographic groups with different practice methods and strategies of conversation with their patients. Minority women are less likely to be given medical advice on how to promote their health (Kogan, Alexander, Kotelchuck, Nagey, & Jack, 1994). In close synergy with individual doctors, entire medical organizations also contribute to this mismatched quality of service. Administrative inefficiencies such as inconvenient clinic hours, long appointment wait-times, and negative attitudes from staff all leave minority women with inadequate healthcare (Heaman, et al., 2015).

Connection of Mental Health to Prenatal Care

Quality of medical service is one driver that potentially dictates the racial disparity in prenatal care. Another potential driver of this disparity is mental health, and its straining factors such as stress, anxiety, and depression. "A strong link has been found between mental and physical health" (Ohrnberger, Fichera, & Sutton, 2017). As seen in the Figure 1, mediator variables like social capital, socio-economic status, life style choices and biological factors all play a role in the connection of mental and physical health. Considering the divisive and fundamental nature of racism across various institutions in the United States, it is little wonder that different demographic groups experience these mediator variables differently.

Figure 1: The Direct and Indirect Effects Between Physical and Mental Health
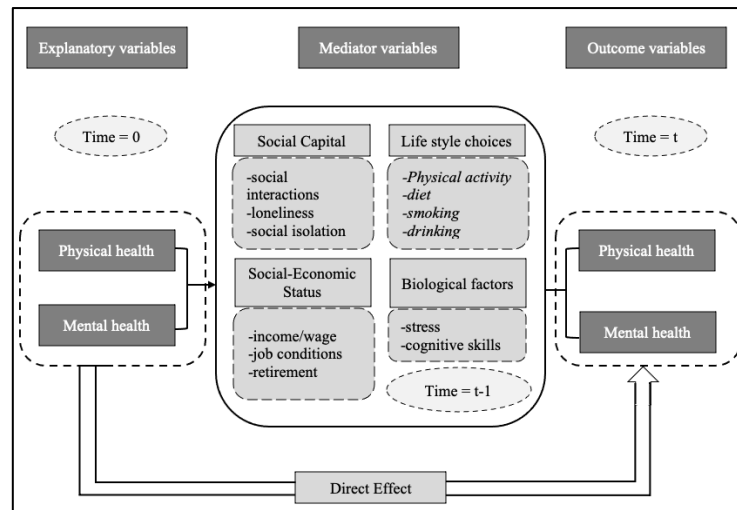
Source: Ohrnberger, Fichera, & Sutton (2017)

Minority women tend to experience stressors on mental health more acutely from these mediator variables which are a contributing factor to the disparity in negative birth outcomes (Gennaro, Melnyk, O'Connor, Gibeau, & Nadel, 2016). Despite these disparities of stressors and negative birth outcomes, the importance of mental health is still not acknowledged in many prenatal care practices (Gregory, Johnson, Johnson, & Entman, 2006). Intentional or not, this failure to connect mental health to physical health in prenatal care could be the difference between life and death for newborn children across the United States.

METHODOLOGY

To test our hypotheses, we use quantitative, secondary data compiled from the Pregnancy Risk Assessment Monitoring System (PRAMS), obtained from HealthData.gov. PRAMS data contains information pertaining to maternal attitudes, experiences, and the health of mothers before, during and shortly after giving birth. Additional questions measure the health of the infant after delivery. This data consists of over 200 self-reported survey questions and answers, spanning across all 50 states in the country. The results of the survey are aggregated by state, race, and survey question.

Since PRAMS datasets are available by year from 2000 through 2011, we use all 12 years to help increase our sample size. Many format alterations are made to achieve data integrity that

provides for legible and analyzable records. The same survey questions are asked in multiple ways across this 12-year time frame. To standardize questions and eliminate redundancy, similar questions are consolidated into one question, and shorter variable names are assigned to each question to make them more manageable during analysis. For purposes of effective analysis, the PRAMS question variables were

transposed so that each survey question becomes its own variable.

To streamline our data, we only compare single responses to the questions which we deem relevant. For questions with "Yes"/"No" responses, only the "Yes" response for each question is taken and included in our analysis.

ANALYSIS

To test our hypothesis, we determine if there is a statistically significant difference between our key variables among the two races. First, we will confirm if a difference in birth outcomes between black and white mothers exists in our data, including if there is a difference of when prenatal care began. Secondly, we will examine if there is a difference in mental health (i.e., stress, anxiety, depression) between our two racial groups.

Two Proportion Z-Test

Our first analysis focuses on the differences in birth outcomes and prenatal care in black and white mothers, with our hypothesis stating that there is no discrepancy in the quality of prenatal care in the United States between these two groups from the years 2000 through 2011. To determine this, a two proportion z-test was used leveraging the prop.test() function in R Studio. Table 2 displays the results. Although black mothers experience infant mortality, low birth weight and late or no PNC more than white mothers, the two proportion z-test indicates these differences are not statistically significant at the 0.05 alpha level.

Focusing next on the mental health variables, our second hypothesis addresses these mothers' mental health, stating that black and white mothers in the United States experienced mental health stressors, anxiety and depression equally from the years 2000 through 2011. Our two proportion z-test found that black mothers experiencing higher levels of financial stress, partner

stress and trauma stress, while white mothers experience higher levels of emotional stress, anxiety and depression, however our proportion test confirms that anxiety is the only variable that is statistically significant between the two races, being higher in white mothers (Table 2).

Table 2: Two Proportion Z-Test Results

Key Variables	Black	White	p-value
Emotional Stress	9.4%	10.3%	0.83
Financial Stress	16.4%	16.3%	1.00
Partner Stress	12.4%	9.0%	0.21
Trauma Stress	7.0%	5.4%	0.51
Anxiety*	20.0%	47.8%	0.05
Depression	30.0%	43.1%	0.43
Low Birth Weight	3.6%	2.1%	0.42
Infant Mortality	54.6%	30.9%	0.19
No PNC	8.0%	2.0%	0.87

Statistically Significant with p-value < 0.05

Principal Component Analysis (PCA)

Next, the goal was to reduce our six mental health variables into fewer dimensions to determine if this dimension reduction may provide different results than testing our mental health variables separately. A Principal Component Analysis (PCA) was run on the variables with no rotation. Results are found in Table 3. The six mental health variables were reduced to two dimensions, with 88% of the cumulative variance being explained. As expected, all stressor variables fall on Dimension One (Dim 1), which we refer to as "Stress". The anxiety and depression variables fall under Dimension Two (Dim 3), referred to as "AnxietyDep".

Table 3: Principal Component Analysis (PCA)

Key Variables	Dim 1	Dim 2
Variance	*3.641*	*1.644*
% of var.	*60.683*	*27.392*
Cumulative % of var.	*60.683*	*88.075*
Emotional Stress	0.899	-0.115
Financial Stress	0.929	-0.167
Partner Stress	0.912	-0.260
Trauma Stress	0.911	-0.195
Anxiety	0.343	0.889
Depression	0.437	0.841

Independent Two-Sample Test

The PCA computed new composite values that are then used to test for differences between the two racial groups. Since the data was found to follow a non-normal distribution, the non-

parametric Wilcox Test will be used to test for these differences. Table 4 reflects the results of the Wilcox Test of our new dimensions. These results reveal statistically significant differences between the racial groups in both newly computed dimensions with black mothers experiencing more stress while white mothers experience more anxiety and depression.

Table 4: Wilcox Test

Key Variables	Black	White
Stress*	153	120
Anxiety/Dep*	-12	3

Statistically Significant with p-value < 0.05

CONCLUSION

Results Summary

In summary of our analysis, while we find that black mothers report higher rates of infant mortality, infant low birth weight and late/no prenatal care than white mothers, our proportion tests do not prove the difference between these two racial groups to be statistically significant. These findings indicate that we fail to reject our first null hypothesis. Thus, it is inconclusive if there was no discrepancy in the quality of prenatal care in the United States between Non-Hispanic black women and Non-Hispanic white women from the years 2000 through 2011.

Examining our mental health variables, we find a statistically significant difference between races in reported anxiety, with white mothers reporting more anxiety than black mothers. After running the Principal Component Analysis, we determine that a difference also exists when mental health variables are combined. The Wilcox Test indicates a statistically significant difference in stressors on mental health between the two racial groups, with black mothers reporting stress more often, and white mothers reporting anxiety and depression more often. These results allow us to reject our second null hypothesis. Thus, we can conclude that Non-Hispanic black women and Non-Hispanic white women in the United States experienced mental health stressors unequally from the years 2000 through 2011.

Limitations

Our study faced many limitations that may have affected our results. First, since our data is based on self-reported survey data, our analysis is subject to a response bias. Survey takers may

not feel comfortable reporting personal or sensitive information surrounding their health and prenatal experiences. Therefore, it cannot be assumed that all responses are accurate or complete.

A second limitation of our study is the age of the data used. At the time of the study, PRAMS data was only available through 2011, making it at least 9 years old as of 2020. Perceptions of the medical industry and health behavior may have changed over a decade which can influence the results of the study if compared to more recent data.

Finally, our analysis was limited by the size of our sample. As PRAMS information is pre-aggregated, it limited the size of our data file. This obstacle of low sample size was further exacerbated by many states not asking the same relevant questions across all years. As a result, we were not able to run test on certain variables.

Recommendation for Future Research

In the future, this study should be mimicked using more recent and granular data in order to increase the sample size and utility of the study. Further research can also be done linking the mother's mental health to the mother's physical health behaviors as well as the mother's physical health behaviors to the birth outcome of the infants.

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DECISION SCIENCES INSTITUTE

RFID Deployment in Healthcare: Innovation in the University of

Tennessee Medical Center/Advanced Orthopaedic Center

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ABSTRACT

This study features the University of Tennessee Medical Center/Advanced Orthopaedic Center (UTMC/AOC), in introducing the concept of "level 2" radio frequency identification (RFID)-enabled system using two frameworks.   Basic processes like inventory management are essential to healthcare medical systems as assets/medical supplies constitute a large portion of hospital budgets. Using content analysis, the talk of the key champion of the RFID projects in UTMC/AOC was codified using concepts from the work systems theory and Zuboff's concepts of "automating" and "informating." Results suggest two RFID deployment possibilities: level 1 on "automating" and level 2 indicating a more advanced "informating" stage with innovation potential.

KEYWORDS: Radio frequency identification (RFID), location based tracking, inventory management in hospitals, asset tracking, innovation in healthcare

INTRODUCTION

This case study features the University of Tennessee Medical Center/Advanced Orthopaedic Center (UTMC/AOC), to explore the deployment of radio frequency identification (RFID)-enabled inventory management systems using two theoretical frameworks.

The healthcare industry in North America has been pressured to use information technologies to attain cost savings and efficiencies in its operations. The strongest drivers pushing hospitals in this direction are: (Frost & Sullivan, Nov. 27, 2019 (a) & (b)).

(1) demand for efficiency in various hospital workflows and monitoring of assets; (2) requirement for government regulation compliance with laws like the Health Insurance Portability and Accountability Act of 1996 (HIPAA) in the U.S. and the General Data Protection Regulation (GDPR) in Europe; (3) anticipated increase in patient traffic as a result of demographic trends like the retirement of "baby boomers"; (4) customer demand for better care and service delivery using their mobile devices, if possible; (5) declining prices of RFID

technologies; and (6) advances in information technology that work well with RFID and other sensor-based methods.

This study focuses on asset management involving inventory as this is one very basic area where efficiencies should be gained, and where a big part of a hospital's budget is committed. Assets could include any instrument, device, hardware, and software used for patient diagnosis, measurement, and treatment, and classified as capital equipment, reusables, or disposables (Frost & Sullivan, Nov. 27, 2019 (b)). Misplacing or downright losing these assets leads to waste, downtime, restricted patient flow, decreased quality of patient care, decreased employee productivity, and financial losses. This is an important issue as costly medical items are shared among hospital departments and service areas.

The key technologies used for asset monitoring are RFID, real-time location systems (RTLS), barcodes, "Internet of Things" (IOT) or sensor-based devices, wireless network (WIFI) enabled tracking devices. Of all these, RFID is leading the pack (Frost & Sullivan, Nov. 27, 2019 (b)).

The business case for these solutions is strong when considering the high costs of medical supplies and the increasingly declining costs for IT solutions for most hospital systems faced with constrained budgets. Also, tracking systems are essential since most medical supply vendors provide medical supplies on consignment basis. This means that until the products are actually used or returned, the hospitals may keep the items free of charge (Frost & Sullivan, May 22, 2015).   Thus, it helps both hospitals and vendors to accurately track medical items that are used, those that are not, and those that have reached expiry dates in order to support an efficient procurement process.

This study also uses two theoretical frameworks to understand and interpret the RFID deployment experiences of UTMC/AOC. These are the work systems theory and Zuboff's concepts of "automating" versus "informating."

The work systems theory contributed to portraying a description of the nine elements of the RFID-enabled work systems in UTMC/AOC (Alter, 2013; Alter, 2010). The lesson learned is that the nine elements need to be mutually supportive of each other and consistently aligned so that the RFID system can achieve its goals.

Zuboff's concepts of "automating" and "informating" were also applied and instrumental in effectively contrasting the RFID deployments in UTMC/AOC (Zuboff, 1988; McLeod, 1989; Burton-Jones, 2014; Kallinikos, 2010; Zuboff, 1985).

Creativity and innovation concepts were also used to explain movement to the more advanced phase of informating.

This paper is organized into the following sections. Following the introduction is a brief description of the two theoretical frameworks used in analyzing and interpreting the case study. The research methodology section explains the use of the qualitative method of case study research after carefully selecting UTMC/AOC featuring a level 2 RFID deployment case.

The section on findings shows subsections devoted to each of the two theoretical frameworks and their application to UTMC/AOC. The conclusions section summarizes the benefits gained from the study, lessons learned, and new insights offered in interpreting the UTMC/AOC experience.

THEORETICAL FRAMEWORKS USED

Work Systems Theory

One of the theoretical frameworks used in this case study is the work system theory (WST) (Alter, 2013; Alter, 2010), which is used for describing and understanding the RFID-enabled systems deployed UTMC/AOC. The WST focuses on a "work system" which is the natural unit of analysis when understanding systems in organizations such as firms or hospitals (Alter, 2013; Alter, 2010). In these settings, resources such as human, informational, and physical assets are deployed by humans and/or machines to create products and services for both internal and external customers. WST uses a framework consisting of nine elements for describing a work system: 1) environment, 2) strategies, 3) participants, 4) processes and activities, 5) infrastructure, 6) technologies, 7) information, 8) customers, and 9) products and services (Alter, 2013, 2010).

The organizational, cultural, competitive, technical, regulatory, and demographic contexts constitute the "environment" and directly influence a work system's ability to achieve goals, aspirational levels, requirements for change, and performance results. For example, stakeholders, policies and procedures, and organizational history and politics, all aspects of the organizational environment impact that firm's capability to achieve its operational goals efficiently and effectively, using a specific strategy.

"Participants" include all those who perform work in the work system, whether or not their work involves information technology and automation.

"Processes and activities" cover those used in the work system to create the products and services (Hall, 2009; Hill et al., 2006).

The "infrastructure" of the work system consists of three components: human, information, and technical resources, following the ideas and guidelines of Star and Bowker (2002). These three components are all used in the operations of the work system.

"Technologies" refer to the tools used by the work system participants and automated agents such as hardware, software, IT vendor supported services, etc., all designed to support the execution of work system processes and activities (Alter, 2013, 2010).

Work system processes and activities in the work system use and create "information," defined in the WST context as "informational entities" captured, transmitted, manipulated, stored, retrieved, updated, displayed, and deleted in the operation of processes and activities (Alter, 2013, 2010). The purpose of work systems is to create "products and services" in the form of physical products, intangible information, and actions that meet the needs of customers (Alter,

2013, 2010).

"Customers" could be "internal" customers or "external" customers who obtain the products and services created by the work system (Alter, 2013, 2010).

The WST has a number of theoretical implications as well (Alter, 2013). First, efficiency and effectiveness   of a work system are more likely to be achieved if all nine elements of the WST framework are aligned. Second, WST view work systems as socio-technical systems in which people perform processes and activities. Third, work systems can also be fully automated computerized systems. Fourth, work systems are not static; rather, they dynamically evolve through time on account of both planned and emergent change initiatives in an organization in response to various motivating factors.

Zuboff Concepts: Automate and Informate

This case study uses Zuboff's concepts of "automating" and "informating" introduced in her seminal book, *In the Age of the Smart Machine: the future of work and power* (Zuboff, 1988).

<u>*Automating*</u>

Zuboff (1988, 1985) defines "automating" as the process of using information technology to replace human labor in order to attain the same work outcomes like efficiency and performance gains at less cost and human labor, and yet, achieve more control and continuity.

<u>*Informating*</u>

Zuboff (1988, 1985) defines "informating" as information technology's ability to generate information about the business processes that undergird particular work outcomes. Informating has profound implications in terms of helping both workers and management understand its business operations in ways that can empower them to make both small and significant changes to the way work is performed. Some of the consequences of informating can be unintended, but if used diligently and dutifully, management and workers can redesign work business processes significantly to obtain strategic advantages.

Actualizing the full benefits of "informating" requires that workers exercise their "…. human capacities for teaching and learning, criticism and insight." (Lehmann-Haupt, 1988).

For optimum results, the firm needs to transform itself into a "learning culture" and make its organizational business processes transparent to management and all workers (McLeod, 1989).

Lastly, Zuboff painted a picture of what she considered a vision of the advanced stage of a fully mature organization that has optimized the learning opportunities provided by "informating." Such an organization would shift to new distributed and collaborative working arrangements (Zuboff, 1988, 1985). The organization would also support and enable a learning culture where the intellective skills of exploration, experimentation, and innovation are cultivated in its workers (Zuboff, 1988, 1985).

Levels of IT Deployment

Level 1: Automation and Early Stage Informating

In this study, level 1 deployment of RFID is defined as the use of RFID primarily to automate business processes. Part of level 1 is also the developed ability to generate information from the computerized system deployed.

Level 2: Advanced Stage Informating and Innovation

In this study, level 2 deployment of RFID is defined as having attained the higher level intellective abilities at the individual level needed to optimize the use of the information generated by the computerized system and at the organizational level, actualizing the attributes of a mature informated entity as described by Zuboff. Also, firms that have used their workers' intellective skills to produce new products and services will be considered level 2 firms.

This study considers technology-related innovations, also under the umbrella of "digital innovation" defined by Fichman et al. (2014) as "….product, process, or business model that is perceived as new, requires some significant changes on the part of adopters, and is embodied in or enabled by IT…." This definition is all inclusive in that it embraces products, services, work routines, and business models.

RESEARCH METHOD

This study uses the case study and content analysis methods in aligning the concepts prescribed by the two theoretical frameworks used in this study: work systems theory and Zuboff's concepts of "automating" and "informating." The source of primary data in this study is the transcription of the conference presentation talk of Becky Ashin, Vice President, University of Tennessee Medical Center Advanced Orthopaedic Center during the RFID Journal Live! 14th Annual Conference and Exhibition, Orlando, Florida, May 3-5, 2016 (Ashin, May 3-5, 2016).

In addition, secondary data sources from academic and trade articles were content analyzed using key concepts in the frameworks. The following are accepted definitions of the content analysis:

> "Content analysis is any research technique for making inferences by systematically and objectively identifying specified characteristics within text." (Stone et al., 1966, p. 5)
> "Content analysis is a research technique for making replicable and valid inferences from data to their context." (Krippendorff, 1980, p. 21)
> "Content analysis is a research method that uses a set of procedures to make valid inferences from text." (Weber, 1990, p. 1)

The concepts used for content analysis were derived from the two theoretical frameworks that also formed the "context" of this study:

"A context is always someone's construction, the conceptual environment of a text, the situation in which it plays a role. In a content analysis, the context explains what the analyst does with the texts; it could be considered the analyst's best hypothesis for how the texts came to be, what they mean, what they can tell or do. In the course of a content analysis, the context embraces all the knowledge that the analyst applies to given texts, whether in the form of scientific theories, plausibly argued propositions, empirical evidence, grounded intuitions, or knowledge of reading habits…. The context specifies the world in which texts can be related to the analyst's research questions." (Krippendorff, 2004, p. 33)

The primary and secondary data was analyzed within the context provided by the two frameworks, which are considered the "prior theory." "Analytical constructs operationalize what the content analyst knows about the context, specifically the network of correlations that are assumed to explain how available text are connected to the possible answers to the analyst's questions and the conditions under which these correlations could change….analytical   constructs ensure that an analysis of given texts models the texts' context of use…" (Krippendorff, 2004, p. 34)

The following key conceptual elements of content analysis as stipulated by Krippendorff (2004, p. 34) were used in this study: (1) body of text selected for the analysis; (2) research question that needed to be addressed; (3) a context of analysis within which interpretations will be made; (4) analytical constructs that operationalize what the analyst knows about the context; and (5) inferences that will be arrived at to address the research question.

FINDINGS

The UTMC RFID deployment is considered a much higher level of implementation or level 2 because of the opportunities actualized for innovation at UTMC. The medical staff developed innovative products like the smart trash can and the Vault software applications over and above the physicial preference card system that instigated the RFID project in the first place.

This section discusses the application of creativity techniques by UTMC and DeRoyal (a technology solution vendor) --- a process arrived at in this case study through the process of "induction." The participants did not consciously or intentionally set out to use the creativity methods described here, but through the process of induction in analyzing this case study, the author surmised that what, in effect, they accomplished was very well the result of the application of the suggested creativity methods.

The three creativity methods illustrated here are the use of the kaleidoscope technique introduced by Rosabeth Moss (1988), selective combination, and social interaction discussed by Davidson and Sternberg (2003).

Kaleidoscope Method

Kanter (1988) introduced the "kaleidoscope" method of generating creativity in organizations, which essentially involves the encouragement of mental stimulation at different levels of the organization through different means. The technique encourages the use of "Kaleidoscopic" thinking which means "rotating" one's perspectives, "orthogonally" shifting orientation, or "shaking up their brains" to produce "different patterns from the same bits about reality" (Kanter, 1988).

Social Interaction Method

Davidson and Sternberg (2003) recognize that although important insights may occur to creative people when they are alone (many consider "quiet time" as essential to hatching new ideas), the company of others greatly facilitates the evaluation and elaboration stages of developing unexpected insights further. Thus, the "social interaction" method was suggested regardless of the form of communication used by the interacting parties.

Selective Combination Method

In their book, *The Psychology of Problem Solving* (2003), Davidson and Sternberg also depict "selective combination" as the method of reframing aspects of a problem so that previously unassociated ideas could be reperceived and reconstituted within a new context that makes sense.

The application of these creativity generating methods will be illustrated further on in the analysis of findings.

Work Systems Theory: UTMC/AOC

Steve Alter's work systems theory (WST) (Alter, 2013, 2010) is applied to UTMC/AOC in analyzing their deployment of the RFID- enabled Continuum inventory management software. WST is a useful theoretical framework to use in describing the different elements of the "work system" --- in this case, it is the inventory management system at UTMC. The key idea behind WST is to ensure consistency and alignment among the different elements of the work system to ensure the attainment of system goals and objectives. Each element should be mutually supportive of the other elements as they are organically interdependent.

Table 1 shows the different nine elements of the WST framework applied to the UTMC/AOC environment.

Table 1: Work systems theory as applied to University of Tennessee Medical Center/Advanced Orthopaedic Center

Environment: -organizational -cultural -competitive -technical -regulatory -demographic	The University of Tennessee Medical Center is known as one of the southern region's academic medical center, Magnet ® recognized hospital, Level 1 Trauma Center. It has six centers of excellence, one of which is the Advanced Orthopaedic Center, which offers a wide range of orthopaedic services covering total or partial hip or knee replacement, arthritis or osteoporosis care, or Level 1 trauma care. The UTMC vision is to "…lead the transformation to value-based care, delivering excellence in clinical outcomes, patient experiences, medical education and biomedical research." (University of Tennessee Medical Center website, 2020) The strategic priorities of UTMC are the following: efficiency/effectiveness, quality/safety, and service. (University of Tennessee Medical Center website, 2020)
Strategies: **-**enterprise -department -work system	-UTMC's detailed strategies at the enterprise, department, & work system levels were not explicitly stated in the materials. but can be deduced from the primary data available in their website.
Infrastructure: -human -informational -technical	**-human infrastructure:** **-**Surgeons, physicians, nurses, & other medical staff at the Advanced Orthopaedic Center -Becky Ashin, Vice President, the Advanced Orthopaedic Center -Beth Kaylor, DeRoyal Representative & Consultant -representatives of medical supply vendors -representatives of DeRoyal **-informational infrastructure:** -RFID tag data -count of expired items -cost of medical supplies used up for a patient procedure/treatment -medical supplies to be procured: quantity, vendor, etc. -items on order -items on "active" purchase order -purchase orders -delivered product items **-technical infrastructure:** **HARDWARE:** -Continuum Tablet -Continuum Scanner

	-RFID tags -Continuum System's OSCAR Receptacle, a smart trash bin **SOFTWARE:** **-**Continuum AIR inventory management system -Continuum Vault software application -Software Interface: HL7 -Doctor Preference Card System -Operating Room (OR) Management Software by GE (Swedberg, May 12, 2015) **OTHER TANGIBLE RESOURCES:** **-**the "Vault" -cabinets; shelves -physical/manually filled out physician preference cards -OR-related medical supplies used in surgeries -tracked items: medical supplies, implants, instrument trays (Basarich, May 1, 2015)
Information:	(see informational infrastructure)
Customers: **-**internal customers -external customers	*-internal customers:* -surgeons; medical clinical staff *-external customers:* -patients -medical supplies vendors -RFID technology vendor like DeRoyal -other technology vendors
Products & Services: -tangible products -intangible services	*-for internal customers:* **-tangible products:** -medical product items delivered on time from vendors -shelves & cabinets stocked reliably with medical supplies needed for medical procedures **-intangible services:** *-for internal customers:* + *Advanced Orthopaedic Center Management:* -efficient inventory management system -more accurate inventory counts -more timely orders for much needed medical supplies -reduced volume of expired items in storage areas & Vault + *physicians:* -greater job satisfaction + *other medical/clinical staff members:* -greater job satisfaction

	+ IT staff -higher morale in that important internal customers like surgeons, physicians, & other medical staff members are happier in doing their "real" job which is taking care of patients -IT staff members are gaining a learning experience in using RFID-enabled technologies and applications ***-for external customers:*** *+patients* -better care from surgeons, physicians, & other medical staff members -more accurate & timely hospital & physician medical charges *+medical supply vendors* -better inventory information/data available for vendor use & product forecasting -more timely replenishment of needed medical supplies to UTMC/AOC

Source: (Ashin, May 3-5, 2016).

Before RFID Deployment

DeRoyal approached UTMC for the opportunity to work with the hospital's inventory and procurement-related business processes and develop a physicians' preference card system in 2013 (Swedberg, May 12, 2015; Ashin, May 3-5, 2016). The task was relegated to Becky Ashin, VP of the Advanced Orthopaedic Center and Beth Kaylor, the DeRoyal representative and consultant who worked with the UTMC medical staff for the project (Ashin, May 3-5, 2016). UTMC pursued the RFID project to achieve the following: (1) confirm the safety of medical supplies; (2) increase the visibility of inventory; (3) improve inventory count accuracy; (4) provide quick access to resources during emergencies; (5) improve medical staff efficiency and effectiveness; (6) reduce mistakes; and (7) identify medical supplies wirelessly (Ashin, May 3-5, 2016).

Surgical procedures require immediate access to medical supplies needed, which makes inventory tracking much more urgent.

Procurement of medical supplies begins will the physician's preference card, which describes the medical supplies needed by a physician for a specific surgical procedure. The information in these preference cards is the basis of the patient charge sheet, operating room medical supply consumption statistics, medical supply demand forecasting, and patient charge sheets used for billing them (Ashin, May 3-5, 2016). Before using RFID, the Advanced Orthopaedic Center relied on a paper-based system in recording physicians' preference cards and the numbers entered in the paper forms were based primarily on hunches of nurses and other medical staffers who most likely had a foggy recollection of the medical items used by particular surgeons for the different surgical procedures.

Development of the RFID Solution

This section describes how the UTMC Advanced Orthopaedic Center medical staff used the creativity methods previously described in developing the RFID solution in collaboration with technology vendor DeRoyal.

At UTMC, the different issues they dealt with which, at first, appeared to be unrelated to each other --- these were the "pieces of colored glass" that moved around using the kaleidoscope viewer. Before RFID was deployed, the Advanced Orthopaedic Center staff experienced the following inventory-related problems. The staff did not really link the following disparate pieces of information: actual count of medical supplies actually used/consumed in the operating rooms; actual count of discarded medical supplies thrown in the trash bin; actual count of packages of medical supplies opened, number of items within the packages actually consumed, number of items within the opened packages not used for various reasons, number of items with the opened packages; possibility of using cheaper medical supplies that are just as efficacious and useful to both surgeon and patient; nurses' guesses and foggy recollections of supplies used in the OR for different types of surgical procedures; actual count of inventory supplies at any point in time; actual count of unexpired and expired inventory supplies; actual count of medical supplies that are either understocked or overstocked; possibility of using cheaper medical supplies that are just as efficacious and useful to both surgeon and patient; and actual count of "pulled items" that are merely returned to stock.

As the participants in the RFID project in both phases 1 and 2 juggled all these pieces around through time, they eventually discovered the linkages in the interlocked business processes and reconfigured these linkages by working on a cluster of interrelated issues into one subsystem.

The application of the "kaleidoscope" method was initiated by Beth Kaylor of DeRoyal. After being given the greenlight by UTMC to develop an RFID-enabled and automated physicians' preference card system, Kaylor spent time observing how working was done in the operating rooms of the Advanced Orthopaedic Center especially as it related to the use of medical supplies in surgical procedures. One of the first things she noted was the traffic of personnel in and out of the operating rooms.

The team started investigating the reasons related to the medical supply inventory for the movements in and out of the OR and came up with a number of them: nurses not having the right medical supplies prior to the surgical procedure that makes them go to the Vault to locate the right ones; nurses discovering that the medical supplies brought in for use in the surgery are expired; and late deliveries of medical supplies needed for the surgery --- thus, vendor reps enter the OR to talk with surgeons.

Eventually, the team figured out the link between the human traffic in and out of the ORs and the potential for surgery patient infection. This served as an even stronger motivator to find ways and means of eliminating this kind of personnel movement in and out of the ORs.

Later on, when the Continuum inventory software solution was fully developed and deployed for UTMC, Becky Ashin of UTMC acknowledged how the full-fledged solution had a positive impact of preventing patient infections in the operating rooms (OR) (Ashin, May 3-5, 2016). The inventory software solution ensured that the right medical supplies were procured from the vendors and delivered in a timely fashion to UTMC. DeRoyal tagged these medical supplies which were stocked in the vault. The much improved Physician Preference Card system is linked with the inventory system and now, the right medical supplies are procured and stored in the Vault. Thus, nurses no longer rush in and out of the OR to get the right medical supplies for a surgical procedure. The software solution also automatically flags expired supplies and removes and returns them to vendors for exchanges or refunds. Medical supply deliveries from vendors are now timely and delivered to   the Vault ahead of time, thus, eliminating last minute vendor visits to the OR.

Another application of the "kaleidoscope" method was in the process of developing Continuum/OSCAR, the "smart" trash bin. Before this smart bin was developed, the staff had no idea about the linkages among the following pieces of data: actual count of medical supplies actually used/consumed in the operating rooms; actual count of discarded medical supplies thrown in the trash bin; actual count of packages of medical supplies opened; number of items within the packages actually consumed; number of items within the opened packages not used for various reasons; and number of items with the opened packages. After the development of the smart bin, the staff was able to analyze the data reported by the bin from the tags of discarded medical supplies.

The development of the Continuum OSCAR smart bin product clearly illustrates the application of *social interaction* and the *kaleidoscope method.* Social interaction took place obviously between Beth Kaylor and various members of the Advanced Orthopaedic Center staff at different stages of the project. Kaylor applied the kaleidoscope method when, after a period of observing the medical staff work, presented the suggestion to read RFID-tagged items after they have been thrown in the trash can. As a result, Kaylor and the medical staff were able to connect the following ideas that normally would not be associated with each other: discarded medical supplies; medical supplies actually used; discarded medical supplies that were not consumed or used; inventory count of medical supplies; expired medical supplies, etc.

In the actual development of the three different versions of the smart bin, DeRoyal through Kaylor actively solicited inputs from future end users of the smart bin about the following design issues: size and color of the bin, ease of accessing/changing garbage bags, importance of bin mobility, usability, and issues related to user interface design. This was a crucial opportunity for social interaction between DeRoyal and the medical staff members.

After RFID Deployment

Medical supplies used for the OR are tagged by DeRoyal. The Advanced Orthopaedic Center now uses the Continuum® AIR inventory management system that delivers important information such as inventory counts of medical supplies when received by the center, current

and real-time inventory level statistics, and medical supplies consumed in surgical procedures attributed to specific patients (DeRoyal, 2020). AIR also performs automatic reordering of medical supplies,   the appropriate reconciliation process, and integrates with other pre-existing software systems in   the facility.

This software application uses a handheld RFID scanner that works with the Continuum LINK box installed in the facility ceiling or walls, and a Continuum app. This scanner captures data from hundreds of RFID tags in seconds (DeRoyal, 2020). LINK, then, transmits data captured by the RFID scanner to the tablet and delivers real-time inventory level data, which is also made available by Continuum to end users using a web portal. Data itself is stored in the cloud and additional software manipulation features enable conducting business analytics and customized   reporting of key performance indicators (DeRoyal, 2020).

Another aspect of the Continuum solution is the "Vault," a software application that tracks, monitors, and secures medical products from the time of storage to dispensing (DeRoyal, 2020). The Vault software also facilitates the medical product restocking process by establishing an inventory re-order set-up that monitors par levels and triggers the reordering process to maintain appropriate inventory quantities for medical supplies.

Finally, the Continuum solution includes an innovative product called "OSCAR," which is a smart trash receptacle jointly developed by DeRoyal and UTMC's Advanced Orthopaedic Center. The smart trash bin reads the RFID tags attached to discarded medical   items and reports supply usage, case costs, and unique device identification (UDI) details. OSCAR delivers 99.8 percent usage capture accuracy (Ashin, May 3-5, 2016).

The following is a summary list of the overall benefits obtained by the Advanced Orthopaedic Center from the RFID System: reduction in the money tied up in excess inventory; less time spent on manual business process related to inventory management; elimination of expired products as they are removed from storage even before their expiry dates; more accurate charge capture; less time and money invested in rush ordering unavailable supplies; decline in dollars spent on lost products; less time spent on the manual version of the physician preference card system; and greater accuracy of cost information per surgical procedure of surgeons (Ashin, May 3-5, 2016).

The deployment of the Continuum-based inventory management software suite eventually led, as well, to the improvement of the physicians' preference card system. Before RFID was used, physicians did not know the cost of the medical supplies they listed in the card system.   The Advanced Orthopaedic Center also had no means of coming up with better and cheaper substitutes that were just as effective as the original medical supplies ordered by physicians for procurement.

CONCLUSIONS

The RFID deployment experience of UTMC/AOC is appropriate because it represents hospital systems that are ahead of the curve and are pursuing more innovative RFID applications in collaboration with a vendor. The two theoretical frameworks used in analyzing UTMC/AOC assisted greatly in understanding and interpreting their RFID deployment experiences.

The UTMC experience was very different as the affected medical staff moved directly from paper-based systems to an automated RFID system. Thus, the end users immediately benefited from the efficiencies gained and without much motivating, engaged in cultivating the intellective skills needed in understanding the information showing up in the screens and gained insights

Overall, this case study confirms the relevance of Zuboff's concepts today, two decades after she broached these ideas. Hospitals have faced with the challenges of digitization for a long time now, but the ubiquity of sensor-based technologies like RFID and the onset of the "Internet of Things," the urgency to upgrade their IT infrastructure is even more pressing. Also, recent technologies make the need to cultivate intellective skills needed for data analytics and mining to actualize the insight-related affordances out of the enormous volume of data now available. This is an immediate challenge and opportunity for the UTMC staff to face, as the medical staff of the Advanced Orthopaedic Center has already advanced in the direction of higher-level informating.

Also, hospitals need to move from staid hierarchical and traditional structures and train their medical staffs in the intellective skills needed to empower them at work, thus, flattening their layers and giving their members permission to be more creative and innovative at work.

On a last note, hospital management needs to take care to ensure that the tracking and monitoring features of RFID do not engender fear among medical staff members who may feel threatened or alienated. Researchers have identified three features of monitoring systems that promote the employee perception of fairness or noninvasiveness on the part of management when deploying monitoring technologies: 1) consistency in how the data or collected and used; 2) freedom from bias (i.e., with selective monitoring); and 3) accuracy of collected data (Montealegre & Cascio, 2017).

REFERENCES

References available upon request.

Human-Technology Interface

EXPLORING THE USE OF CHATBOTS FOR THE EDUCATION AND SELF-CARE MANAGEMENT OF PATIENTS WITH ALCOHOLIC LIVER DISEASE

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Abstract

Alcoholic liver disease (ALD) is caused by excessive alcohol consumption over an extended period. Education can help patients with ALD. To assist patients with education and self-care for the disease, we developed a low code chatbot using Microsoft PowerApps. The chatbot was created to provide information on the ALD condition, treatment, and available resources. The chatbot serves as a supplement to in-person care and is not intended to replace any treatment methods. Our results indicate that the bot can be designed to address existing inequitable access to information and lessen communication difficulties between provider and patient.

Keywords: Alcoholic Liver Disease, Chatbot, Microsoft Power Platform, Patient Education and Self-care Management

Introduction

Alcoholic liver disease (ALD) is caused by excessive alcohol consumption over an extended period. This pattern of behavior is defined as alcoholism. Profuse drinking is a worldwide healthcare concern as 35% of alcoholics develop severe liver disease that, without proper management, can lead to hepatic lesions (Osuna et al., 2017). According to the CDC, the total percentage of alcohol-induced deaths between 1999 and 2017 increased by 84%. In 2017 alone, 22,246 people in the United States died of alcoholic liver disease. While there is a substantial burden on the overall population, alcoholic liver disease disproportionately affects marginalized groups, and alcohol-related deaths are higher in low socioeconomic and educational groups. There is a relationship between educational level, socioeconomic status, and the onset of alcohol-related diseases (Addolorato et al., 2016). Unfortunately, most patients are diagnosed late and begin struggling with jaundice and liver failure (Singla et al., 2018).

Non-pharmacological therapies, including psychoeducation, motivational enhancement therapy, cognitive behavioral therapy, motivational interviewing, and supportive therapy, are recommended for patients diagnosed with ALD (Singhal et al., 2018). Psychoeducation prioritizes patient education centered on rehabilitation and treatment. In prior studies, the terms "patient education', 'patient teaching,' and 'patient instruction' are used for this process" (Xia, Mariner, & Begawan, 2011). Education is an essential factor in determining an individual's ability to access a livable wage, equitable healthcare, and access opportunities. Exemplifying the disproportionate effects of education, a report published by the CDC and Morbidity and Mortality Weekly Report (MMWR) found that 22.1% of adults with less than a high school diploma either started or increased their substance use because of stress caused by the COVID-19 pandemic. In comparison, 12.6% of those with a professional degree saw increased substance use (CDC & MMWR, 2020).

In this study, our objective is to improve patient education and self-care management by leveraging technology. We developed a chatbot using the Microsoft PowerApps – Power Virtual Agents platform to educate patients on ALD. A bot provides a human-like interaction that improves as more patients interact with it. The chatbot can provide a safe and comfortable environment with low to no medical terminology where the patient can ask questions without shame or embarrassment. Chatbots are different from books, websites, and mobile applications because the platform offers a two-way conversation. A chatbot is not a replacement for in-person

care; however, it can provide supplemental information tailored to help patients follow their care plan and increase compliance with treatment.

A chatbot can be used to reduce the burden on healthcare professionals, as patients can access the information about the treatment and prevention of ALD at home. Providers can service patients more efficiently, and they can leverage the chatbot analytics for clinical quality improvement programs. Provides are able to understand what aspects of treatment their patients commonly misunderstand and program those questions into the chatbot or provide follow-up care to those who need it. The chatbot is a learning mechanism that provides data that is meant to be utilized for its improvement. This research's contribution is twofold; firstly, our study is one of the first to propose chatbot technology for patient education and self-care management in ALD patients. Secondly, our project is one of the first to propose a low-code PowerApps chatbot customized for education and analytics in primary-care. The rest of the paper is organized as follows: our literature review follows. The next section is our methodology, followed by our results and a discussion of our findings. Finally, we summarize our study with a conclusion and future research.

Literature Review

Alcoholic Liver Disease Treatment and Education

A review of treatment options for both alcoholic and non-alcoholic fatty liver disease conducted by Veterans Affairs Nebraska-Western Iowa Health Care System found that ALD treatment has remained relatively consistent for the past 50 years. The study found that the primary treatment options are abstinence from alcohol, prescribed corticosteroids, and nutritional guidance. (Singh et al., 2017). For patients with worsening alcoholic liver disease symptoms, a liver transplant may be required; one rule dictates they remain abstinent from alcohol usage for six months to qualify for a transplant. A review of the policy conducted by Universidade Federal de Ciencias da Saude de Porto Alegre Graduate Program in Medicine criticized this rule as arbitrary and lacking consideration of risk factors such as low survival rates (Marroni et al., 2018).

A joint study conducted by the National Institute on Alcohol Abuse and Department of Behavioral Science, Brown University, explored the current treatment of alcohol use disorder in patients suffering from ALD. The report's review of psychosocial and behavioral treatments found

that brief interventions in the form of a 10-minute visit with a medical professional were useful in treating patients with alcoholism. These visits served as a form of education that highlighted the negative consequences of excessive drinking, which helped patients abstain from alcohol during their treatment (Leggio & Lee, 2016). The European Society for Clinical Nutrition and Metabolism examined medical and nutritional guidelines for alcoholic liver disease patients and developed 85 recommendations. The resulting recommendations compile evidence-based guidelines from expert opinion for use in a multidisciplinary team. One recommendation with strong consensus (95% agreement) was the use of education to potentially alter patients' behavior (Plauth et al., 2019).

A survey of the literature indicates that education can support the treatment of patients with alcoholic liver disease. While patients can directly contact healthcare providers, there may be miscommunication. Patients need a general hub to access consistent and unbiased answers, ask follow-up questions, and receive detailed information. A chatbot can provide patient education without increased labor hours or additional cost; used in conjunction with in-person care; a patient may see improvements in ALD.

Chat-bot Technology in Healthcare

As patients are more engaged with technology, chatbots can become an efficacious method of providing extra care. A study centered around semi-structured interviews explored chatbots, AI sentiment, and cyber-security. The study found that while most users are receptive to using chatbots in healthcare, they are hesitant and require user-centric functionality (Nadarzynski et al., 2019). Affiliates of the University of Zaragoza developed a chatbot architecture to support patients with psoriasis. The architecture attempts to address the scalability and the interoperability of chatbots by converting Fast Health Interoperability Resources (FHIR) resources to Artificial Intelligence Markup Language (AIML). This architecture is intended to help patients monitor their comorbidities and encourage adherence to treatment guidelines (Roca, 2020).

In another study for patients with recurrent illness, patients with chronic pain were enrolled in a randomized study enabling them to interact with a text-based health care chatbot (TBHC) for eight weeks. The study concluded that the chatbot called SELMA provided care that was comparable to online services offered by humans. Participants were able to use SELMA on their mobile phones and receive proper care from the comfort of their own homes. The positive feedback was considered an incentive to continue trials with SELMA (Hauser-Ulrich et al., 2020). A study

developed by The Australian E-Health Research Centre revealed that nonverbal patients on the autism spectrum benefited from engaging with an artificial conversational agent, affectionately called Alex. Alex's development benefited from experts' input in speech and occupational therapy, which provided a vital contribution to the patient's treatment and engagement (Cooper & Ireland, 2018). Chatbot technology can be effectively used to treat patients with chronic diseases or who are disabled. To effectively implement a chatbot for Alcoholic liver disease, the developer must address patients' previously identified needs.

Methodology

Microsoft Power Apps allows developers to access Power Virtual Agents to create and manage low to no code chatbots. Microsoft Power Virtual Agents is an efficient platform to build a chatbot to educate patients with alcoholic liver disease. The platform is compliant with the Health Insurance Portability and Accountability Act (HIPAA), certified by the International Organization for Standardization (ISO), and has the support of the Cloud Security Alliance (Kumar, 2020). The platform's HIPAA compliance will allow patients to input protected health information (PHI) that will allow for personalized treatment plans. The low code environment guarantees that the bot can be deployed in a short time, quickly getting information to patients. There is no need to shut down the bot for maintenance because changes to the bot can be published while patients utilize the existing version. Key development features of the chatbot in the Microsoft Power Apps environment, coupled with design thinking and usability inspection methods can improve the reception of chatbots in alcoholic liver disease treatment.
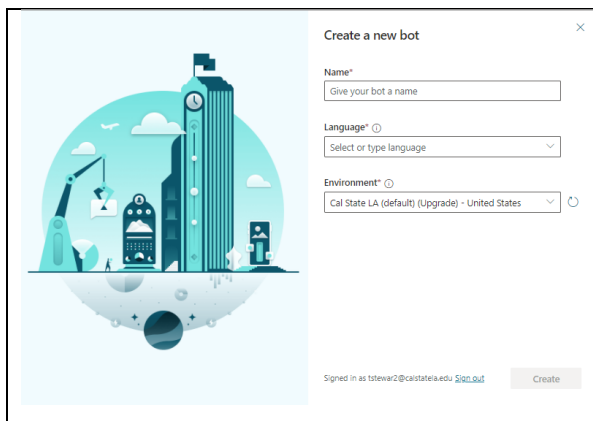
| Figure 1: Create a New Bot | Figure 2: Basic Conversational Bot |
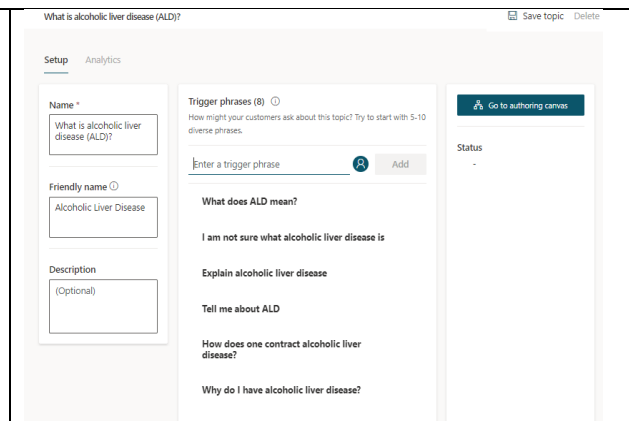
To create a chatbot using the Microsoft platform, the developer must have access to a Power Apps account, as shown in figure 1 above. From within the Power Apps service, Power Virtual Agents can be used to create a chatbot. Figure 2 displays the basic conversational bot option used to create The Alcoholic Liver Disease chatbot. Each chatbot created in Power Virtual Agents must have a unique name, a language that users will be reading and inputting content in, and whether it is for a business or educational environment. Once the bot is created, the developer must input topics corresponding to the user's interest. If the bot does not have a comprehensive list of topics, the patient will not get substantive results. If questions and topics are not available within the bot, they can be escalated for human follow-ups.

To input new topics, developers must give each topic a user-friendly name and at least five trigger phrases. These names and trigger phrases should correspond with anticipated patient concerns, interests, and questions. Each topic must have various trigger phrases because patients may input questions differently. It is essential to account for variations and slang when creating a complete list of trigger phrases. Once there are more than five unique phrases, the topic must be completed in the authoring canvas illustrated in figure 3. Power Virtual Agents automatically saves the progress in the cloud when entering the authoring canvas. Within the authoring canvas, the developer inputs a message that the chatbot will send to the users when the trigger phrases are inputted via keyboard or dictation software. The plus sign indicator also gives the option for a follow-up question, an action, another topic, or an end to the conversation. After the developer types in the message, it must be saved.
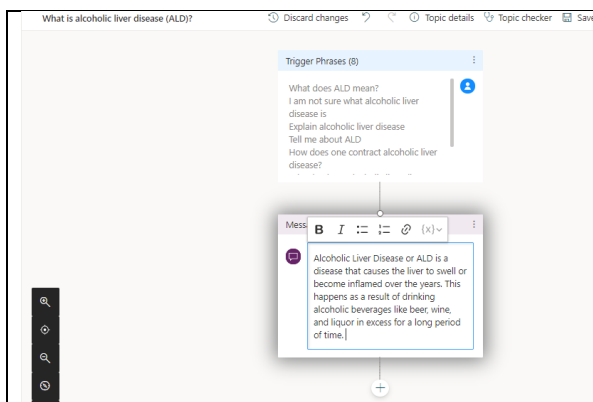
Figure 3: Authoring Canvas
Figure 4: Suggested Topics
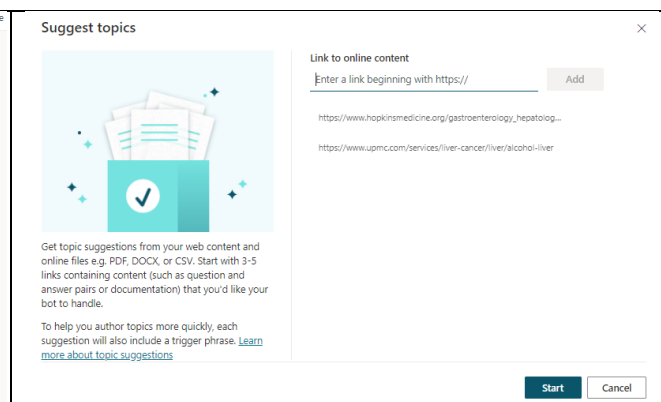
Power Virtual Agents' suggest topic feature shown in figure 4 enables the developer to pull frequently asked questions from credible websites. As a result, users can receive information from

numerous sources in one convenient location. The Alcoholic Liver Disease chatbot, along with questions and phrases developed internally, pulls information from John Hopkins University FAQs about Alcoholic Liver Disease (John Hopkins Medicine, n.d.) and UPMC Liver Cancer Center FAQ: Alcohol and the Liver (UPMC, n.d.). These FAQ websites are trusted sources of information on ALD and supplement the chatbot's previously created topics. All suggested topics must be vetted for accurate and complete information, tested, and toggled on to be included in the chatbot. The suggested topic feature can take up to twenty minutes to program depending on the volume of imported FAQ. In total, 28 topics were suggested from John Hopkins and UPMC, but only 22 were used.

While the authoring canvas and suggested topic feature offer a comprehensive method to input data gathered from external sources and medical providers into the chatbot, user input is important in the chatbots acceptance among a wide audience. As the infrastructure of the chatbot is enforced, developers can engage patients suffering from alcoholic liver disease using the design thinking methodology. Design thinking reinforces the patients needs in all stages of implementation. Patients can provide the developer their questions and concerns via survey and interview which can be transcribed into the chatbot. Upon completion of the alcoholic liver disease chatbot, the analytics features are used to further enforce the patient's needs.

Escalation is an integral feature in the chatbot, the configuration page is shown in figure 5. Although the chatbot gives a human-like conversation, there are some questions that the chatbot cannot and should not answer. Power Virtual Agents provides 65 trigger phrases associated with the escalation feature that can be updated as necessary, but there must be a curated message for each unique chatbot. Given that the Alcoholic Liver Disease chatbot engages with at-risk patients, it must provide details for emergency services and the substance abuse hotline. Users are also prompted to contact their primary care provider because the chatbot is not intended to replace human interaction.

Developers can test the bot directly in the Microsoft Virtual Agents platform, as demonstrated in figure 6. The Alcoholic Liver Disease chatbot was tested during each iteration. The testing stage simulates a user inputting a message in the bot. The chatbot outputs the exact message that it would use for real interactions. If the bot is not functioning correctly, the developer can edit the topic by adding more trigger phrases. Once the bot has been successfully tested in

numerous iterations and is fully functional, the chatbot is ready to be published. Microsoft Power Virtual Agents can publish the bot to Microsoft Teams, a Demo Website, Custom Website, Mobile App, or a wide array of social media platforms. The Alcoholic Liver Disease chatbot is intended for easily accessible education; it has been published on a custom website. Power Virtual Agents gives starter code to embed the chatbot into a custom website. This HTML script can be edited to function on a WordPress website. Once the bot is published on the website, it must be tested to ensure that it works properly.
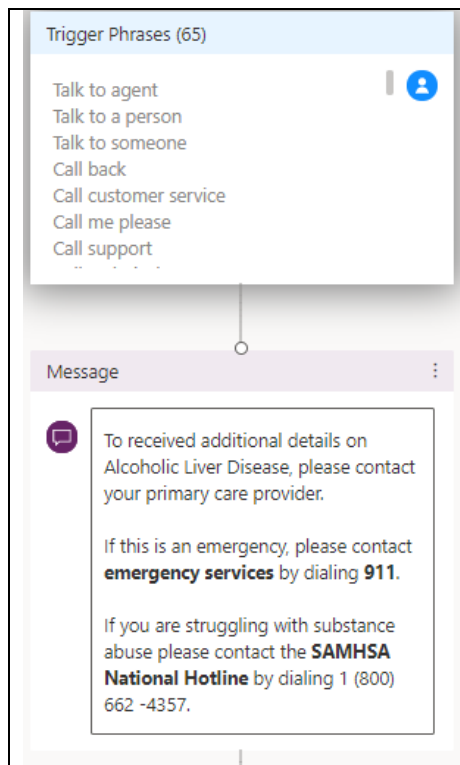
| Figure 5: Configuring Escalation | Figure 6: Testing the Chatbot |
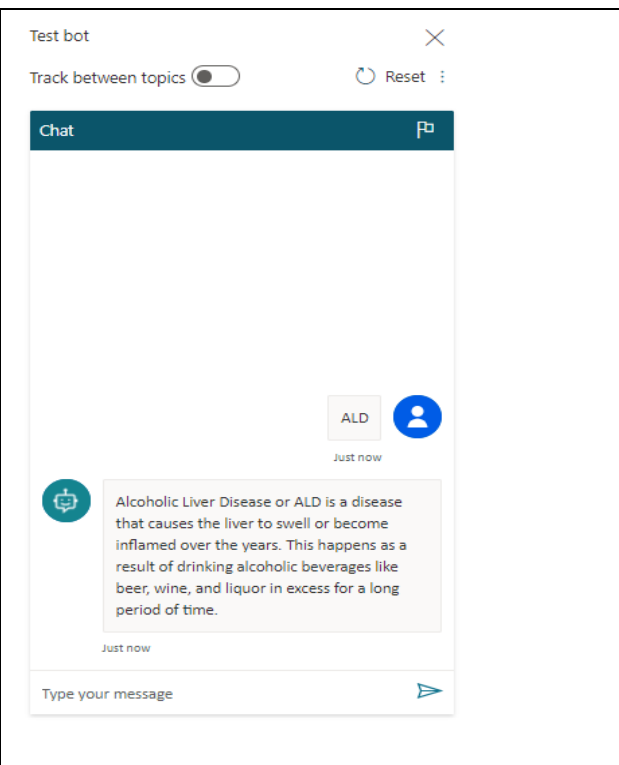
In conjunction with the traditional testing methodology and design thinking, usability inspection methods can be used to evaluate the functionality of the user interface. A study on usability inspection methods noted that "regular developers" can serve as evaluators in applying usability inspection methods (Nielsen, 1994). Although this can be an effective method, in future work users will be selected from a pool of patients with alcoholic liver disease to rank the reliability of the Alcoholic Liver Disease Chatbot and its ability to inform their behavior. Low ranking features that are not found in the analytics pane of the Microsoft Power apps platform can be rectified with medical professionals or relevant research and input via the authoring canvas.

Results

The low code Microsoft Virtual Agent Alcoholic Liver Disease chatbot developed in this study has 40 topics and over 200 trigger phrases to address ALD questions and concerns. Figure 7 exemplifies how patients can use the internet or mobile service to access the comprehensive list of topics 24/7, privately or from a public device. The topics provide a detailed view of what ALD is, how it is treated, and an overview of the effects of continued alcohol abuse. The chatbot was created using detailed sources so that patients feel that they have enough information. Continued use of the bot may provide insight into what patients are concerned about and what questions remain unanswered. These features are all summarized in the analytics pane of Power Virtual Agents.

Figure 7: Comprehensive List of Topics included in the ALD Chatbot

The chatbot is published to http://_____/alcoholic-liver-disease. It is publicly available to anyone who would like to utilize the information. When the user types a question, trigger phrase, or topic, they receive a detailed answer, as shown in figure 8. The user is provided with follow up questions and can rephrase questions to ensure that their needs are met; this functionality is displayed in figure 9. Assuming that the user's needs were not met, they select 'No' from within the chat display, as they will be prompted to talk to a human or agent. This is important because we do not want any individual to be forced to go without answers. In a patient with alcoholic liver disease, an unanswered question could result in a lack of treatment that can cause worsting conditions or even death. If the user selects 'Talk to an Agent' they will get the escalation message developed in our methodology.
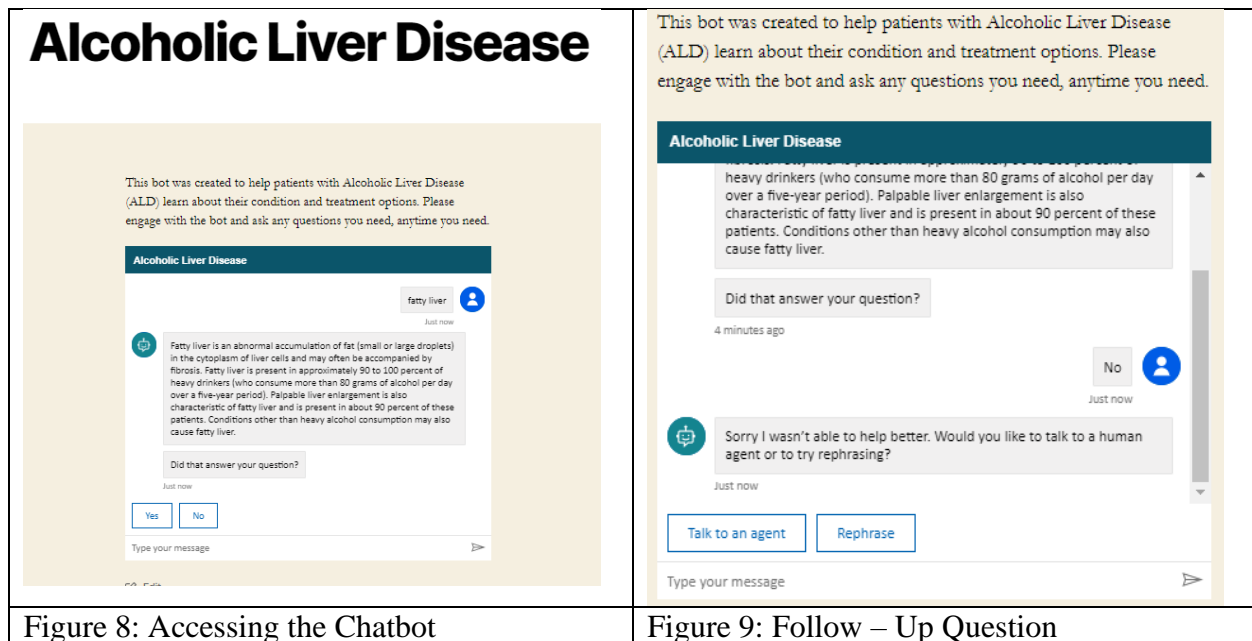
Figure 8: Accessing the Chatbot	Figure 9: Follow – Up Question

Discussion

The Alcoholic Liver Disease chatbot was developed to educate patients suffering from ALD. With more resources and education, people with ALD will have the tools to make informed decisions regarding their health and the care they receive. The chatbot can empower patients to improve their condition by following detailed recommendations. Improvement in patient education and self-care management can significantly change patient outcomes.

Providers can be sure that their patients are receiving accurate and up to date information on ALD and track unanswered questions, emergency services use, or engagement with the substance abuse hotline. This data can be used to improve treatment for patients with alcoholic liver disease and alcoholism. Providers now have the data they need to understand where failures occur in the delivery of patient care. When aggregated with data from electronic health records, the healthcare community can better understand patient needs without increasing labor hours using a convenient and accessible medium to patients. As the chatbot is used at a high volume, the bot becomes increasingly patient centric because the bot is informed by user input. As more patients use the Alcoholic Liver Disease chatbot, the provider may contribute less hours to patient interaction overall.

The results indicate that the chatbot can provide unbiased communication with users. It is necessary to explore the relationship between patient demographics and the need for follow-up questions, escalations, and the use of emergency resources. This study may help marginalized and at-risk patients find the resources that they need. Patients at a higher risk of relapse and continued alcohol abuse need to be included and considered in more studies to reduce the increase of alcohol-related deaths in vulnerable communities.

Conclusion and Future Work

Patients that receive Alcoholic Liver Disease education can change their outcomes significantly. This study is one of the first to propose using chatbot technology for patient education and self-care management in patient ALD. The general educational inequity in the United States affects its citizens in numerous ways. For patients with alcoholic liver disease and other chronic conditions, these inequities can lead to disparities in care and worsening condition or death. The Alcoholic Liver Disease chatbot developed in this study can improve the amount volume of information available to ALD patients in one place and improve the communication between the patients and providers. Providers, especially those in primary care, now have a low-code application to explore new treatment avenues, and patients are empowered to play a significant part in their care. The PowerApps chatbot can be easily customized even with limited technical personnel available for patient education and analytics.

In future research, we will evaluate the usability of the Alcoholic Liver Disease chatbot. Engagement with the chatbot will help develop future versions that are more informative and have a more human-like communication style. With funding, we will post the chatbot on a secure website. A new domain name would help promote the chatbot and allow the web search optimization.

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ONLINE CONSUMER PURCHASE DECISIONS IN THE AGE OF AUTOMATION AND ARTIFICIAL INTELLIGENCE

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Abstract

Purchase decisions are complex and require numerous factors to be taken into account prior to the final decision. Both consumers and companies can benefit from a better understanding of the decision dynamics as it will create a better buying experience for consumers while reducing expenses and increasing conversion performance for companies. This research highlights the most important factors that influence purchase decisions and investigates the impact of automation and artificial intelligence on the decisions. The findings can assist companies in developing the appropriate level of automation and artificial intelligence.

Introduction

Over the last few years online shopping has increased significantly. In 2019, 1.92 billion people purchased goods or serviced online and e-sales were more than $3.5 trillion.[1]. Additionally, the pandemic has shown that online shopping will continue to grow. The pandemic has also changed how consumers shop online. There are many habits of consumers that may retract to pre pandemic habits, but consumers have formed additional habits that will continue to impact online buying behaviors. [2]. Hence it is critical that companies understand the reasons impacting online behaviors. This paper proposes an approach to combine various factors that influence online buying behaviors of consumers.

There is common consensus in the related literature that if a product or service generates more value to the consumer then the price paid by the consumer, the purchase decision will be favorable [3]. Value generation however, is affected by a variety of factors such as Gender, Generation, Education, Employment, Salary, Personal Characteristics, Psychological Factors, Cultural Influence, Social Factors, and Marketing Mix Strategies [4].

The recent pandemic has furthered the need for companies to better understanding the factors impacting online purchase decisions. Companies—even with the most advanced digital transformations underway—are not fully prepared to properly respond to the post pandemic demands [5]. The pandemic also influenced the client base and caused significant changes in consumer behavior with higher impact on specifically digital operations.

While many habits are expected to return back to normal, consumers have found new ways that are more convenient, affordable, and accessible[2]. The recent pandemic has also reinforced the unpredictable nature of our world, and how the best laid out plans can be required to change in an instant.

Literature review

This study focuses on four key factors, contact method, personal situation, emotions, and company factors that influence a purchase decision and the interactions that are ripe for automation and artificial intelligence.

Contact Method is one of the key factors that influences a purchase decision Contact methods include the device by which the consumers are contacted to make their purchase decision regarding a product or service that a company is selling [6]. It is considered as an influential factor due to its impact on the time duration provided to consumers for decision making [7].

Personal Situation considers unique characteristics of customers. For instance, different age groups have different buying preferences, and look for different information available during the purchase process [8]. Additionally, cultural background [9] and the occupation of consumers [10] have an impact on purchase decisions. Used appropriately, Personal Situation can help organizations with information segmentation and customized design creation for each segment [11].

A relatively new contributing factor to purchase decision models is the impact of emotions [12] and the personality traits of the consumers. That is, certain personalities look for certain information during the buying process prior to the final purchase decision [13].

The organizational factors, in addition to the factors discussed above, play an equally important role on purcahse decisons. The experience, product features, and pricing provide consumers information regarding the inherent value of the product. A positive experience can pursuade the consumers to make a decision to buy [14]. Price, as expected, also plays an important role in the final consumer purchase decision[15].

Methodology

The field of online purchase decisions is ever evolving and the with the increase in pace of change in the recent times digital transformation is permeating many different aspects of businesses. Digital transformation is a complex issue that needs to be understood especially as it related to the application of various concepts. This study explores the topic of digital transformation further by understanding the various elements of a successful model. There are five different research to conduct qualitative research: Narrative Research, Phenomenological Research, Grounded Theory Research, Ethnographic Research, Case Study Research. In this study we use Phenomenological Research which takes on input from various participants and their lived experiences of phenomenon. Researchers talk with multiple participants and thread together a phenomenon if there is one that exists. There are two types of phenomenological research 1) Hermeneutical phenomenology, where research is interpreted towards lived experiences 2) Transcendental phenomenology, identified one phenomenon to study and then collect data from several persons who have experienced that phenomenon.[16]. We talked with four industry experts to determine the inputs for the model described below.

Model Description

The main goal of this study is to better understand consumer behavior during purchases using digital channels and to explore opportunities for automation and artificial intelligence to positively affect the purchase decisions. The proposed model combines both quantitative and qualitative elements of online

buying decisions. Quantitative factors include transactional elements of decision making, such as contact method and specifics about the company. Qualitative factors include personal situation and the current emotional state of the online shopper.

Contact Method: Contact method is defined as the way and the time the consumer is shopping online. Sub-factors include time of day, method of contact such as laptop, app etc., day of the week, and month of the year.

Company: There are several components of the company that impact online shopping behavior. Sub-factors include the brand and marketing related factors, product features of the offering, customer experience elements of the buying experience, and the price of the product.

Personal Situation: Online shopping decisions are highly impacted by the personal. Sub-factors include the age, education, marital status, life stage, and employment type of the consumer. These factors are qualitative inputs in the buying decision.

Emotional: Emotional factors are key inputs to the consumer decision making while shopping online. These factors impact the type of information the consumer might need during the buying process. Sub-factors include cultural background, health status, and stress and personality type of the consumer.

Figure 1 provides a summary of the factors decisions for online purchases.

Time of day
Method of contact
Day of week
Month

Age
Education
Marital status
Life stage
Employment

Contact method

Personal situation

Purchase decision

Brand and marketing
Product features
Customer experience
Price

Cultural background
Health
Stress level
Personality type

Company

Emotional
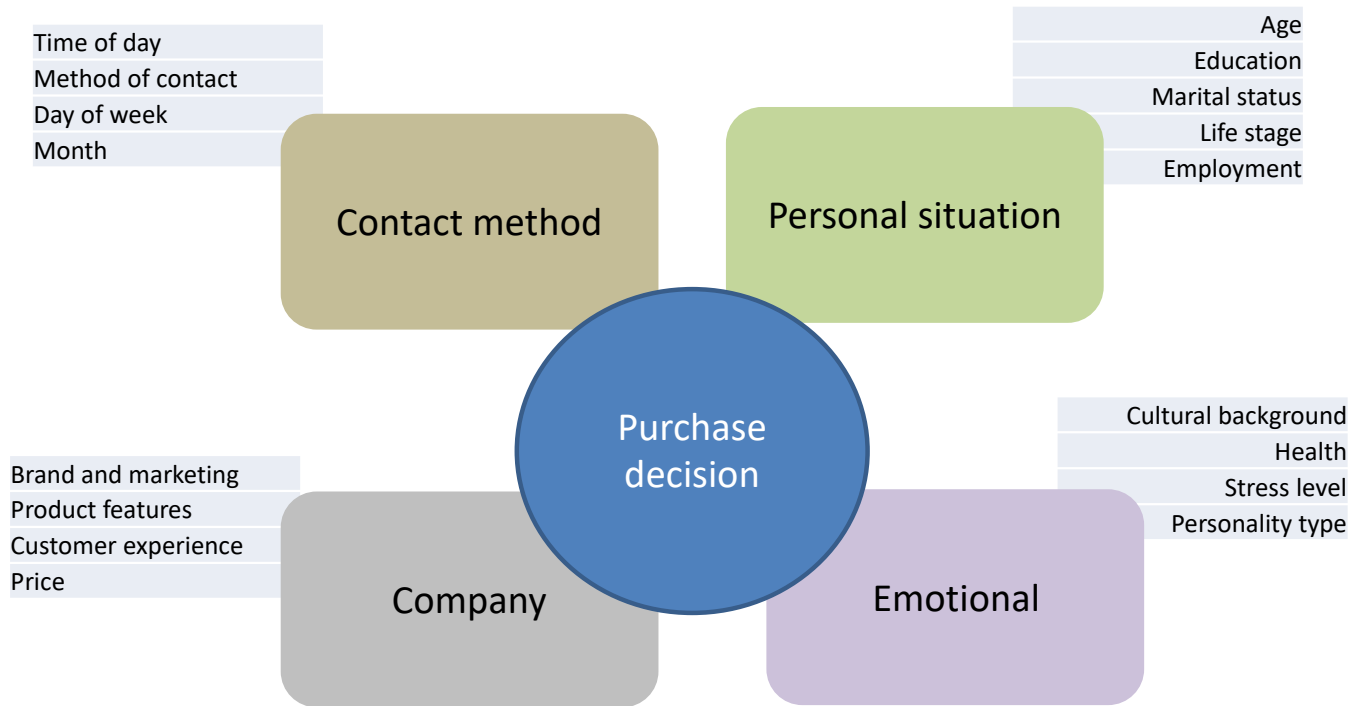
Figure 1: Online Purchase Decision Model

Limitations of Research

The major limitation of the proposed methodology stems from the size and the scope of the collected data. In this study, expert opinions in addition to real-life banking industry data are utilized to construct the proposed methodology. The research would greatly benefit from additional data from additional banks and expert opinions. Furthermore, in order to provide a more comprehensive understanding on online decision making is unique in various industry verticals would be beneficial. This would also provide a deeper insight regarding the unique factors that may be applicable to specific industry verticals.

Discussion and conclusions

The proposed purchase decision model aims to provide consumers with the fastest path to decision making. Once companies are able to fully understand all the factors that impact their consumer base a combination of automation and artificial intelligence can be applied to design new products, services, and experiences for consumers. Every industry will have variations of the model described in this paper. The variations will depend on many factors including but not limited to the type of industry, type of consumers, complexity of online transactions, emotional connection of the decisions. Automation and artificial intelligence can be used to test and improve each of the factors.

Companies should also incorporate the fact that consumers behave differently when they perceive virtual humans portrayed themselves as opposed to when they portrayed themselves as computers [17]. Companies will also need determine the correct mix of human and artificial help based on varying levels of product complexity and on the emotional attachment of consumers to the products. The analysis will help companies to better understand the best designs and technology to implement for various segments during the digital shopping experience.

While this paper provides a framework to understand the various factors that impact an online purchase decision, there is need for further research to identify the specific factors by various industries, products, and services. Future research should focus on developing these factors based on the types of products and services companies are selling. Future research should also further develop quantitative ways to develop some of the emotional factors. These factors will be helpful in designing and then optimizing experiences that are targeted to micro segments. Companies will be able to use this information to change buying experiences dynamically as the consumers go through the buying experience. Companies will also be able to design offers of add on products and services based on the segmentation informed by purchase decision factors.

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TACKLING ALZHEIMER'S DISEASE WITH LOW CODE TECHNOLOGY

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Abstract

In 2017, Alzheimer's disease killed 2.4 million people and was ranked among the top five causes of death worldwide, negatively impacting patients socially and economically. This study aims to contribute to the Alzheimer's community through the design of our low code Mendix mobile application prototype designed to help providers and patients with the early detection of Alzheimer's disease. The low code mobile health app focuses on early detection by administrating the Mini-Mental State Examination (MMSE). Our design shows that MMSE can be administered to patients more frequently with a simple low code technology which can help with identify cognitive impairment.

Keywords: *MMSE, Alzheimer's Disease, mHealth, Decision support, Mendix*

Introduction

Alzheimer's Disease (AD) is a neurodegenerative disorder that deteriorates the patient's cognitive function. The disease is statistically very deadly. In an interoperability review article, Dr. Kush, the President and CEO of Clinical Data Interchange Standards Consortium (CDISC), stated that beginning in 2011, more than 10,000 individuals daily (over 4 million per year) for the next 19 years would be facing a higher risk of Alzheimer's (Kush, 2010). In "2017, AD ranked among the top five causes of death worldwide, with 2.44 million (4.5%) deaths" (Ritchie, 2018, Dorger, 2019). The Alzheimer's Association reports that in 2020, Alzheimer's and other dementias will cost the US $305 billion, and by 2050, these costs will rise as high as $1.1 trillion.

Alzheimer's has an enormous health, social, and economic impact. Even with the prevalence of the disease, there are still challenges in utilizing data for early detection or therapeutic intervention opportunities. Some of the data constraints impeding the early detection of AD include data missingness, censoring, imprecise human-involvement, lack of model reproducibility, limited interoperability, and limited model interpretability (Golriz Khatami et al., 2020). A data source is clinical trials; however, researchers found that many early studies could not be appropriately compared since the data was not in a standard format. Significant efforts have been made to ratify interoperability issues so the results of clinical trials can be compared (Kush, 2010). Though some progress has been made to improve Alzheimer's data interoperability, many challenges still need to be tackled.

There is no cure for Alzheimer's disease or a way to stop or slow its progression. There are drug and non-drug options that may help treat symptoms. Research has shown that early detection could help control the disease's progression (Tarnanas et al., 2014). By detecting Alzheimer's disease earlier, therapy and medication can be prescribed as soon as possible to treat symptoms. Consequently, attaining, aggregating, and making data interoperable can be instrumental in caring for patients with Alzheimer's disease.

In this study, we focus on early detection and diagnosis of Alzheimer's. We are developing a mobile application using the Mendix Low Code Platform that detects AD's early signs and symptoms. Our application can be utilized to engage patients with Alzheimer's; therefore, providers can make treatment decisions earlier and lessen Alzheimer's disease's economic impact on the healthcare system. Additionally, healthcare professionals can gather and analyze data over time rather than cross-sectionally at annual physicals or routine check-ups. Combined with

powerful analytical tools and algorithms, the application's data will track the patients' progress and predict if cognitive functions are deteriorating. With this data, clinicians can more accurately determine treatment or course of action.

This study makes two significant contributions. First, we design an early detection mobile application using the Mendix low code platform. The application leverages the well-validated Mini-Mental State Examination (MMSE). The exam allows the mobile application to assess and monitor cognitive function, memory loss, and mental. Secondly, we provide a mobile user interface that provides greater usability. The rest of the paper is outlined as follows; the next section is the related work, followed by the methodology, results, discussion, and future work.

Related Work

The related work is categorized into two sub-sections. The first section reviews previously developed Alzheimer's applications, and the second summarizes the testing requirements for early detection of Alzheimer's disease.

M-health Apps designed for the treatment and management of Alzheimer's Disease.

Nearly one-third of US adults use health apps with their accessible devices (Guo et al., 2019). In a fascinating study in 2019, a group of researchers identified mobile dementia applications and gathered evidence of patients and caregivers using these apps to help them with everyday living with dementia, including Alzheimer's Disease (AD). What they found was out of the 678 apps they studied, 38 apps were useful in areas that were measured: "(1) activities of daily living (ADL) based cognitive training, (2) monitoring, (3) dementia screening, (4) reminiscence and socialization, (5) tracking, and (6) caregiver support." They determined that mobile apps were feasible in their capabilities to incorporate various strategies and resources to improve care in the dementia community (Yousaf et al., 2019).

There are currently various mobile apps available for healthcare tasks such as psychoeducation, symptom assessment, resource location, and tracking of treatment progress (Alharbi et al., 2019). Recently, Uruguay deployed several low code applications to maintain prompt communication channels to fight COVID-19. These applications ranged from call-center forms to integrated chatbots written and developed in GeneXus, a low code tool. This "Uruguay Miracle" project was completed on a tight deadline because they used the low-code platform (GeneXus) for rapid application development (Milano et al., 2020). In an article in the

International Research Journal of Engineering and Technology, a group of engineers proposed an app that targeted Alzheimer's patients. The proposed system is a mobile reminder system that will remind patients of the dates of their medications and the amount of medicine and hospital appointments (Alharbi et al., 2019). Other researchers have looked at various m-Health applications for Alzheimer's and have created four categories to classify Alzheimer's apps. The four categories include enhancing human memory, ensuring safety, improving awareness, and facilitating patients' daily activities (Elfaki & Alotaibi, 2018). The mobile prototype we designed falls into the improving awareness category; it could be great for the Alzheimer's app ecosystem.

There have also been some studies on the developers of Alzheimer's disease-focused mobile apps. In a review of 38 mobile apps in the e-collection/theme issue: Connected Health Conference 2017 CHC17: User-centered design of connected health technologies and applications, the authors determined that 36.8% of the apps were developed by IT companies, followed by non-profits (18.4%), and health-consulting organizations (10.5%). Most apps were intended for the caregivers of patients with Alzheimer's disease (Ezeanya et al., 2017). Other studies showed promising results, "the efficacy of using these apps in fighting Alzheimer's has been demonstrated by Yasini and Marchland in a study that followed 15 older adults for six months; the results proved that a mobile application could improve cognitive function in elderly patients" (Elfaki & Alotaibi, 2018, Yasini & Marchland, 2016).

As Alzheimer's affects the aging population, we evaluated the ease with how older patients use mobile devices for rehabilitation purposes. In a study titled - the usability of spaced retrieval exercise using mobile devices for Alzheimer's disease rehabilitation, the researchers found "that people with early stages of AD used mobile devices" successfully without any prior experience in using such devices (Zmily et al., 2014). Our literature survey indicated that most Alzheimer's applications were developed for rehabilitation purposes rather than detection. Our study's objective is to develop an application for earlier detection rather than for memory assistance and rehab.

User testing and usability inspections are quite important. There are a few ways of evaluating the efficacy of an interface. In 1995, Jakob Nielson lists seven usability inspection methods to find problems in a design such as heuristic evaluations, cognitive walkthroughs, and pluralistic walkthroughs (Nielsen, 1995). Though all seven methods can be employed to evaluate the interfaces, cognitive walkthroughs might be best for finding usability faults with application

developed for use with Alzheimer's patients. Cognitive walkthroughs simulate a user's problem-solving process at each step while checking if the simulated user's goals and memory can be assumed to lead to the next correct action (Nielsen, 1995).

Detecting Alzheimer's Early

In a Journal of Internet Medicine publication, researchers found that "most technologies were far removed from everyday life experiences and were not mature enough for use under uncontrolled conditions" (Piau et al., 2019). This gap in the extant literature supports the need for developing a prototype application that can be used anywhere in everyday life so the elderly can complete a quick and simple test of cognitive functions. One other example is an application called the Jungle app, created by students at Pace University. When the user touches an animal's image, the app can call out the name and sound of the chosen animal. When the app exercise was done in a group, the users communicated and commented on their activities driving engagement. However, when the task was performed alone, most participants demonstrated little or no interest (Yamagata et al., 2013).

In a randomized controlled trial, "researchers concluded that clinical application for the cognitive rehabilitation of elderly patients with neurodegenerative cognitive impairment was feasible and could improve global cognitive performance" (Jelcic et al., 2014). In another article, researchers stated that, "although mHealth apps serve as potential healthcare interventions, although little is known about the usability and interface design" (Brown & Kim, 2018). There have been numerous studies on apps related to Alzheimer's and related dementias, but studies show that the apps may be challenging to use and may not meet complex needs. These studies concluded that higher-quality apps need to be developed and tested (Guo et al., 2019). After reviewing multiple studies, we find we can contribute to Alzheimer's disease research by focusing our efforts on a low code mobile application designed with patient usability in mind.

Methodology

Features of the Mendix Mobile Application for the Early Detection of Alzheimer's

The scope of this study is to create a Mendix low-code mobile application to aid in the early detection of Alzheimer's. The application must be easily accessible and straightforward to use for patients diagnosed with Alzheimer's disease. The mobile app will administer a commonly

used standardized assessment known as the Mini-Mental State Exam; it evaluates memory, the ability to solve simple problems, and other thinking skills (Alzheimer's Association, 2020). The application will save patient responses in a structured format that can be transferred to the electronic health record for personal and population management. The application will monitor the patient's performance on the assessments over time. Using Mendix microflow technology, the data can be analyzed to help physicians detect a rapid decline or mild decline in cognitive function leading to a possible early detection of Alzheimer's.

Typically, the MMSE is administered by a health professional who asks a patient a series of questions to test memory and mental skills. Our app will administer the MMSE by asking multiple-choice questions and answers. It will also show shapes and objects for patients to recall later in the exam. Parts of the test will also have audio, where it will ask patients to repeat specific phrases and count. The speech shall be analyzed using natural language processing (NLP). The score (data) from the exam will be saved and initially reviewed in early versions by a health professional. The max score of the MMSE is 30 points. A score of 24-20 suggests mild dementia, 13-20 suggests moderate dementia, and a score of less than 12 reveals severe dementia. A person with Alzheimer's disease will slide two to four points a year on average (Alzheimer's Association, 2020).

The idea is that a patient will take this test on his/her phone, tablet, or laptop periodically (monthly, quarter, annually, or semiannually). The exam results will be stored in the patient's record, where the patient's care team can retrieve them. Using Mendix microflows, the results can be analyzed, and notification sent if the patient needs an appointment with a health professional. Alerts can also be sent to the provider, letting them know that the patient's score suggests signs of dementia or Alzheimer's.

Developing the Application using the Mendix Web-Platform

Our current method of approach is using the Mendix for rapid prototyping. Mendix is a low code platform to build and continuously improve web and mobile apps that enable innovation at a web-scale ("IBM & Mendix", 2020). Mendix offers full support for creating full native mobile applications in a low-code environment. Mendix also provides a rich set of actions to leverage native device capabilities like the camera, biometric authentication, GPS, and Bluetooth

("Building Native Mobile Applications in Mendix", 2020). Not only does it offer back-end capabilities but also front-end design services for creating multi-channel applications.

The UI and UX are a crucial part of our prototype because of our focus on increasing usability among Alzheimer's patients. Wireframing our activities for our patients is also easy on Mendix with their Atlas UI package. The Atlas UI framework comes with diverse layouts and templates to easily combine and create a stunning and easy to use interface for our Alzheimer's patients ("Building Application Front-Ends in Mendix", n.d.). If the library does not suit our UI/UX needs, we can also leverage custom UI components called pluggable widgets ("Building Application Front-Ends in Mendix", n.d.). As our end goal is a highly usable mobile application that caters to Alzheimer's patients, the team believes the best approach is utilizing Mendix's low code rapid native mobile application to build out our app.

Results

The prototype we developed illustrates the mobile interface design and framework for a mobile health application that administers the MMSE. The goal is to help combat Alzheimer's by early detection. The data generated from the app combined with health interoperability and analytics could provide healthcare providers and professionals insight and possibly a different perspective in tackling Alzheimer's. Below are screenshots from the app.

Figure 1 shows the homepage of our mobile MMSE and Patient Data app. Using Mendix's low code app development, the MMSE app delivers an accessible quiz to aid with early Alzheimer's detection. We kept the app simple as we wanted users to input answers easily. The test results are then forwarded to the physician's database; providers score and evaluate the MMSE for early detection of Alzheimer's disease. Figure 2 shows the patient view of the form. This form is used to collect necessary details, including the years of school attended as the answer affects the MMSE diagnostic results. After saving the details, the app registers the patient and allows them to take the test.
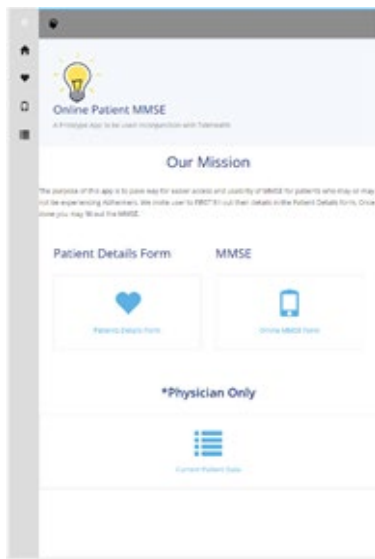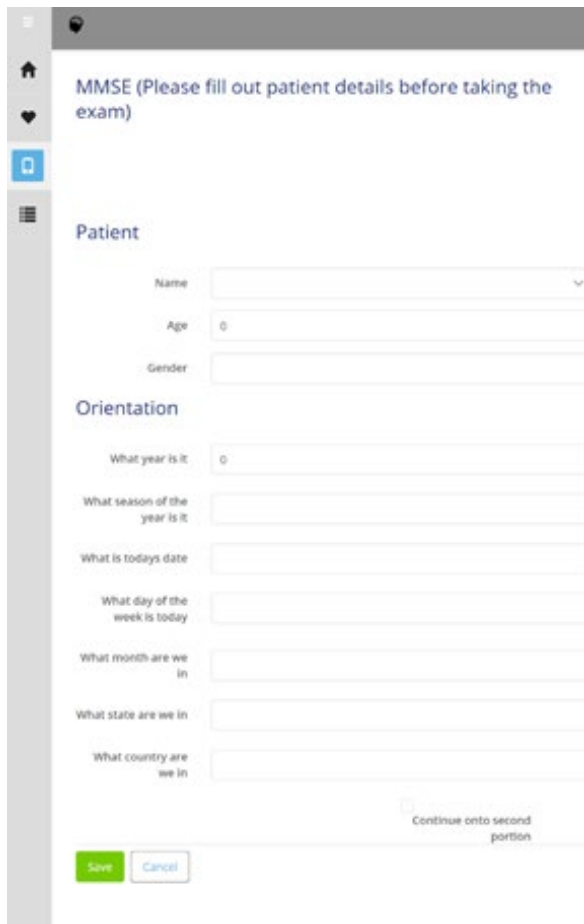
Figure 1. MMSE App Homepage

Figure 2. Patient Detail Form

Figure 3 is the MMSE form on mobile. The name, ideally, is prefilled based on the patient details from the prior form. The user then inputs their age and gender in the text fields. We have divided the MMSE into two parts. The first part is the standard orientation test patients are assessed for their awareness of the date, time, and location. As the patient reaches the end of the orientation portion, they are asked to check a field if they are ready to move forward on the test. In the current app version, this design was implemented to include a proctor or physician who will provide some questions and instructions, as depicted in figure 4.

We established previously that the application would be interoperable with health information technology to allow the proctor, nurse, or physician to help deliver some questions in real-time. One of the fundamental designs of the MMSE is the integration of real-life objects and language skills that can be tested by a healthcare professional. Delivering those questions through the application will require the use of embedded audio objects. Because we are using the rapid application development methodology, the audio will be added in future iterations; our priority is to deliver a product as soon as possible in an agile development environment. When each patient completes the exam, the results are then saved in the Physician Database.
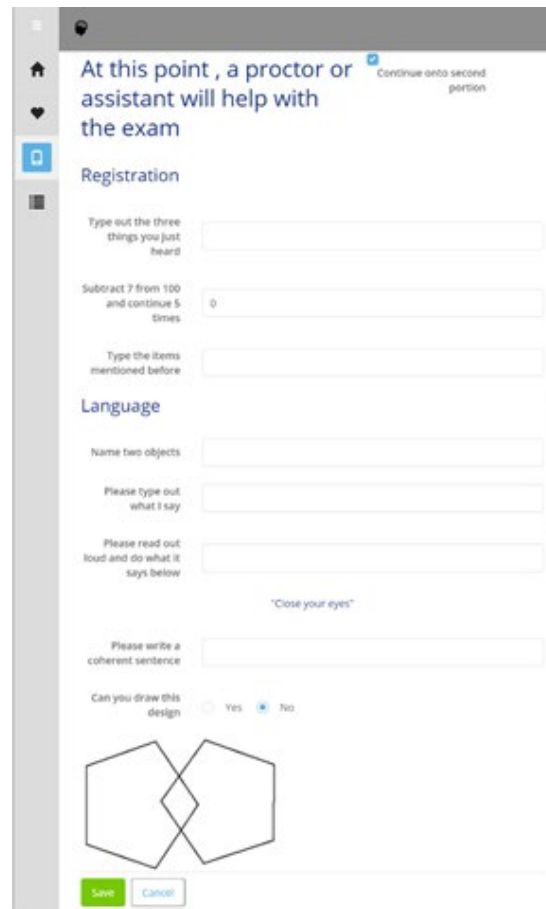
Figure 3. MMSE Mobile Form
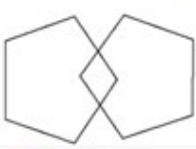
Figure 4. Second Part of MMSE Mobile

Figure 5. A Patient Details Physician View

Figure 5 is the patient details view for the physician. It currently holds the necessary details of the patient as well as the test scores and current notes. Currently, the scores need to be manually

updated after checking the answers of the patient. The physician can also write notes or make other observations not specified by the form.

Figure 6 is the physician's view of the test results for all patients; here, they can view and grade the answers. Providers also have the option to export to Excel for more comfortable viewing. In future iterations, we will incorporate automatic checking to ease the workload of nurses and physicians and provide a faster assessment to the patient. The next figure will showcase the physician edit view.

Patient Data View
This view is for the physician, where they can see their patient scores and other details

MMSE Results   Patient Details

Search   New   Edit   Delete   Export to Excel   1 to 2 of 2

Name	Age	Gender	What_year_i	What_seasor	What_is_tod:	What_day_of	What_month	What_statep	What_count:	The_examine	From_100_co	Type_in_Wor	Name_the_it	Name_these	Please_type_	Please_read_	Please_write	Can_y
Shaq	40	M	2019	Fall	Not Sure	Tuesday	November	California	USA	Ball Flag Tr...	93	dlorw		Watch and ...	No ifs buts	Close your ...	The cat	Yes

Figure 6. Patients MMSE Test Results Physician View

Figure 7 illustrates the physician details editor; it is quite like the patient details form. The main difference is the ability to change the score and have notes on the patient. The goal of future iterations is to calculate the scores automatically. In the current version, the physician would input the score and notify the patient. Figure 8 shows the domain model; the entity MMSE is where data from the mini-mental state exam is stored. In the entity MMSE, attributes include the patient's name, age, gender, followed by answers to questions from the mini-mental state exam. The Test_Details entity has attributes of patients' details, such as name, dob, and the patient's score on the MMSE. The association between Test_Details and MMSE is one to many, as one patient can take the exam multiple times.

Figure 7. Physician's Patient Editor

Figure 8. Entity Relationship Model

We designed this prototype as the first of many steps toward a more accessible technology for early detection of Alzheimer's. We will add many other features to truly make it easier for patients and physicians to participate in the early detection of Alzheimer's disease.

Discussion

In this study, we designed version one of our Mendix low code prototype to detect Alzheimer's using the Mini-Mental State Examination (MMSE). The MMSE app delivers an accessible quiz to potential Alzheimer's patients. The literature showed there were issues with accessibility and ease of use with current apps on the market. We addressed this issue by simplifying the input of data and making it easily accessible. The MMSE results are easily stored so that they can be leveraged for data analysis to support provider decision-making. Developing the application using the Mendix platform allows for deployment on mobile, tablet, or web. This flexible functionality is suitable for senior citizens who may have low vision or varying degrees of comfort with different devices.

Low code allows not just for rapid development and low-level full-stack development knowledge but also rapid deployment. Our application was completed and deployed in three months. We estimate it will take a year to finalize and integrate user feedback allowing patients

and providers faster access to better quality service. People are drawn to the mission of fighting Alzheimer's. This prototype is only the beginning of adding value to our complex learning healthcare system. This application can generate momentum to help further the need to fight against Alzheimer's disease.

Alzheimer's disease is a deadly disease that deteriorates the patient's cognitive function. While many mobile apps are available to help combat symptoms of Alzheimer's, our contribution is aimed towards the early detection of Alzheimer's. With the development of a prototype mobile app using Mendix, we could collect data easily to enhance decision making. We designed the application, so it is simple and easily accessible for the Alzheimer's population. Our results suggest that a fully functioning app can be made in the future with the guidance and expertise of Alzheimer's professionals. As there is no current cure for Alzheimer's, we hope to help with early diagnosis to treat patients before it is too late.

Future Work

In the future versions of the app, we hope to address the questions: will this app lower healthcare costs? Furthermore, will this app ultimately lead to better outcomes for patients and clinicians? Like many, our project can move forward with generous funding. The source of this funding can range from various hospital organizations to NIH grants. It is fundamental for Alzheimer's experts to test our design to evaluate and provide feedback to our methods and design. Their expertise can help narrow the application making it more user-friendly and effective.

Alzheimer's disease affects people from various backgrounds, a mobile application accommodating diverse needs will help make early Alzheimer's detection more accessible. To accomplish our goals of greater accessibility, we need multi-language support. A future iteration of our application will incorporate automatic answer checking that would save many manual hours of the nurse or practitioner and deliver results faster for an earlier diagnosis. As we develop more features into the application, we want to adhere to the three key principles of design coined by John D Gould and Clayton Lewis in 1985. The three principles - early focus in users and tasks, empirical measurement, and iterative design are fundamental guidelines to improving usability for our current application and as well as any future updates (Gould, J. D., & Lewis, C. 1983). Our application is geared toward a niche population for a specific purpose. The early focus on the elderly demographic can help form the app to the nature of their behaviors. Previously we

described, the use empirical measurements such as cognitive walkthroughs. Carrying out those simulations as well as analyzing said tests can help us identify stop gaps or areas of future improvements. Finally, an iterative design to fix any problem that have failed our behavior specification is key to optimal usability.

We hope to incorporate video calling features between the physician and patients; then, we can ease the learning curve of using our mobile MMSE app. Updated versions of our mobile application will include any modifications to MMSE. There are also problems we may never notice until we do a field test. As such, those problems will be addressed when they arise. The application will likely need continuous improvement to improve the quality-of-life for patients and implement new features generated by user feedback.

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Legal, Ethical, and Social Issues

AN ALTERNATIVE APPROACH FOR DIVERSITY TRAINING BASED ON VISUALIZATION ANALYSIS OF SOCIAL MEDIA DATA

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Abstract—Diversity and Inclusion are one of the challenges facing many organizations. Diversity training shall be fostering diversity, but it turns out to be non-effective in many cases. This study is based on retrieving more than 40,000 interactions in the year 2020 from Twitter. The data was retrieved from Diversity (Diversity and Inclusion) and Diversity Training hashtags to deduce the network's structure, density, and the crowd's sentiment about diversity. An alternative approach for diversity training is suggested based on the results. Three of the top nodes followed are BOTS, and the top clusters are related to Black Lives Matter, Women Leadership, and the Future of Work.

Keywords—Diversity, Training, Social-media, Clusters, Sentiment.

I.   Introduction

Diversity is an important topic that many organizations are urged to take action toward it. According to the United States Bureau, the entrants' labor to the workforce from 2016 to 2026 will be around 38 million people, and 30 % of that workforce is expected to be from diverse ethnicity (U.S. Bureau Labor Statistics, 2017). Organizations spend resources to enforce diversity and inclusion following the federal law of the Civil Rights Act Title VII that prohibits discrimination against employees because of their race, color, religion, sex, views, and origin (Commission, 2017). Diversity is about a variation on the physical or external appearance level and variation on the intellectual level (i.e., beliefs, ideas, viewpoint, etc.) (Rozado, 2019). Mckinsey & Company reported in the year 2017 that approximately $8 billion is spent a year on diversity training in the United States alone, and the report stated the unfortunate fact that no

studies found that confirms that diversity training leads to an increase in Diversity (Kirkland & Bohnet, 2017).Diversity training targets decreasing the discrimination that the minorities may face at the workplace (Pendry, Driscoll, & Field, 2007). Moreover, it aims to change employees' perceptions toward others (Kalinoski et al., 2013).

II.   Literature Review

Researchers noted that diversity training advantages and befits are not fruitful in many cases (Edmondson & Roloff, 2009). Diversity training is a core component in diversity initiatives (Kalinoski et al., 2013). Traditional diversity training (in lecture format) does not provide the intended results (Glover & Mehnert, 2020). There is little empirical evidence about the situations or conditions under-which the diversity training proved to be beneficial (Kulik, Pepper, Roberson, & Parker, 2007). Some fields like software development are still men dominant, as only 25% of the computer scientists are women (Camera, 2016). Black and Hispanic are underrepresented in technical jobs (Muro, Berube, & Whiton, 2018). Microsoft forms inclusive teams, especially for the design, so that the designers consider the different customers' needs, especially those with disabilities and minorities (Microsoft Corporation, n.d.).

Artificial Intelligence can help create a diverse work environment through systems that help select and ensure diversity is fulfilled. That will be reached if the people working on the design and implementation of these systems include the system's rules (Daugherty, Wilson, & Chowdhury, 2019). Diversity is strengthened and promoted in organizations that use digital platforms for workforce composition and connections (Kane, 2018). Junior employees and women are the types of employees who benefit the most from digital collaboration tools (Wu & Kane, 2019). Venture Capital firms adopt Artificial Intelligence algorithms and predictive analytics to avoid gender-biases in the evaluation and selection process(Hernandez, Raveendhran, Weingarten, & Barnett, 2019). Organizations and institutions need to be aware and prepared with actions for the shift in job skills, affecting hiring, managing, and training employees(Beck & Barry, 2017). The lack of diversity in organizations, especially technology-related organizations, is due to algorithms used behind Artificial Intelligence (Gratton, 2019). H.R. needs to continuously review policies related to discrimination and harassment and ensure the guidelines are communicated effectively to the employees(Lenkov & Kurionis, 2018). Based on a study on 1.4 million comments by employees working in Culture500 companies on

Glassdoor; it was found that the average culture rating by the employees for the employers had a sharp increase and spike in the positive culture between March and April 2020 after the pandemic when most of the organizations shifted to remote work. One of the top positive topics found in the analysis was the employees' appreciation for leaders' communication quality (Sull & Sull, 2020). Social media have great potential to support diverse information sharing(Shore, Baek, & Dellarocas, 2018). Cultivating connectivity is crucial to foster and diversity. Companies need to educate the staff on developing a professional network and cultivating connections(Connors, 2019). A study was run in the year 2019 using machine learning technique to analyze the corpus (keywords) on the profiles of 50 American Universities to see the diversity-related words, and it was found that Universities use the term diversity to refer to varieties in terms of appearance and not intellectually (Rozado, 2019).

III.   Problem Statement

Many barriers hinder diversity training effectiveness in organizations (Gebert, Buengeler, & Heinitz, 2017). One of the common barriers is the dogmatic communication within the training groups (Stewart, Crary, & Humberd, 2008). Another barrier is the trainees' behavior (employees)and their tendency to interact or share what sounds politically correct, even if it is not their thoughts (Avery & Steingard, 2008). The lack of a diversity training task force is another cause for its failure, as the task force may develop a strategic plan to ensure commitment (Belgrave & Allison, 2018) (Neblett Jr, 2019). Ineffective diversity training had counterproductive cases where the exclusion of minorities took place after the diversity training (Anand & Winters, 2008). In addition to all that, with the fast pace of life, long or traditional training may not be effective for many employees. Most people want short and efficient updates. According to Kalinoski et al., organizations that adopt and employ better practices in designing and delivering training harvest better results (Kalinoski et al., 2013).

IV.   Objective of the Study

The majority of the people, especially the employees in their twenties and thirties, spend a lot of time on social media platforms. This study investigates an alternative approach to using social media as a platform for Diversity Training. That is evaluated by analyzing the Networks related

to' Diversity," Diversity & Inclusion,' and' Diversity Training' on Twitter to understand the structure, density of the network, the sentiment, and the crowd's opinion on this social media platform about those topics. Twitter is one of the most suitable platforms for short training, as all types of structured and unstructured data may be shared.

V.   Analysis and Results

To examine that and determine the crowd's status and sentiment, tweets were retrieved using Twitter Developer API and NodeXL from three hashtags: #Diversity, #Diversity and Inclusion, and #Diversitytraining.

A. Network Topology

1) Diversity Hashtag: We were able to retrieve 40521 interactions from #Diversity (Tweet- Re-tweet-Mention - Replies). Eighteen thousand two hundred ninety-nine accounts did these interactions. Figure1 shows the network diagram for the data retrieved from Twitter, and the Influencers' nodes are represented by their account profile picture in Figure 1. Table II under the Appendix shows further details about the network. In figure 1, each node(point) represents an account, while each link or edge(in grey) represents an interaction between nodes. Most of the edges are hidden due to the density of the network. Interactions may be in terms of tweets, re-tweets, mentions, replies. The nodes' images show the top accounts in terms of in and out-degree (representing the edges going in and out of the node), or the nodes with high betweenness centrality, or the nodes with high page rank. NodeXL calculates page rank based on the quantity and the quality of the nodes connected to a particular node. An Example of the measures that the software tool uses to determine the node's quality would be the user's popularity. 16 Accounts out of 18299 were ranked as the top accounts in terms of in and out-degree, betweenness centrality, or page rank. One of these 16 accounts is an account developed for sharing awareness tweets about diversity, and the account's user name is' Diversity tweets'. Table I shows the 16 nodes and more details about them. The Top two accounts in terms of popularity and interactions related to diversity are" The New York Times" and India Narendra Modi's prime minister. Two interesting accounts are" 50:50 Future", which is an organization dedicated to achieving gender equality in the workplace. At the same time," Live & Color" is the account for a theater that produces work (plays and lyrics) that reflects the status of color or other underrepresented communities. Figure 2 shows the impact, spread, and density of links with three accounts

regarding centrality and degree. Those accounts are" Diversity Tweets," a B.O.T. that re-tweet the tweets posted by humans. While the other two are" Trumpster Fire" and" Humanhood. " Trumpster Fire" is an account developed by a high school teacher to resist and fight for the rights of the minorities, mostly" Black Lives Matter" and" Feminism. " femtech" is a B.O.T. that re-tweet the tweets by females in the Science and Engineering field.

2) Diversity and Inclusion: We were able to retrieve 207 interactions from #Diversity Inclusion(Tweet- Re-tweet-Mention - Replies). One hundred twenty-nine accounts did these interactions. Figure 3 shows the network structure for # Diversity and Inclusion. Figure 4 shows the nodes with the highest inflow or outflow edges and the nodes with more than 100 k followers in # Diversityinclusion. Some public figures and large corporations quoted are the Prime Minister of New Zealand Jacinda Ardern, Google, Linked-in, and Glassdoor. The largest nodes interacting about the topic was within users specializing in the medical field.

3) Diversity Training: We were able to retrieve 70 interactions from #Diversity Training, including(Tweet- Re-tweet mention - Replies). Forty-seven accounts did these interactions. Figure 8 under the appendix shows the structure of this network.

B. Cluster Analysis

1) Diversity Network: Four significant clusters were found in the network using the Wakita-Tsurumi algorithm. Each cluster contains the vertices that have a common theme between them. Figure 5 shows the four clusters in the Fruchterman-Reingold layout. Four thousand one hundred ninety-nine vertices are in these four clusters. Cluster 1 (Navy Blue) had a theme related to Black lives matter, George Floyd, sanctity, and equity. Cluster 2(Light Blue) had a theme related to inclusion and leadership. While, Cluster 3(Green) had a theme related to women inclusion, women in tech, women in stem, and feminism. Finally, Cluster 4(Yellow) had tweets related to Diversity and I.T., H.R. Technology, the Future of Work, and H.R. analytics.

2) Diversity and Inclusion: Figure 6 shows the network clusters and the connections between them. Figure 7 shows the top 3 clusters in the network (Navy Blue, Light Blue, and Red).

TABLE I
NETWORK ANALYSIS METRICS FOR INFLUENCERS IN #DIVERSITY

Vertex	Account Name	In-Degree	Out-Degree	Page Rank	Centrality	Followers
djhinz17	A Trumpster Fire	21	1595	451	22582422	3082
diversityup	Diversity Tweets	1	1402	313	64491418	1250
roterhut1	United4Navid	1	849	205	5638897	249
humanhood12	Humanhood	6	267	88	4992023	131
femtech_	FemTech_	1	256	46	8581708	16321
souindia	Statue Of Unity	115	0	8	294768	20955
narendramodi	Narendra Modi	115	0	8	294768	63362653
ishtaaaa	MISHI	115	0	8	294768	182
radiochinar	RadioChinar	115	0	8	294768	7676
khushnumakashm1	Khushnuma Kashmir	115	0	7	294768	5872
nytimes	NY Times	32	0	7.5	5061211	47761383
clin_trials	AppliedClinicalTrial	2	2	0	1.3	8321
retailingafrica	Retailing Africa	2	2	0	1.3	5727
theatreincolor	Live & in Color	2	2	0	1.3	310
5050_future	50:50 Future	2	2	0	1	2435
111lynsey	Lynsey Harbottle	2	2	0	1	1442
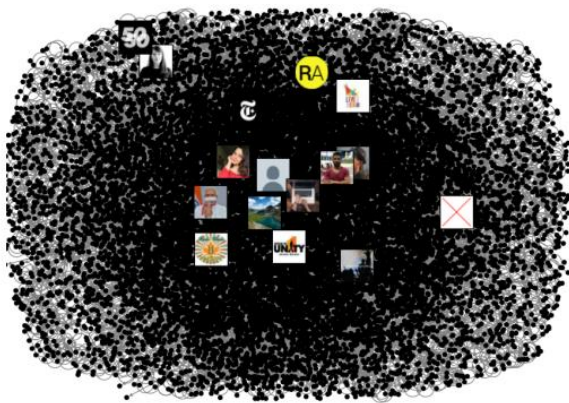
Fig.1. Network diagram for Twitter accounts with diversity related interactions
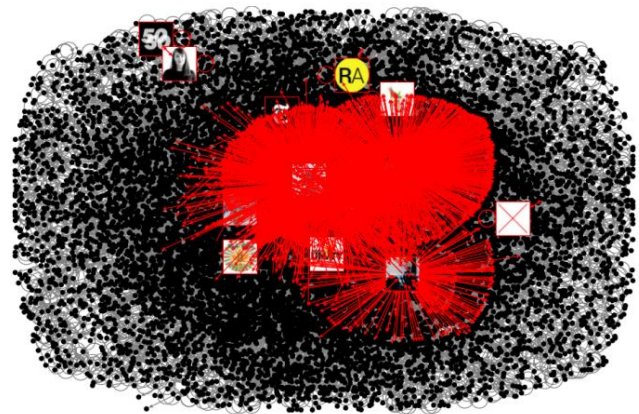
Fig.2. Network diagram for Twitter accounts with interactions of Top 3 nodes
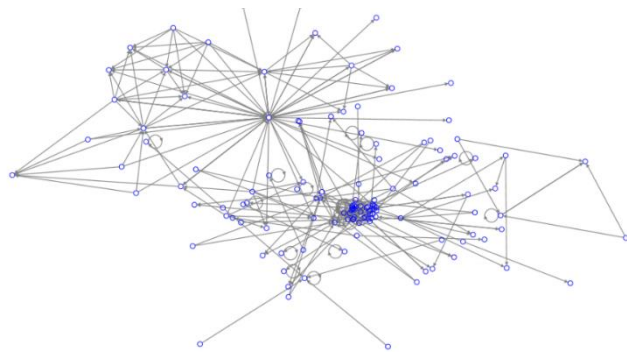
Fig.3. Network diagram for Twitter accounts for diversity and inclusion hashtag
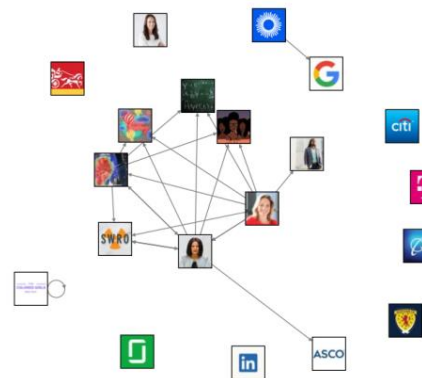
Fig.4. Nodes clustered by Motif

C. Sentiment Analysis and Word Pairs

1) Diversity Network: The sentiment in these interactions was classified into positive, negative, and non-categorized (including stop words). Twenty-one thousand two hundred thirty-six words in the tweets were classified as positive words, versus 7240 words classified as negative. The most repeated positive words written on # diversity were" Work, " Support," and" Commitment" While for the tweets classified as negative sentiment, the most repeated words were" Problem, " "Racism, " Bias," and" Inequalities." The following word pairs appear together in several tweets: (diversity, inclusion)3173 times,(equity, racism) 652 times, (feminism, education)627 times, (spread, message) 210 times.

2) Diversity and Inclusion: The sentiment in these interactions was classified into positive, negative, and non-categorized (including stop words). The most repeated positive words written on # diversity and inclusion were" Support"," Patient"," Respect"," Powerful"," Unity". The most repeated words were" Racist, " Biases, " Confusion" for the tweets classified as the negative sentiment. The following word pairs appear together in several tweets: (rise, up),(disclosing, low vision), and (support, employer).

3) Diversity Training: The sentiment in these interactions was classified into positive, negative, and non-categorized. 52% of the words that had sentiment were negative. The most repeated words in the positive tweets were" Support, " Love," and" Work." While for the tweets classified as negative sentiment, the most repeated words were" Struggling, " Stigma," and" Bias." One of the influencers found in # Diversity Training is Julie Kratz, a TedX speaker, and inclusive leadership trainer. She is also one of the influencers in #Diversity

Created with NodeXL Pro (http://nodexl.codeplex.com) from the Social Media Research Foundation (http://www.smrfoundation.org)
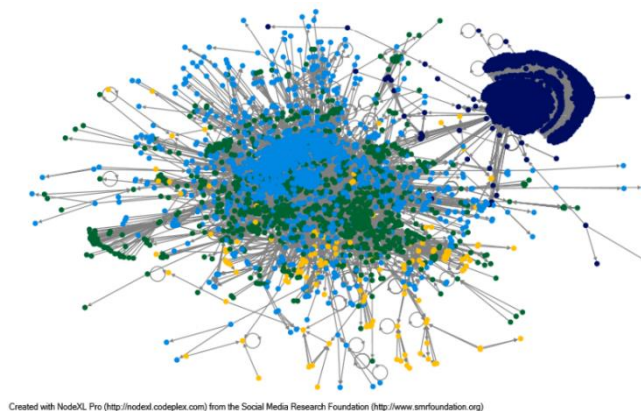
Fig.5. Four Large Clusters in the Diversity Network

VI.   Conclusion and Recommendations

Three out of the top 16 nodes are BOTS, and still, many people follow them to get tweets and content related to diversity." femtech" has 16321 followers, while" Diversity Tweets" has 1250 followers. So that shows that people are willing to follow an account even though knowing that it is a B.O.T. re-tweeting from other accounts but is sharing content related to their interest. Accordingly, that reflects the idea that organizations use Twitter as a new or alternative channel to feed the employees with informative mini-Diversity related tweets that may reach them faster and also will be encouraging for them to check it as it will be embedded in their daily routine while checking their social media accounts. Diversity training tweets need to cover struggles that employees may need to take, rather than providing generic awareness. Based on the cluster analysis, the top four clusters are related to topics and issues to Black Lives, Women, leadership, Future of Work in terms of diversity and technology. Diversity training needs to be designed in an effective way to cover these areas based on the input of the crowd from Social Media Platforms. Public influencers have the power to outreach thousands of users. Figure 2 shows the spread and reach for only three nodes based on the analysis presented in this study. That may spread short training content through the public figures to help spread awareness among the crowd. The level of diversity and inclusion in future organizations will be determined based on the rules and algorithms used in the Artificial Intelligence systems used for employee hiring. The more the system is designed and built to ensure diversity and avoid bias, the more inclusion will be fulfilled. The spike jump in the rating and the perception of employees regarding the positive culture during the remote work phase for 500 large corporations (Sull & Sull, 2020), implies the importance of communication and transparency for employees despite the communication channel. The rating increased when the messages were shared electronically during the pandemic versus the previous years where it was mostly facing to face. So, sharing and spreading messages related to diversity is more likely to reach the employees if accompanied by transparency and covers the employees' challenges and not just theory. Accordingly, one of the recommendations is shifting the diversity of traditional face-to-face training to short, useful, and practical snippets via a digital platform, either internally within the organization or publicly via the social media platform.

VII. **Limitations**

The data were retrieved via Twitter developer API, and Twitter sets a limit according to the number of accounts that may be retrieved. Also, the users who chose their accounts or data to be private are not shared by Twitter. That may have an impact on the bias and inclusion of a comprehensive view. Furthermore, not everyone has an account or a user on social media. So, this study represents social media users. The Diversity Training data set is small compared to the other two networks retrieved, so the Clustering algorithm was not applicable.

VIII. **Appendix**

Created with NodeXL Pro (http://nodexl.codeplex.com) from the Social Media Research Foundation (http://www.smrfoundation.org)

Created with NodeXL Pro (http://nodexl.codeplex.com) from the Social Media Research Foundation (http://www.smrfoundation.org)

Fig.6. Clusters in the diversity inclusion network using Wakita-Tsurumi Algorithm
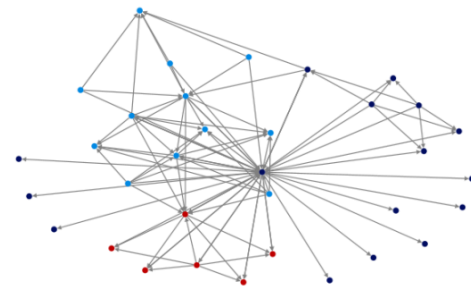
Fig.7. Three clusters in the diversity inclusion network

TABLE II
METRICS OF THE #DIVERSITY NETWORK

Graph Metric	Value
Graph Type	Directed
Vertices	18299
Unique Edges	27468
Edges with Duplication	13053
Total Edges	40521
Self Loop	5449
Connected Components	3626
Maximum Vertices ub a connected component	9194
Average Geodesic Distance	5.07
Graph Density	0.000085
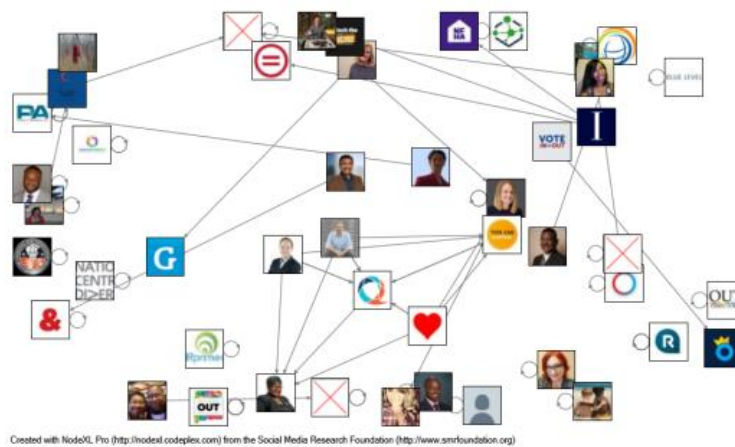
Fig.8. Network structure for diversity training hashtag

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PANDEMIC MANAGEMENT WITH MOBILE APPLICATIONS: DESIGNING AN EXPERIMENT IN ETHICAL AI

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Abstract

The Covid-19 Pandemic has overwhelmed hospitals globally, with nations quarantining to slow contagion but devastating economies in the process. As communities seek to operate, contact tracking applications using GPS functionality have emerged throughout the world, raising significant ethical concerns. We discuss development of an experimental Covid-19 virus tracing capability to examine tradeoffs between economics and public health in the community of Gettysburg, Pennsylvania. We used a consequential analysis to examine concepts of beneficence, justice, and respect for autonomy, as we considered data collection & analysis, informed consent, privacy, security, and outcomes. The design process led to developing a deontological framework for ethical AI.

Keywords: ethical AI, contact tracking, pandemic management

Introduction

With fear of infection increasing as the speed of contagion overwhelmed hospitals globally, governments implemented social-distancing and quarantine protocols around the world leading to massive unemployment and an economic recession (Chaney & Morath, 2020). Within days of the first lockdowns in the United States, a George Thompson Channel video produced by Patreon began circulating on YouTube. The video depicted the Chinese government's use of advanced sensing technologies combined with artificial intelligence capabilities to manage the Covid-19 pandemic, including facial recognition, social media, buying patterns, internet connected thermometers, cameras, and a range of other surveillance equipment (Thompson, 2020).

China's success with technologically managed contact tracing (Llupia et al., 2020) seemed to offer a way back to more normal times. If the use of advanced technologies and Artificial Intelligence (AI) can enable communities to balance public health and economic health, is it worth it to employ this approach? (Mihalcik, 2020). Based on the number of Corona virus tracking apps flooding the market, it appears that for many businesses, governments, and researchers around the world the answer is yes (O'Neill et al., 2020).

While it was exciting to see that technology can be used to manage a public health crisis, the approach being implemented in China and other authoritarian nation states raises significant ethical questions for those of us in western cultures (Criddle & Kelion, 2020; Segun, 2020).

Contact Tracing Takes Off

Because of the speed of contagion, the seeming number of asymptomatic (but contagious) individuals, and the scale of the Covid-19 pandemic, contact tracing efforts are being implemented globally and across the United States (Wigglesworth, 2020; Llupia et al., 2020). Cities and states continue to hire contact tracers (Cerullo, 2020) in the hopes of creating a mechanism that will identify undiagnosed cases, in order to slow or stop the chain of transmission (Ash et al., 2018).

The challenges of a system that collects contact data through interviews and self-reporting, which is collected in disparate systems (Llupia et al., 2020; Desclaux et al., 2016) creates a huge number of challenges, such as memory lapses in self-reporting, transcription errors, duplicative entries, and a lack of enterprise level systems integration (Ash et al., 2018; Schafer et al., 2016; Llupia et al., 2020). The traditional process of contact tracing does not scale well in a global pandemic because the combinatorial complexity is too great.

Enter Big Tech

The tech community is seeking to solve this combinatorial complexity problem by developing mobile tracking applications and partnering that sensing approach with Artificial Intelligence. The use of mobile tracking for contact tracing is a rapidly emerging field, but it shows promise as a contact tracing methodology. Google and Apple have already integrated contact tracing into the operating systems of their smartphones (Pichai, 2020; Google.com, 2020). This is cause for serious concern because it raises ethical questions concerning long term sacrifice of personal data and the monetization of fear (Gabriels, 2016). For example, Sax (2020) found that for profit health applications have been designed as optimization systems to optimize <u>not</u> the *health of the user* but *user engagement*, with desire for heath as a tool for manipulation.

We set out to determine if there was a way to leverage the benefits of "MIST technologies"—mobile, imaging, sensing, and tracking capabilities in smartphones (Nebeker et al, 2015), while addressing these ethical concerns throughout the study, beginning with the construction of an ethical experiment and ethical capability design. Although many researchers are identifying the ethical issues associated with the use of MIST technologies, there does not

exist a deontological framework for the design of ethical AI capabilities that leverages the data they collect.

In this paper, we discuss the development of an experiment that uses artificial intelligence in conjunction with MIST technologies and a smartphone based application to collect data for the purposes of tracing Covid-19 virus hotspots in the community of Gettysburg, PA. We begin with a discussion of the ethical challenges inherent in the use of mobile tracking and contact tracing. We then discuss available data collection approaches, the types of Covid-19 related data that can be gleaned from smartphone – based, MIST technologies, and the unique data privacy and security challenges that result. We conclude with a consequential analysis of the experiment to inform capability design decisions, and share potential rules for a deontological framework for ethical AI design.

Three Dimensions for the Ethical Use Of MIST Technologies for Pandemic Management

Contact tracking applications reside at the nexus of mobile tracking and contact tracing. each of which raises ethical questions because they intrude into private behaviors such as intimate personal contact and human movement. Thus, we considered the ethics literature for each of these activities. Kass and Gielen (1998) offer three principles of bioethics in the context of contact tracing that can be extended to mobile tracking: beneficence, justice, and the respect for autonomy.

Beneficence requires people to do no harm. At a minimum, there must be a balance between the harms and benefits that might result from a given public policy or capability, in order to determine whether or not the tradeoff between individual and community is largely beneficial (Kass & Gielen, 1998).

Justice requires that people be treated equitably, without undue restrictions being placed on one specific group of the population unless there is a suitable explanation. For example only asking only gay men to participate in HIV contact tracing, ignores other demographic groups who may benefit from inclusion (Kass & Gielen, 1998). Conversely, using GPS tracking to examine the movements of only low-income youth in urban environments may stigmatize the demographic groups being observed (Roy, 2017).

The *respect for autonomy* requires that people be regarded as self-led individuals with the right to make their own decisions without the interference of others. Issues such as privacy and personal freedom fall into this category (Kass & Gielen, 1998; Waxman et al., 2011; Dixon-

Mueller, 2007). With respect to contact tracing, the invasion of privacy is a common theme in the literature (Ketels & Vander Beken, 2012; Kass & Gielen, 1998; Desclaux et al., 2017). Privacy is also the number on theme in mobile tracking because of the surveillance and control issues it raises (Roy et al., 2017; Shilton & Greene, 2017; Taylor, 2016; Apte et al., 2019; Cooper et al., 2009; de Montjoye et al., 2018; Gelman et al., 2018; Harari et al., 2016; Nebeker et al., 2015).

Designing a Covid-19 Virus Tracing Experiment

We began by proposing a mixed methods study to the Internal Review Board (IRB) at the York College of Pennsylvania to develop a mobile application using a variety of sensing functions from mobile devices. We submitted a draft of our study proposal in April 2020 in order to understand what documentation would be needed to evaluate the efficacy of our experiment. We submitted the full proposal in June, but the scope of the proposal was so large, that we suggested breaking it into two parts for IRB review.

We received approval for part one on June 14, 2020. Part one of the study consisted of interviews with individuals from local organizations and small businesses to learn about their decision making challenges during the pandemic. These interviews were semi-structured, consisting of questions regarding what kinds of data study participants had to support making risk trade-offs in the pandemic environment, what kinds of information they thought would be useful, and what kinds of information were not useful. The results from these interviews were used to shape design requirements for the C-Gettys mobile application and the associated information dashboards.

After answer several rounds of questions, and participating in a second review by the Wellspan Health IRB, we obtained approval for part two of our study on September 10, 2020. Part two includes the use of the C-Gettys mobile application to develop case-based risk maps identifying Covid-19 virus hotspots in the community of Gettysburg, Pennsylvania. The mobile application will use MIST capabilities to collect data related to symptoms and contacts in order to understand how the virus propagates through the community. The development of these capabilities involves collecting data related to mobility patterns, health data, Covid-19 risk factors, behaviors, and social contacts, requiring us to pay particular attention to data anonymity, privacy, and security in the design of the experiment and the C-Gettys application.

Data Collection Capability

Traditional contract tracing

Traditional methods of contact tracing for epidemic management involves collecting contact data through interviews, a process that is impacted by the fear of stigma (Desclaux et al., 2016; Dixon-Mueller, 2007; Catania & Osmond, 2008) and memory lapses (Ash et al., 2018). But fear of stigma is just one challenge created by traditional methods of contact tracing.

In a study of the 2014 – 2016 West African Ebola epidemic, Schafer et al. (2016) found that traditional contact tracing uses a "stone in the pond" method where contacts are categorized as family, close friends, or casual acquaintances, leaving out physical contact that occurs in outside venues (Valway et al., 1998). Furthermore, if there are no infections in one of the "pond ripples" closer to the index case, testing ceases, creating the potential for contacts that fall outside that ring to remain in the dark about their exposure, and eliminating contact in public settings entirely (Braganza-Menezes et al., 2018; Valway et al., 1998). But two studies of Mycobacterium Tuberculosis, which spreads through respiratory droplets, demonstrate the need for virus tracing in public settings such as educational, recreational, occupational, and transportation environments (Braganza-Menezes et al., 2018; Valway et al., 1998).

Covid-19, which is also spread through respiratory droplets, demands an approach that takes into account public settings and super-spreader events (Woodward, 2020). Currently there is a lack of evidence regarding the appropriate methods for contact tracing in public settings (Braganza-Menezes et al., 2018), but studies by Tatem et al. (2014) and Farrahi et al., (2014) experiment with the use of mobile phones as a methodology to track disease contagion through human mobility patterns and social contacts at a growing scale.

The Capacity of Smartphone Sensing

Smartphones offer a technical approach that can address the challenges created by traditional contact tracing methods. First, smartphone sensing is an unobtrusive, observational method (Harari et al, 2016). The use of a technology based, real-time observational method reduces the problem of bias, self-awareness, memory lapses, fear of stigma, and the tiered approach that neglects to include casual contacts and public settings. This approach also overcomes the exponential growth rate of disease transmission, because the technology automatically adapts (Farrahi et al. 2014).

Farrahi et al. (2014) used mobile phone communication and interaction data to approximate social contacts, comparing their findings against self-reported social networks, finding that the overlap in contact tracing was significant enough to suggest that this approach would limit the chain of transmission in a growing epidemic (Farrahi et al., 2014). Tatem et al. (2014) used mobile phone network data to track the *intra*-community and *inter*-community mobility patterns to develop case-based risk maps identifying the transmission of malaria within and between communities in Namibia. Although there is scant literature investigating the use of mobile devices to track epidemics, the video of China's technologically driven approach offers anecdotal evidence that mobile tracking can be a useful tool (Thompson, 2020).

Symptom Assessment Capabilities

In addition to the use of GPS to determine location and mobility patterns, and Bluetooth to capture contacts with other devices as a proxy for human contact (Farrahi et al., 2014), a range of MIST capabilities are available to evaluate symptoms. The microphone, camera, and the touch screen can all be used to sense various types of health data.

Parkinson's research has been leveraging these capabilities to discern "invisible" tremors via the camera, changes in speech via the microphone, and motor skills via the touch screen (Arora et al., 2015; Yu et al., 2018; Wiliams et al., 2018). Majumder et al. (2019) conducted a broad review of emerging smartphone sensor-based healthcare technologies, including temperature sensing through the touchscreen. Yu et al. (2018) collected data by eavesdropping on the use of a computer keyboard with smartphone microphones in order to sense a study participant's computer operations (Yu et al., 2018).

Based on this existing research, the use of MIST technologies could be used to assess Covid-19 symptoms such as cough, temperature, and community contact. However, one person's unobtrusive, observational method can quickly become a nation state's surveillance capability.

Designing the C-Gettys Mobile Application

Because ethical AI is an emerging field and the management of public health includes many stakeholders, we employed a mixed methods approach to develop the C-Gettys mobile application design requirements. We had several goals for this experiment: 1) to build case-based risk maps indicating Covid-19 virus hotspots, 2) to provide relevant data for risk trade-offs by combining information about virus propagation and hotspots with business specific operational

data, and 3) to ensure the respect, privacy and anonymity of all study participants. Figure 1 shows the final design of the study.

In the absence of a deontological framework for ethical AI, we used a consequential approach to consider the ethical questions raised by the use of mobile devices to track participant movement, social contacts, and health data. Our analysis considered the potential consequences of our research and what is most likely to benefit both the individual and the common good. We then identified ways to enable study participants to make the final decision regarding how fully they would participate. Our consequential analysis is captured in Table 1.

Building Case-Based Risk Maps

To build the case based risk maps, we need to be able to combine known or suspected case data with mobility patterns and contacts. Based on this requirement, we decided to employ multiple sensor capabilities within the mobile device. We proposed to build in the ability to use the GPS and Bluetooth to collect mobility patterns and contact data. We have also proposed to include the capability to use the camera to detect changes in the pallor of a participants skin, the microphone to detect changes in voice, such as a scratchy voice or cough, and the touch screen for temperature assessment.

In addition to the use of device-based sensing of data, we also include a survey to be completed during the setup of the application, related to personal habits and Covid-19 risk factors. There is also the option for study participants to provide access to the health data collected by other applications in the device. In addition to the initial set up survey, there is also a daily survey that collects self-reported symptom data.

The collection of health data creates the potential for Personal Health Information (PHI), so it was immediately necessary to design a means for anonymizing and aggregating the data to ensure that PHI was not being collected. In addition to ensuring anonymity, it was also important to give people the freedom to choose through informed consent. Not only was it important to have informed consent to participate in the experiment, but *it was also important for study participants to make an informed decision to opt in to the use of these technologies* rather than having to opt-out.
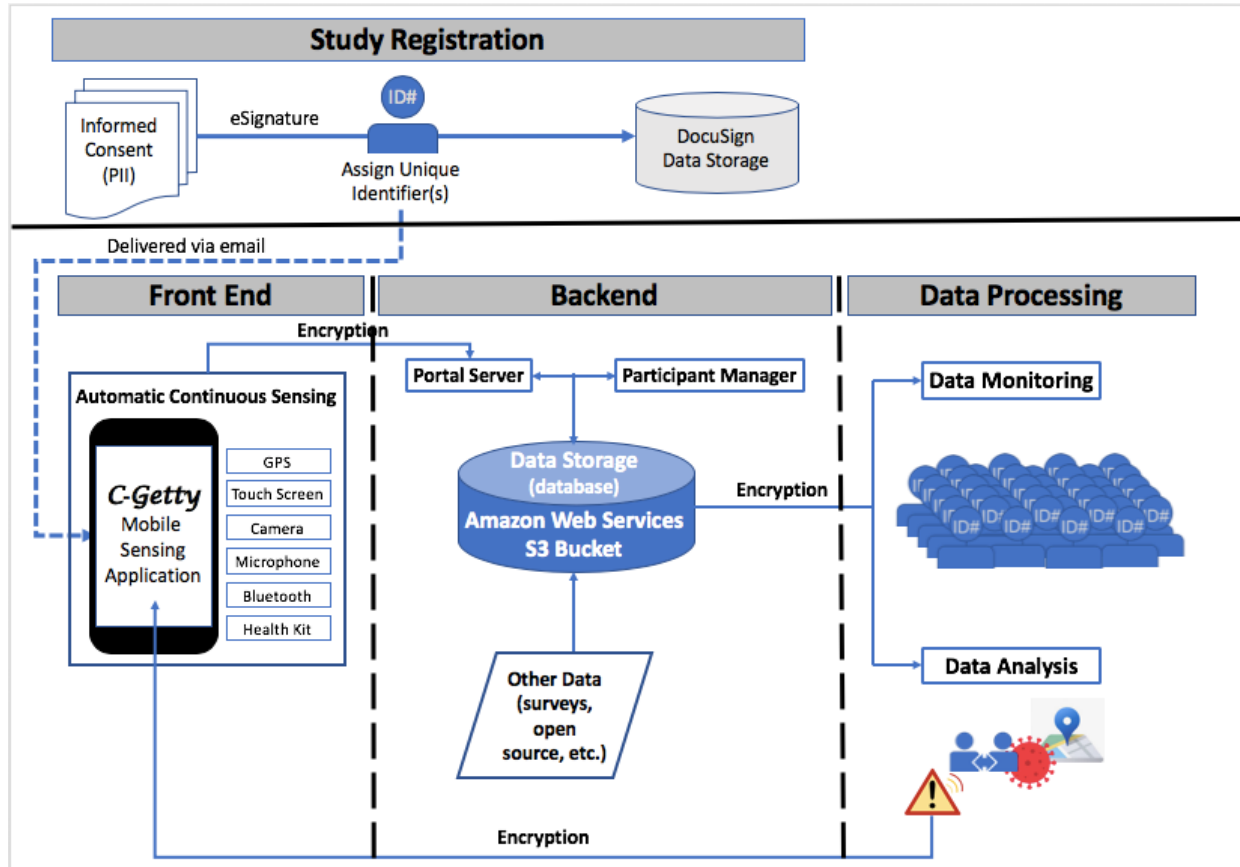
Figure 1. Phase 2 Study Design and Data Security Approach

Information Dashboards for Risk Trade-offs

Cooper et al. (2009) offer two principles for ethics in modelling (building AI capabilities): *responsibility*, and *sharing and cooperation*. Responsibility requires that the perspectives of all potential stakeholders be taken into account, not just the perspective of the paying client, while sharing and cooperation requires the open distribution of results. (Cooper et al., 2009).

The use of mobile technology data collection will result in huge datasets. In order to provide relevant, actionable information for operational and economic decision making, this data has to be tailored to a specific context, which changes depending on the end user. We addressed this challenge by incorporating community stakeholders into the AI design process through our phase one interviews.

Participants in phase one of the study included representatives from healthcare organizations, educational organizations, religious institutions, and not for profits. Each organization faced unique challenges in the spring economic shut down, and each organization required a different set of operational data to weigh against the Covid-19 virus data. Furthermore, it became apparent that merely tracking case numbers by county does not provide an accurate picture of transmission.

According to one interviewee, *"We discovered 75% of people riding the bus to the New Oxford, PA turkey processing plant, located in Adams county, were infected with Covid-19, but the case numbers were being counted in York County. The cost of living in Adams county is too high, so the people who work at the turkey processing facility live in York county."* Another organization confessed that despite collecting self-reported symptom data, they did not have a way to use the data for effective risk trade-offs, while a third organization revealed that, *"we went on Facebook to share information about available PPE and to learn what other clinics were doing to protect staff and patients, and even when most clinics had closed, we continued to handle patient emergencies."*

As we discussed the operational challenges with an absence of data, misleading data, and available but unused data, our team kept returning to a single question: *where is your red line?* What information do you need in order to make the decision to close or to remain open? Our team realized that few people can answer this question, but that the answer is critical for designing useful outputs from an AI capability. In order to address the need for customization based on context, we added a design requirement for widgets to enable customized data mashups.

Respect, Privacy, & Anonymity

Built in Anonymity

Upon signing the informed consent for phase 2, study participants will receive a unique ID and temporary password with directions to download and install the C-Gettys mobile application. Data from the informed consent will be retained in a separate database stored on DocuSign servers. The only link between a study participant's device and personal data collected in the informed consent is the person themself.

Several additional aspects of the set up procedure are designed to safeguard the rights and privacy of study participants once they have been assigned a unique ID for anonymity. All

subject records and data will be stripped of individual identifiers following data collection, and all data will be coded with the unique study ID rather than personal identifiers.

In order to protect the confidentiality of study participants, we applied the <u>HIPAA Privacy Rule standard for de-identification of protected health information</u>. De-identified health information created following these methods is no longer protected by the Privacy Rule because it does not fall within the definition of PHI. Tracking data is also anonymized by separating Personal Identification Information from mobility data.

Respect, Privacy & Securing Participant Data

We are using encrypted storage AES256, which is the strongest exportable encryption in the industry. In order to ensure respect of participants, we will retain their data for just 45-90 days. We believe this is the minimal amount of time necessary to conduct virus tracing in order to understand virus exposure and propagation. We will offer study participants the opportunity to choose to retain their data for up to 1 year in order to compare potential past exposure to future positive antibody tests.

Taylor (2016) identifies "a growing tendency toward data maximization." It is in the researcher's nature to wonder what else can be learned from a dataset, but AI applied to big datasets has the potential to expose information that was not identified in an informed consent. Further, in the absence of public policy, powerful actors have a tendency to justify surveillance under the heading of public safety. Based on the potential for abuse, we made a clear design decision to limit how long we keep participant data.

Finally, in addition to obtaining informed consent from participants at the beginning of the study, we have built informed consent into the application itself. During set up participants will be led through a series of settings where they can enable MIST functionality only after making an informed choice to do so. The design includes clear choices for each setting and an explanation for why access to a particular functionality is requested.

Table 1. Ethical Considerations in Gettysburg Covid-19 Virus Tracing Study & C-Getty Mobile Application Design				
Design Decision	**Description**	**Ethical Considerations**	**Implications**	**Design features to Address Implications**
Data Collection				
What PII will we collect and how do	Study participants must sign an	Respect for autonomy (privacy)	• PII could get connected to location data and	• Collect only names, birthdates, & signatures

we disconnect PII from other data to be collected?	Informed Consent which includes PII	Justice (Vulnerable populations) Beneficence (do no harm) (Kass et al., 1998)	social connections that participant may not want known • Protect children from exploitation • Study could support decision making to support public health during Covid-19 Pandemic	• Parents must sign informed consent for their children to participate in the study • Assign a unique ID to each study participant • Unique ID is sent via the DocuSign system with participants' signed copy of Informed Consent
How will we use GPS sensors?	C-Getty mobile application will collect location data	Beneficence • Potential for harm	• Criminals could use to select victims • Private interactions could become known (Taylor, 2016) • Potential for benefit by identifying virus hotspots & exposure	• Participants control access to location services and make an informed choice to enable GPS tracking • Participants alerted to virus exposure and encouraged to seek testing • Virus hotspots identified so organizations can apply remediation
How will we collect health indices?	C-Getty mobile application will be designed to: • Use camera or touchscreen to measure temperature • Use microphone to sense cough or congestion • Integrate data from health kit applications • Integrate data from survey questions	• Respect for autonomy • Privacy • Right not to know (Waxman et al., 2011) • Beneficence • Potential for harm through compromise of private health data • Potential to identify early symptoms of Covid-19	• Embarrassment • Stigma • Loss of health insurance • Stress/Anxiety (Waxman et al., 2011) • Early identification of Covid-19 symptoms • Opportunity to seek testing • Opportunity to limit spread of disease through early identification	• Anonymization through unique ID • Apply HIPPA Standards for collection • Participants control access to microphone and make an informed choice • Participants control access to camera and make an informed choice • Participants control access to health kit applications and make an informed choice • Participants decide whether or not to allow temperature sensing • Participants may choose not to answer a survey question
How will we collect behavioral data?	Using survey questions, the C-Getty mobile application will collect information using related to behaviors that increase vulnerability to Covid-19 such as	Respect for autonomy (personal choice)	Private interactions could become known creating potential for: • Embarrassment • Stigma • Stress/Anxiety (Timan et al., 2015) Opportunity to identify specific	• Anonymization through unique ID • Participants may choose not to answer a survey question

	wearing of masks, smoking, and other lifestyle choices.		behaviors that spread of disease Potential to identify vulnerable disease candidates	

How will we collect social network and contact data? (Contact tracing)	C-Getty mobile application will collect location data and connect location data amongst users to derive social contacts	• Privacy
		• Justice
		• Beneficence
		  • Do no harm
		  • Public health
			• Stress
			• Anxiety
			• Stigma (Desclaux, 2017, p. 42)
			• Potential to indicate contact with virus hotspots
				• Anonymization through unique ID
				• Participants control access to location services and make an informed choice to enable GPS tracking

Data Storage				
How will we protect PII?	PII is collected through informed consent	• Privacy • Vulnerable populations • Beneficence	• Potential for discomfort from choosing to participate in study • Protect children from exploitation • Potential to support decision making to support personal and public health during Covid-19 Pandemic	• Anonymization through unique ID • Store informed consents in the DocuSign document repository which is managed separately from raw data
How will we protect PHI?	Health data becomes PHI when combined with PII	Privacy		• Using the HIPPA standards, we anonymize data so that **there is no collection of PHI** • All raw data is aggregated and stored in AWS S3 Bucket (managed by Amazon) distinct and separate from PII contained in the informed consent documents (managed by DocuSign)
How will we protect data in motion?	C-Getty mobile application sends data to repository	Data is most vulnerable while it is in motion (Klonoff, 2015)	Potential data disclosure	Data will be encrypted using the strongest exportable encryption in the industry (AES-256 encryption algorithm)
How will we protect data at rest?	Once data has been collected through C-Getty mobile application it will be sent to a data repository in	• Privacy • Beneficence	Potential for data to be compromised if stored incorrectly, which could, in turn, hurt study participants	• Anonymization through unique ID • Anonymization through aggregation with other data • All raw data is aggregated and stored in

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	order to be analyzed			AWS S3 Bucket (managed by Amazon) • Data encrypted using AES-256 encryption algorithm
How long will data be retained?	Data must be stored for a period of time in order to understand virus exposure	Beneficence	Potential for abuse because of function creep "what else could we do with this data?" (Taylor, 2016, p. 332) Potential to identify exposure to virus hotspots	• Data will be stored for only 45-90 days • Participants may choose to retain data for up to 1-year in order to compare potential past exposure with future positive antibody test
Data Analysis				
How will models be developed?	Mathematical models (algorithms) will be developed to analyze the data and provide alerts to individuals and organizations regarding virus hotspots within the community including: • Contact tracing • Mobility patterns • Disease factors • Symptom assessment	Justice • Responsibility principle: take into account point of view for all stakeholders, not just client • Sharing & Cooperation principle: open distribution of research results (Cooper et al., 2009) • Respect for autonomy • Beneficence • Justice (Kass et al., 1998)	• Potential for surveillance-based control if individual privacy and autonomy is not considered (Cooper et al., 2009) • Potential for technical translation that ignores contextual, ethical, and political factors (Taylor, 2016)	• Taking the study through the IRB for ethical evaluation • Limitation of function creep by maintaining data for only a short time • Semi-structured interviews (elicitations) to get feedback from study participants (multiple stakholders)
How will we conduct contact tracing?	The C-Getty mobile application will identify & alert those at risk of contracting Covid-19 due to contact with virus hotspots (Ash et al., 2018)	• Respect for autonomy • Beneficence (Kass et al., 1998)	• Traditional contact tracing is done through interviews which can violate privacy (Rivas et al., 2002)	• Data is observed unobtrusively through the use of the C-Getty mobile application • Data is anonymized • Participants make an informed choice to enable GPS • Participants receive alerts when they are at risk
How will we map virus hotspots?	The C-Getty mobile application will map mobility patterns to identify virus hotspots and develop "case based risk maps" (Tatem et al.,	Beneficence	• Potential for surveillance-based control if individual privacy and autonomy is not considered (Cooper et al., 2009)	• Participants make an informed choice to enable GPS • Participants make an informed choice to enable access to health data

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	2014) by aggregating mobility patterns with symptoms and case data			• Participants receive alerts when they are at risk
How will we identify disease factors?	The C-Getty mobile application will aggregate data collected via survey questions with sensed health data, health kit mobile applications, and open source data to identify specific factors related to infection	Beneficence	• Potential discomfort with survey questions • Potential to identify risk factors & unknown symptoms of Covid-19	• Participants choose to answer survey questions • Participants make an informed choice to enable access to health data • Participants make an informed choice to enable access to microphone • Participants make an informed choice to enable access to camera • Participants make an informed choice to enable temperature sensing
How will we assess symptoms?	The C-Getty mobile application will aggregate data collected via survey questions with sensed health data, health kit mobile applications, and open source data to evaluate participants for Covid-19 symptoms	• Privacy • Beneficence	• Potential discomfort with survey questions • Potential to identify Covid-19 infection in early stages and enable participants to seek testing	• Participants choose to answer survey questions • Participants make an informed choice to enable access to health data • Participants make an informed choice to enable access to microphone • Participants make an informed choice to enable access to camera • Participants make an informed choice to enable temperature sensing • Participants receive alerts when they are at risk
User Experience				
What platform will we use for mobile application?	The C-Getty mobile application will be accessible through app stores in order to be installed on a mobile device	Justice	The potential exists to exclude members of the community who would like to participate in the study based on the type of mobile device they own	The C-Getty mobile application will run on both iOS and Android devices in order to enable maximum access to this capability within the community

How will we establish a unique ID?	The informed consent process will provide a unique ID to each study participant	Privacy	Potential for discomfort related to sharing information through the C-Getty mobile application	• Upon receipt of the signed consent form using the DocuSign system. DocuSign is used by financial & legal organizations to manage private documents. • The unique ID will be used to set up the C-Getty mobile application
How will we ensure it is easy for participants to make informed choices about mobile application sensing functions?	During set up the C-Getty mobile application will walk users through a series of questions to enable each sensing function to be used for data collection.	Respect for autonomy	• Potential exists to violate participant privacy if the default settings are "opt-in" • Potential exists for participants to become frustrated because the application appears not to work if the default settings are to "opt-out" and there is no clear method to enable sensing function	• Participants make an informed choice to enable GPS • Participants make an informed choice to enable access to health data • Participants make an informed choice to enable access to microphone • Participants make an informed choice to enable access to camera • Participants make an informed choice to enable temperature sensing
How will we collect behavioral data?	During set up the C-Getty mobile application will ask a series of questions regarding behaviors	Privacy	Potential for discomfort with some of the survey questions	• Participants choose to answer survey questions
How will we make sure that participants are aware of alert notifications?	The C-Getty mobile application will alert users when they have come into contact with virus hotspots or are exhibiting symptoms of Covid-19	• Beneficence • Justice	Potential for physically impaired users to miss alerts	The C-Getty mobile application will provide visual, auditory, and vibration signals to capture user attention
Who will have access to case-based risk maps?	The C-Getty mobile application will provide maps indicating virus hotspots	Beneficence	• Potential for individuals to avoid certain locations could result in impact to local business • Potential for local businesses to see areas of aggregating virus	Both individuals and local organizations will have access to the risk maps in order to enable data driven decision making.

			to enable remediation • Potential for organizations to remain open • Potential to manage the tradeoffs between public health & the economy	

Research Contributions

Emerging Rules for a Deontological Framework for Ethical AI

George Thompson's 2020 video showing the Chinese government's use of surveillance technology to manage the Covid-19 pandemic both intrigued and alarmed us. Although it showcased the many benefits of this approach to public health, as Americans, we were alarmed at the potential for abuse. Segun (2020) explores how our culture influences our conceptions of ethics, and by extension our perceptions of ethical AI, but throughout the design of this experiment and the development of the associated smartphone application, we were hyperaware of the ethical issues our study and similar technologies create within our own, western culture. Based on our consequential analysis, three rules for the design of ethical AI development emerged. Although we expect to identify additional rules for ethical AI development as we continue with the launch of phase 2, these three rules are an important discovery from our work thus far.

1) End-users should be required to make an informed decision to *opt in* to the use of any sensing capabilities. Building a capability that requires end users to opt out, but does not inform them of the surveillance taking place exploits user trust.

2) Data should be used only for the sole purpose for which it is collected. Research culture is to exploit a dataset for as many insights as possible, but AI and enormous datasets have created the opportunity for findings that were not included when informed consent was obtained, and again, this violates the end user's trust.

3) Data should be retained for the shortest amount of time needed to obtain the identified, sought after insights. Retaining data beyond the necessary minimum facilitates the misuse of data for purposes beyond its original intent.

Conclusion

This paper is limited to only phase one of the proposed study protocol. While mobile applications such as the proposed C-Gettys application have the potential to assist in the management of an enormous public health crisis, there is need for further study. Additionally, as our phase one interviews suggest, the current methods for assessing Covid-19 virus hotspots are misleading because cases are counted based on where people seek testing and treatment. Despite these limitations, the emerging deontological framework for ethical AI shows promise. Not only will it provide researchers with valuable ethical guidance in the development of experimental AI, but it can also inform the development of public policy related to the regulation of privacy, Big Data, and artificial intelligence.

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THE ROLES OF TECHNOLOGY, TRANSPARENCY AND TRUST IN CRISES: IMPLICATIONS FOR COVID-19 RESEARCH

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Abstract: With the number and severity of crises increasing and propagating on a global level, a comprehensive framework for research in the key areas of crises is needed. This paper presents Crisis Compliance, a theoretically based framework for evaluating crisis management and the appropriate use of technology across seven key characteristics of crises. Directions for research in each of these areas emerge from the analysis. This paper then extends the Crisis Compliance framework to address the issues of Transparency and Trust and develops research directions for them. Examples of recent crises, including COVID-19, illustrate the analysis

Keywords: COVID-19, Crisis Compliance, Transparency, Trust, Crisis Management.

The Need for a Crisis Research Framework

Crises and their impacts on individuals, organizations and governments have grown in number and intensity. Crisis management has become a major issue in organizational research. In their groundbreaking work on Organizational Crises, Pearson and Clair (1998, 60) defined a crisis as:

> An organizational crisis is a low probability, high-impact event that threatens the viability of the organization and is characterized by ambiguity of cause, effect, and means of resolution, as well as by a belief that decision must be made quickly.

In their recent survey of Crisis Management research, Bundy et al. (2017) categorized the crisis literature as focusing on five key areas of concern: 1) crisis antecedents, 2) managing an ongoing crisis, 3) crisis outcomes, and whether the study was focused on 4) the internal dynamics of a crisis or on 5) managing external stakeholders.

This paper presents a theoretically based framework—Crisis Compliance--for educating individuals, crisis managers, organizations, and government leaders about how to manage the crisis and to approach the crisis with technology. Crisis compliance was developed by Lally (2003, 2008) and has been applied to crises such as Y2K (Lally, 2003), 9/11 (Lally 2004), Hurricane Katrina (Lally, 2006), and Fukushima (Lally and Garbushian, 2016).

Crisis Compliance seeks to establish guidelines for the appropriate use of technology and available methodologies, before, during and after crises. In the wake of the COVID-19 pandemic, a wave of lawsuits is emerging. If Crisis Compliance guidelines are followed, managers and government leaders should be able to limit their liability for damages. Citizens, likewise, should be informed of potential risks and the ability of their leaders to cope with disasters.

Crisis Compliance was developed from the two major organizational crisis theories, Perrow's Normal Accident Theory and the Theory of High Reliability Organizations, which are presented here in summary form. Crisis Compliance draws on these theories and provides a theoretically based framework for evaluating the role and appropriate use of technology across seven key aspects of a crisis: Crises in Diverse Areas, Unprecedented Crises, Beyond Design Risk Crises, Crises with Deterministic versus Stochastic Risks, Contained versus Cascading Crises, Crises with Malicious Origins, and Post-

Crisis Renewal. Research directions for these seven key categories of crises will result from the analysis. Examples of crises will illustrate these categories of crises management with an emphasis on COVID-19.

This paper then extends the Crisis Compliance model to encompass two additional aspects of crisis management that address the issues involved with communicating with stakeholders: Transparency and Trust. Transparency is defined in the organizational literature as: Disclosure of all relevant information, Clarity in communication, and Accuracy of the Information (Schnackenberg and Tomlinson, 2016). Trust is defined as the Ability of the trustee in terms of knowledge and influence in the relevant domain, a Benevolent attitude toward the trustor by the trustee, and Integrity in terms of shared ethical principles between the parties (Mayer, Davis, and Schoorman, 1995). This paper will argue that the perspectives of *Transparency and Trust can help identify emerging crises, mitigate their damages, and enable the resolution of crisis, and that individuals facing a crisis are entitled to Transparent information from Trusted Sources before, during and after a crisis.* Research directions regarding Transparency and Trust emerge from the analysis. Examples from the COVID-19 pandemic and other major crises are presented to illustrate examples of good and bad Transparency and Trust in crises.

Theoretical Foundations of Crisis Management

Normal Accident Theory (NAT)

The first theoretical perspective, Charles Perrow's Normal Accident Theory (NAT) argues that characteristics of a system's design make it possible for small "incidents" – minor failures which

have little consequence if corrected and contained, will propagate in system wide "accidents" with serious or disastrous consequences.

Perrow argued that accident prone systems are complex, "In complex systems, where not even the tip of the iceberg is visible, the communication must be exact, the dial correct, the switch position obvious, the reading direct and on-line," (Perrow 1984, 84). Perrow argued that without information transparency about the inner workings of the system, the system can become "unknowable." Perrow also argued that complex systems are also subject to "common mode failures" where one incident can disable multiple system components, including backups designed to come online when primary components fail.

A second characteristic of systems that allow for the propagation of incidents is tight coupling. Tightly coupled systems have no slack time or buffering of resources and interactions happen immediately. Automation frequently produces tight coupling to increase productivity at the cost of lag time for human intervention. Without human intervention or automated shutdowns, incidents can propagate into accidents in real time.

A lack of control is the final characteristic of disaster-prone systems. Perrow (1984, 1999, 2008) argued that systems must be designed with failures anticipated and controlled for to prevent propagation.

Technology based systems clearly fit the definition of "accident prone"—they are complex, tightly coupled, and frequently lack the controls necessary to prevent incidents from becoming accidents. Interactions frequently occur within the hardware and software without time for human intervention. The recent Boeing 737 tragedy in which

human operator were unable to correct malfunctioning navigation software before the plane crashed is a striking example (Glanz, Lai, Wu, 2019, 1)). Technology is often embedded in systems, and organizations that are already complex, adding another "black box" dimension of complexity and tight coupling. The COVID-19 pandemic is another example of how a small amount of a destructive biological substance can propagate quickly to a highly destructive global pandemic. Future research must focus on how the original virus escaped and spread widely, and the use of technologies and methodologies to prevent the release and spread of other toxic substances in the future.

High Reliability Organization Theory (HRO)

A second theoretical perspective, High Reliability Organization Theory (HRO) examines organizations with complex, tightly coupled, technologically based systems that are well controlled enough to prevent disaster.

HRO theorists argue that if organizational leaders put a high value on safety and reliability, personnel are well trained within a "high reliability culture" and the organization learns from failures, complex tightly coupled technologies can be used effectively (LaPorte 1991), (Grabowski and Roberts 1997). HRO research tends to focus on military operations and other environments which emphasize high levels of control over employees and other subordinates' behavior both under normal circumstances as well as in crisis situations.

Implementing similar policies in other types of environments is likely to be more problematic. (Lally 2004) argued that technological

systems are frequently used in large diverse environments with heterogeneous cultures in which communicating safety procedures, making the implementation a control culture much more difficult. Examples include 9/11 (Lally 2003), (DePalma 2011) and Hurricane Katrina (Brinkley 2006), (Lally 2008). Lally also argued that crises may span international borders and jurisdictions making legal forms of control difficult or impossible to enforce. Lally (2008) developed the concept of Crisis Compliance to address these issues by focusing on the development of best practices for crises in diverse real-world environments, rather than the more controlled environments used in HRO theory.

The COVID-19 crisis raises the possibility that a lack of safety and reliability protocols of the viruses handling may have allowed the virus to propagate on a global scale. Enforcing safety standards on a global basis across a range of economic and political environments has been a challenge for government leaders.

Crisis Compliance (CC)—Predicting, Preventing, and Prevailing Over Crises

The study draws up the perspective provided by research on IT and Crises Compliance, developed by Lally (2008, 2008a, 2009), and Lally and Garbushian (2016).

Lally and Garbushian, (2016, 37) defined Crisis Compliance as:

Crisis Compliance: 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, and 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.

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…. 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.

Finally, as a result of post-crisis learning, sustainable solutions must be developed to prevent the re-occurrence of similar problems in the future.

Crisis Compliance—Categorizing Crises on their Key Characteristics

Crisis compliance research creates a taxonomy of crises based on key common characteristics. These characterizations can aid decision makers in understanding the major impacts of the crisis and its impacts. Best practices from similar types of past crises can be used in dealing with emerging ones. Crises with unique emerging characteristics can point to areas needed for further research. This section presents seven characteristics of crises that have emerged from Crisis Compliance research.

Crises in Diverse Areas

NAT and HRO were developed to prevent innocent mistakes from propagating into system-wide disasters in organizational settings. However, these theories must be extended to more heterogeneous and

less controllable environments, such as cities and nations. Lally (2004a) argued that cities and nations are more complex and involve an array of subcultures, each with its own values and behavioral norms. The shared mental models advocated by High Reliability Theory are more difficult to convey and enforce. A heterogeneous environment, therefore, provides additional challenges in a crisis. COVID-19 has spread globally across the complete spectrum of social, political, cultural and economic environments, increasing the challenges of combatting the virus.

Research Direction #1: Investigating the challenges presented by crises in heterogeneous environments and their solutions that are currently examples of best practice.

Implications for COVID-19: Study how different cities and countries responded to the virus. Study the impact of the virus on different demographic groups. Study the implementation of social distancing and a safety culture across different social groups.

Unprecedented Crises

When a crisis occurs, crisis managers draw on both the domain knowledge and crisis management technologies and methodologies used in past similar crises. When crises were unprecedented, such as Y2K and 9/11, crisis managers had a lack of past best practices to draw on. A pandemic on the scale of COVID-19 is unprecedented in the last 100 years, therefore, leaders and researcher must either draw on old examples or draw insights from related fields. Experts must first expand the body of domain knowledge to fully comprehend how the disaster happened and how to approach its solution. A major challenge is to put the emerging research through the rigorous review process of

journals, and then to convey the results in understandable language to stakeholders in a timely manner (Tingely, 2020).

Research Direction #2: How do we expand the domain knowledge of the subject of the disaster to fully understand how it happened and how we can combat it? For unprecedent crises, what insights can be gained from related fields?

Implications for COVID-19: There are no identical crisis on the scale of COVID-19. COVID virus is "novel," it never existed before, even experts are not sure and must learn as crisis evolves.

"Beyond Design Basis" Risks

Two additional concepts are essential for understanding the riskiness of a technology or methodology--"Design Basis" and "Beyond Design Basis". Design Basis Risks are inherent in the design and intended purpose of a given technology (flat tires in cars). These risks are expected to be taken into account during design and manufacturing. Designers address these anticipated risks with methodologies to prevent their occurrence and minimize their impact. Beyond Design Basis risks are "out of the box" risks beyond those that can reasonably be expected to occur (using a car as a murder weapon). Lally and Garbushian, (2016) argue

> Due to their unexpected nature, they have no clear precedents from which best practices can be drawn and no immediate technological or methodological solutions. Disaster response becomes a much more challenging problem. Y2K and 9/11 can be clearly characterized as "beyond design basis" disasters at the time of their occurrence, because they had no clear precedent at the time they occurred. However, because of these disasters, expanded definitions of "design basis" risks emerged and required new technological and procedural methodologies for responding to these classes of crises. New disasters make

future disasters more foreseeable. Manufacturers of complex technologies can no longer cling to overly optimistic definitions of Design Basis Risks when confronted with the actual consequences of risks that have already materialized. Other recent examples of overly optimistic definitions of "design basis accidents," include the December 2013 Amtrak train wreck in upstate New York, and the 2016 crash of a commuter train in Hoboken, where a fatal accident occurred, despite the availability of technology to remotely stop the train (McGeehan, Rosenberg, and Fitzsimmons, 2016).

The origins of COVID-19 are still under investigation, but the issue arises as to whether global pandemics are a design basis risk of epidemiological research, and the degree to which designers and manufacturers are responsible for unintended results.

Research Direction #3: How do we establish guidelines for accountability when products and services have unintended disastrous impacts? How do we determine what a design versus beyond design risk is?

Implications for COVID-19: Study how a virus developed for research purposes was released into general population with disastrous results. (Best theory as of 2/21).

Deterministic versus Stochastic Risks

Another major distinction in risk analysis hinges on the degree to which the negative outcome automatically happens once the disaster has occurred and the degree to which they are measurable immediately or soon after. These risks are called "deterministic." An example of deterministic risks would be a rescue worker falling on debris and breaking their ankle. A second type of risk, called "stochastic risk" occurs when negative results do not follow directly from the risk. In

this case the debris is still there but no one has as yet been injured. The damages may take years to emerge or may not manifest at all.

Other examples include the impact of smoking on cancer, and the impact of exposure to dust, during the cleanup of Ground Zero after 9/11, on emphysema and cancer among cleanup workers. Attributing causality and the resulting liability in these scenarios is much more problematic. Much time and energy can be spent on investigations to prove who is responsible, who has been victimized, and how much the injured parties can recover. In the case of nuclear power, when radiation exposure exceeds a threshold value, usually in the tens to hundreds of rems, the results are deterministic. The radiation kills cells and damages organs causing "acute radiation syndrome," resulting in death. The impacts of severe exposure to radiation over a short period of time are, therefore, deterministic. When the radiation exposure is below the threshold value, the risks of the exposure are stochastic. The radiation does not definitively cause the exposed individual to immediately experience illness or death. Therefore, the link between exposure and illness is not as clear in terms of causality. Other factors can come into play such as the individual's lifestyle or preexisting conditions that may impact the individual's response to the exposure and resulting longevity. Exposure to radiation, or to the dust at ground zero after 9/11, or the prolonged effects of alcohol and tobacco are other examples of factors that gave rise to impacts that have been debated because of their non-deterministic nature. (Lally and Garbushian, 2016).

The immediate health effects of COVID-19 are being analyzed currently, but the likelihood of exposed patients to develop serious symptoms and the long-term impacts on survivors of the virus will

require extensive further study. Pre-existing conditions appear to have a negative impact on patient's likelihood to survive.

Research Direction #4: What mitigating factors make the likelihood of serious illness in exposed patients more likely? What long term risks are likely to emerge? What methodologies can we use to predict and mitigate the impact of long-term stochastic risks?

Implications for COVID-19: Why do some individuals develop fatal cases of COVID as a result of exposure and some people have no symptoms?

Contained versus Cascading Disasters

A crisis may begin with a single incident that can be contained in time and space. Plane crashes, 9/11, the Kennedy assassinations, and the Shuttle explosions all occurred within a relatively short time period, although their ramifications extend far forward in time. Likewise, these crises occurred withing a relatively limited geographical area. These characteristics make the initial incident easier to isolate and study. A pandemic such as COVID-19 continues to evolve over a time period of months and years and has spread quickly across the globe. The longer time period and global scope of a pandemic makes the disaster harder to isolate and study without considering the context in which it is happening. The evolving nature and global scope of the crisis requires researchers to study how it develops across multiple time periods and different populations.

When one disaster leads to another of a different nature, a separate location, and/or at a different time, the result is a cascading disaster. In the case of Fukushima disaster, the earthquake and tsunami were separate types of disasters, with one giving rise to another. After the initial terrorist attacks of 9/11, the resulting toxic resulted in serious

health problems to those who lived and worked in the area. Cascading disasters result in even more devastating consequences. The links between the disasters need to be understood and prevented or mitigated if possible. Understanding the relationships between cascading disasters is important in containing their impact. COVID-19 has rapidly evolved from a health crisis to a social and economic one. An integrated approach to this and future crises is required to address the different areas of society that are impacted.

Research Direction #5: How do we contain disasters and prevent them from cascading into new forms of crises? How do we develop research methodologies to study crises that cannot be contained?

Implications for COVID-19: How do we mitigate the damages and contain the impacts of COVID-19, both medically, economically, and socially.

Disasters of Malicious Origin

When a disaster is deliberately caused a new range of challenges emerge. Preventing the initial incident becomes of paramount importance. Studying the causes of malicious incidents draw upon fields of psychology, criminology, sociology, and political science to a greater degree than with disasters of non-malicious origins. The current state of knowledge of origins of the COVID-19 virus indicate that it was not malicious in origin. Further inquiry into the release of the virus is currently being conducted and requires transparency and trust between the parties involved to encourage information sharing. Technology to predict and prevent disasters with malicious origins, such as surveillance technology, are likely to have serious privacy implications.

Research Direction #6: How do we prevent and mitigate the impact of malicious threats?

Implications for COVID-19: There is no proof it was malicious in origin. Current impact of COVID would be the same.

Post-Crisis Renewal: The Role of Technology in Rebuilding Infrastructure and Restoring Culture

During crises, individuals, organizations and governments often develop and use new technologies and methodologies for coping with the crisis. Data analysis tools are widely used to expand knowledge of the disaster domain, and the technology evolves and utilizes new methodologies to enhance communication (Lally, 2013). After Hurricane Katrina, survivors used the Internet to keep in touch and to track missing loved ones. New Yorkers during Hurricane Sandy used the Internet to locate sources of food and gasoline. In the wake of Katrina, many virtual cultural events were staged to raise awareness, preserve local culture and raise funds for recovery. In the case of COVID-19, the crisis is still evolving, but technological solutions such as new forms of virus testing, methodologies for working from home, new methodologies for teaching, new methodologies for conducting interactions with clients/patients, and virtual events are beginning to emerge and are likely to continue to prove useful and rewarding after the crisis has passed.

Research Direction #7: What technologies and methodologies have evolved from the crisis that can have a positive impact in the post crisis environment?

Implications for COVID-19:
Tighter controls over virus research. Prevent future releases.

New ways of using IT--"Natural Experiments" resulting from the virus, such as:

Better hygiene practices combat other diseases. Social distancing and mask wearing have led to a decrease in the occurrence of other diseases.

New ways of working—more working from home, more virtual meetings, less stress and wasted time from commuting, less traffic congestion and pollution.

Telemedicine for routine medical problems.

More distance learning, online classes for appropriate subjects.

Improvements in Zoom to support different types of telework.

The Need for Information Transparency in Crises

Crises often have complex causes requiring specialized professional knowledge to understand. Crisis managers have the challenge of first understanding the problem themselves and then conveying it to stakeholders in what is often an emotionally charged atmosphere. Complex technology or rare diseases are often a "black box" to the public until they have disastrous consequences. To develop and maintain trust with stakeholders, crisis managers must establish a reputation of being honest about what is known about the crisis, and not be secretive--withholding key information that could impact stakeholders' well-being. This paper draws on the research regarding Information Transparency to further illuminate this challenge. Information Transparency has been defined by (Schnackenberg and Tomlinson 2016, 1785) in their survey of research on the concept, as "the perceived quality of intentionally shared information from a sender". Information Transparency consists of three dimensions: information Disclosure, Clarity, and Accuracy (Schnackenberg and Tomlinson, 1792).

Disclosure: the perception that relevant information is received in a timely manner. Individuals, organizations and governments openly share all relevant information.

Clarity: the perceived level of lucidity and comprehensibility of information received from a sender. Information must be understandable without the overuse of technical terms the intended audience may not understand. Granados Gupta and Kauffman, et. al. (2010) argue that overreliance on complicated mathematical algorithms can obscure information rather than making it transparent.

Accuracy: the information is correct to the extent possible. Although complete ex post transparency is not possible during the early stages of a decision, correct information must be shared to the extent possible and not deliberately contrived.

As research emerges through scientific channels, there is a great challenge in making the studies and results understandable to the general public in need of the information (Yan, 2020).

Similarly, Zhu (2004) defines information transparency as "the level of availability and accessibility of market information to its participants." Therefore, Granados, et al. (2010, p. 210) argue that, "both the quality of the information and the quality of the interface to make information available" are key features of transparency. They conclude:

In the era of information overload, availability of information is not enough. If a firm is truly interested in revealing information to an external party, it will not just make the information available, but it will also design the search mechanism such that the receiver can sort through the data and extract the information necessary to meet its goals.

Lally (2014) argued that the transparency regarding the Y2K crisis and the Clinton administration's willingness to share information

globally led to improved developmental methodologies in the Post 9/11 environment.

Information technology can provide a means of improving decision quality by providing as much information as possible to stakeholders. In many instances, however, stakeholders are confronted by government representatives, sellers, agents, and other parties with a vested interest in the decision outcome and who, will conceal or misrepresent relevant information.

In the case of COVID-19, the need for timely and accurate information arose quickly, with a need for accurate, timely information in a form the public can understand. Data gathering has been delayed and otherwise hindered by the reluctance of politically interested parties to share information that could indicate their negligence in addressing the crisis.

Research Direction #8: How do we establish and maintain information transparency in a crisis? How do we measure the degree to which managers and government leaders have been transparent in conveying vital information?

Implications for COVID-19: Currently there are warring perspectives with frequent attempts to discredit experts in disagreement with vested political interests. Finger pointing has led to a lack of information sharing.

The Role of Trust

In their groundbreaking study of organizational trust, Mayer, Davis, and Schoorman (1995), (Schoorman, Mayer and Davis 2007) argued that trust is an essential factor in an individual's willingness to assume risk and make themselves vulnerable to the actions of another. (Jackson and Alvarez 1992), emphasized that in diverse environments people with different cultural backgrounds must be willing to work

together, without the shared values and experiences of homogenous groups. Diverse environments require the cultivation of mutual trust to enable individuals to work together. This paper will argue that, *the development of trust is a critical factor in creating the co-operation necessary to implement sustainable responses to crises in diverse environments.*

Mayer, et. al. 1995, 717 characterizes three basic elements of trust: ability, benevolence, and integrity.

> Ability: is that group of skills, competencies, and characteristics that enable a party to have influence within some particular domain. The domain of the ability is specific because the trustee may be highly competent in some technical area affording that person trust on tasks related to that area. However, the trustee may have little aptitude, training, or experience in another area, for instance, in interpersonal communication. Although such and individual may be trusted to do analytic tasks related to his or her technical area, the individual may not be trusted to initiated contact with an important customer.

In the case of a crisis where public cooperation is required to mitigate the impacts of the crisis, both aspects of ability, technical knowledge and the ability to communicate it with a diverse group of stakeholders, are required. Mayer, et. al. 1995, 719 define benevolence and integrity as:

> Benevolence: The extent to which the trustee is believed to want to do good to the trustor.

> Integrity: The trustee adheres to a set of principles that the trustor finds acceptable.

In both cases, the trustee must value the well-being of the trustor, as well as the common principles they and the trustor believe in, beyond what Mayer, et. al. describes as the "egocentric profit motive."

A challenge in establishing trust in is that many of the parties involved, are motivated by a desire to protect or enhance their reputation or to personally profit from the crisis. To establish trust, stakeholders need to know that crisis managers have the knowledge and ability to solve the problem, and that crisis managers have their best interests at heart.

In the case of COVID-19, citizens must obey government orders to curtail their activities, often at a significant economic cost. Citizens must trust their governmental leaders and their technical representatives to provide accurate and timely information in a rapidly evolving crisis. Individuals must make informed decision regarding their own return to a normal lifestyle as the crisis subsides.

Research Direction #9: How do we establish and maintain trust in a crisis? How do we measure the degree to which managers and government leaders are competent to comment on the disaster and are motivated by the best interest of the stakeholders?

Implications for COVID-19: Currently, economic interests are frequently placed above public safety. Some news sources goad their constituents to not be cowards and return to work while was virus still raging.

Crisis Research in the Post COVID-19 Environment

This paper has presented a taxonomy of the key aspects of crises and addressed the unique issues each type of crisis faces. The research directions that emerge from the analysis can guide future researchers in their studies of future crises. The rapidly emerging body of COVID-19

research can be mapped into the key areas of crisis research suggested by this framework, to help educate crisis managers about how to deal with the ongoing crisis and its consequences.

Crisis managers and government leaders, as well as crisis scholars can gain insight from the work of researchers in fields with similar key characteristics. Crisis education programs can draw on this research to form curriculum to educate and train future crisis managers. Citizens can draw on insights from the research to help them make more informed decisions about the potential of new technologies, methodologies, products, and services to be crisis prone and to better evaluate their risks versus benefits in the future.

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Operations Management/Operations Research

A Simulation Study of Kanban Production System for a Single Line Production System under Various Setup Times with Work in Process (WIP) Units as Performance Metric

Oral

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There are advantages to both Economic Production Quantity (EPQ) model and the Kanban model. (Nicholas, 1998). The objective of this study is to fill a research gap by evaluating Kanban for a single line, multi-product item production system under various setup times. The objective will be accomplished by utilizing simulation to evaluate the Kanban production systems. The primary variable is setup time. The performance measure is average WIP inventory units. This research will help practitioners determine the conditions under which the EPQ system is appropriate for them so that their companies could better compete in the competitive global marketplace.

Evaluating and Comparing the Outputs of Comparable Units

Oral

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In order to improve the performance of comparable units of an operation producing a variety of results, decision-makers in public and private organizations often apply a number of different multi-criteria benchmarking techniques when comparing and evaluating performance. In this paper we apply the Data Envelopment Analysis (DEA), the Ordered Weighted Average (OWA), and the newly developed Order Rated Effectiveness (ORE) model, (Klimberg and Ratick 2018, 2020a, 2020b), to the Technology Achievement Index (TAI) data, a Weighted Linear Combination (WLC) composite measure. We then compare and evaluate the original TIA results to those obtained using the DEA, OWA and ORE methods.

Group Decision Making Problem – Under Hesitant Fuzzy Linguistic Terms Multiple Criteria and Dynamic Environment

Oral

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In group decision-making (GDM) problems, the members' varying opinions are suitably aggregated to obtain the group's representative opinion. In group settings, the consensus is evolved if a sub-group is able to influence or move the majority of the group through their interaction and reputation in the group. In this paper, we present an algorithm that maps the consensus evolution process of GDM based on interrelationships of members in the group. The members' views are taken in hesitant linguistic fuzzy term sets to incorporate qualitative aspects and vagueness/ confidence in their expressions.

Guest Recovery Costs in Hotels

Oral

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As major economic drivers, hotels should determine methods to reduce costs so that a decrease to its financial bottom line during lean economic times, is minimized. An important variable to reducing these costs is minimizing the amount spent on service recovery. For this study, the internal operational factors of employee empowerment, employee training, and employee turnover are examined in relation to the costs of service recovery. These factors help mitigate the potential for service failures and thus limit the negative financial impact on the hotel by empowering well trained and tenured employees to have the ability to correct a service.

Modeling the Effect of Big Data Analytics and Lean Capability on Firm Performance

Oral

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This research investigates the relationship between big data analytics, lean capability, and firm performance. We propose a conceptual model to examine the links among these constructs. Structural Equation Modeling (SEM) has been selected and utilized to estimate expected structural relationships. Based on this model, research hypotheses have been developed. Our preliminary results show that lean capability has a substantial effect on firm performance and that a higher level of big data analytics practice leads to higher lean capability. This implies that firms should emphasize the development of their lean capability and seek more engagement in big data analytics.

Optimal Inventory Policy for Systems with Bundled Supplies

Oral

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In recent years, demand for different cloud services has faced a surge. This has resulted in a crucial question for cloud companies–how to optimally expand their capacity? The distinctive feature of could industry is that one unit of supply increases the capacity of different attributes (i.e., RAM, CPU, storage, network) simultaneously. To find the optimal expansion policy, we consider a cost minimization problem in a continuous review, finite time horizon setting. We, further, find the best server configurations to be deployed each cycle.

Palm to Palm: Another Outbreak

Oral

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2020 was an unremarkable year for Palm to Palm (P2P), a sustainable operations project in rural Sierra Leone that processes the fruit of the oil palm tree into palm oil and soap and sells the products locally. The COVID-19 pandemic dominated global news in 2020, but the pandemic's impact on P2P has, to date, been small. To aid in local COVID-19 efforts, the project produced and distributed at no charge 10,000 bars of soap. Another notable 2020 achievement is the receipt of a small grant-in-kind to expand our production facility.

Resource Renting Problem with Discounted Cash Flows: A Genetic Algorithm Solution

Oral

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In the problem of project scheduling, activities require resources to be implemented. The resource renting problem, assumes that the resources needed for the project are rented, thus making rental costs time-dependent. A standard resources renting problem tries to minimize the cost of having resources, where the objective function only includes costs and does not include time preferences. In the problem defined in this article, which is called the problem of resource renting with discounted cash flow, we consider the objective function to be the maximization of the net present value of money.

Summary Of Relative Quality Measures

Oral

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Abstract

The objective of this paper is to discuss some relative quality measures for process capability. We examine and interpret these measures for both bilateral and unilateral cases. A discussion on the process capability measures for non-Normal process distributions is also provided along with examples of some studies done in this area. In addition, use of the capability measures in a dynamic fashion is briefly discussed in the conclusion section. This is an extension of our prior work, in which we discussed some issues regarding different types of specifications provided by the customer.

Systematic literature review of ISO14000 certification and its impact on financial performance

Oral

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The impact of operational excellence frameworks on financial performance is a well-recognized topic in operations management research. The methodological approaches vary as well as the results that appear to disagree on whether the impact is positive or negative.

To understand this discrepancy better, a systematic literature review is executed, focusing on ISO14000 certification. The objective is to gain an overview of the methodologies applied and to compare the respective findings in order to elucidate whether the methodological approach influences the said findings.

Strategy and Organizational Behavior

The Discussion on Developing Strategies through SST for Pandemic Decreasing-Take Covid-19 as the Example

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Abstract

Tracing back to Dec, 2019, China faced a mystery epidemic, the disease was similar to SARS-CoV-2, WHO caught the information and treated the cases as the global public health problems, and formally named "Covid-19" on Jan, 12th, 2020. Covid-19 became a horrible pandemic, hit economic severely and changed people's lives hugely, and spread fast to more than 149 countries. The research motivation was from observing the severe hitting records of Covid-19 in the world and hoping to make a review with individual aspects. The research questions through the motivation were: (1) what might be the good strategies under Covid-19? (2) could the strategies be developed through SST? And (3) how to implement? The main purpose of this paper was to develop good strategies through SST for pandemic decreasing. 3 frameworks were to explain the whole structures; the results were from 9 inferred questions and 15 analytical and practical answers. This research intended to contribute on expanding the knowledge of systematic thinking in academic field; developing effective strategies with SST perspectives in SSM field; and proposing positive suggestions and predictions with global views in practice and managerial field. The analytical results demonstrated that pandemic may possibly be decreased by recognizing cultural differences and referring to Taiwan's quarantine model, and the whole paper showed that the research was going successfully through systems control with SST strategies in academic under a literature review.

Key words: Pandemic, Prevention, Contingency, Control, SST, SSM

Paper type: Research paper

The abbreviation: SST (Soft Systems Thinking); SSM (Soft Systems Methodology)

Ch 1 Introduction

Chapter 1 stated the background, motivation, questions, and purposes of this research. The ranges, limitations, and gaps were also put forward, and contributions were being arranged in the last part. Background composed by collecting the information of Covid-19, briefly introducing its history, describing global epidemic situations, and addressing Taiwan's quarantine as a learning model.

1.1 Background

(1) Covid-19

Covid-19(Coronavirus Disease 2019) caused by SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2). Covid-19 was not the only Coronavirus epidemic in 21st century, Mers-CoV (Middle East Respiratory Syndrome Coronavirus) hit in 2012; SARS-CoV hit in 2002; and SADS-CoV(Chinese Swine Acute Diarrhea Syndrome Coronavirus) hurt pigs and infected people in 2016; SARS(Severe Acute Respiratory Syndrome) broke out in 2002, and caused damages from 2002 to 2003. SARS-CoV-1 & SARS-CoV-2 shared almost 80% of genetic sequences, and both of 2 types used the same host cell receptor to initiate viral infection. At the first time, the diagnosis of Covid-19 was pneumonia, attacked human upper respiratory tract; later, the diagnosis became complicated, and Covid-19 attacked human's heart, kidney, and gastrointestinal tract. The virus is more active than SARS, the variant goes quickly, and the death rate is higher than SARS.

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According to the statistical data from MHWT[4] the injuries and deaths of SARS was just 1/10 of Covid-19, the data showed that Covid-19 has a strong dissemination power. Due to Coronavirus is a deadly infectious disease, many scientific and research teams made their great efforts to find out the origin but all in vain, so far with no real answers. The scientists, professionals, and experts doubted that the virus might be coming from: (1) an unknown animal intermediary; (2) the variants from SARS; (3) the variants from HIV[5] virus; (4) one of the zoonoses from wildlife; or (5) an unknown virus under global warming effect…..etc. The source of the virus was unable to trace may cause the limitations on R&D (research and development) of the vaccine. Diseases always hit the weak firstly, yet the vaccine cannot simultaneously be developed in time, based on the factors, the spread is strong. This paper made a review on the influences of Covid-19, and discussed the emerged global problems; these 2 parts are the background of developing the strategies.

(2) History

History varies with culture, and different country has a varied epidemic disease situation. According to the media reports, the first earlier case was found in Oct, 2019 in China, however, some researchers speculated that the break-out period might be earlier, and might be in western countries. Even so, the source remain with no clear evidences, until Dec, 31st, 2019, WHO (World Health Organization) alerted by such unknown epidemic cases; on Jan, 7th, WHO formally named the virus "SARS-CoV-2"; on Jan, 12th, 2020, Chinese scientists published the paper and mentioned about the genome of this virus; after that, WHO hold the solid evidences that the virus is deadly, and identified the virus can actively infect through people to people by a diagnostic test; on Jan, 12th , 2020, the disease was formally named Covid-19 by WHO; On Jan, 30th, 2020, WHO made an announcement that SARS-CoV-2 outbreaks as a PHEIC (Public Health Emergency of International Concern); and on March, 11th, 2020, WHO declared to the world that Covid-19 is a "pandemic".

From Jan. to Mar. of 2020, China was hit seriously by this virus, and with no ways to trace the sources. China had thousands of patients and more than 30,000 suspected cases had been reported during that period, China had a great losses through this sudden, unknown, and severe disease. The virus spread quickly to Japan, South of Korea, and Thailand in the middle of Jan of 2020, eventually, the virus was spreading to the whole world. The first case was found in the USA was in Feb, 2020 in Seattle City. In May, 2020, more than 8000 new cases of Covid-19 were being confirmed daily, and the deaths rate were over thousands per day. The history of Covid-19 actually has been changed day by day, the number of confirmed cases inevitably increased, and the deaths rate have been climbed moment by moment. Covid-19 continually hit America & Canada in Nov, 2020, and caused tens of thousands people died, the bad situations are increasing from time to time.

At the same period, Italy, Britain, and France were hit seriously by the virus; and both Japan and South of Korea also used to lose control for the spreading. According to the official report, the latest index showed that the most serious country is the USA, apparently, the elections and protest activities maybe increase the spreading. The next stage of the pandemic followed by the development of vaccine, presumably, if the vaccine market lacked of justice, and some related companies manipulated by raising prices through monopoly, then except Covid-19, the history will be a tragic record repeatedly.

(3) Global Situation

There has no accurate answer regarding the source, Covid-19 is like a killer, and continually raging across at least 149 countries in this world. The virus spread rapidly, so far the update records[6] are: the confirmed cases: 57,164,742; the death cases: 1,364,959; and the cured cases: 36,682,753. Countries in the world took the similar policies to reduce the spread, such as: closed the border; banned in docking cruise; imposed a curfew regulation; issued severe quarantine policies; semi-blocked the cities; and controlled the entrance…etc. Importantly, CDC (Centers of Disease Control) of each country necessarily asked travelers submitting the quarantine report-negative NAT (Nucleic Acid Test) report, and checked repeatedly for the Ct (Cycle Threshold) value of PCR(Polymerase Chain Reaction).

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[4] Ministry of Health and Welfare of Taiwan

[5] Human immunodeficiency viruses

[6] The update was on Nov, 20th, 2020. Source: https://www.boca.gov.tw/cp-56-5248-791bd-1.html

The governments in the whole world have been trying their great efforts to face this horrible disease, because the disease threatens human lives with a speedy transmission; Covid-19 hit global economics and industries as well, the current situations maybe just the first page of the whole history. Economic is the primary proof of the development and progress of the world, nevertheless, the long term of the decreased economic maybe carry a risk for conflictions and wars thereafter.

Japan and South of Korea are similar to Taiwan in culture, race, food, social structure, and habits; unfortunately, they ignored the strength of the spreading, and with no timely preventive strategies; their weaknesses were: lacked of medical supplies; and lost the primary key time to prevent and control; USA failed by late warning, and the optimistic personalities and the spirit of advocating freedom also made USA citizens neglect the prevention; UK failed also by late-preaprations, and noble nationality and with the lack of crisis awarenesses brought a serious harm to the medical systems. Most of the speedy spreads came from people's negligence, and the severity of epidemic situations caused many countries blocking the borders, cities, and schools; the consequences impacted global communication. It's the worthy of mention that cultural differences practically played an important role to influence the pandemic spreading. Such as: Taiwan is successful for preventing the virus because of the experiences of fighting SARS in 2003, and the quarantine model can be learned and imitated by countries through culture exchange.

(4) The Quarantine Model of Taiwan

Taiwan succeeded in controlling the pandemic by 4 strategies: *first*, track the infectious cases with high-tech electronic enclosure system; *second*, control highly on medical resources supplements; *third,* issue severe government policies; and *last*, block the borders and control the airports severely. Taiwan can make through the tough sessions because of the leaderships, experiences, professionals, severe quarantine policies, and high technology; other key factors are also significant such as: information transparency, functional epidemic investigation, central quarantine scheme…etc; importantly, unities and cooperations from the whole country. Taiwan took isolation as the main strategy and supplemented by quarantine. Taiwan-a science & technology island, successfully used high technology, big data, health insurance system, genomic testing, artificial intelligence, home isolation, home quarantine, and monitoring & tracking systems to protect the whole country away from pandemic hitting.

More, Taiwan treated the patients with asymptomatic, false positive, and cross reaction with the most rigorous attitude for the repeated inspections. Taiwan has started moving the steps to share the medical resources with some countries, and this is the evidence of culture exchange, such as: Taiwan helped some countries with the rapid screening reagent for testing; and Taiwan helped and shared NTD 6.2 billion of medical resources for global.

1.2 Motivation and Purpose

The motivations were from: (1) observing the severe records in the world and hoping to make a review of Covid-19 on individual aspects; and (2) hoping to make this review become a worthy evaluation and reference. Why these are such important? As Covid-19 is a problem to every country and everyone; and what we planned to pursue is about people's lives and deaths. The main purposes were: (1) to explore the antecedents and consequences of Covid-19; (2) to search effective strategies through SST; and (3) to implement the strategies to decrease the spread. The other purposes combined with the motivations also are meaningful such as: to present a special analytic method for future researchers; to expand relevant knowledge in SST field; to reinforce the related knowledge in strategic field; to create a new 7-stages process in SSM field; to make suggestions to countries that backward in epidemic prevention; and to make predictions according to the real global situations; both the motivations and purposes have deep relationships with the topic, and starting from here, the connections are closely related to the contributions.

1.3 Research Question

The specific research questions through the above motivations and purposes are: (1) what might be the good strategies under Covid-19? (2) could the strategies be developed through SST (Soft Systems Thinking)? And (3) how to implement the strategies under SSM (Soft Systems Methodologies)? The research questions matched the topic, motivations, purposes; and the purposes of the research questions are to solve the research difficulties (exploring the strategies) and dilemmas (analysis & implementation).

3

The key words selected by reviewing the literatures and according to the current situations, and the principle of the selection focused on the definitions that related to the topic and the research questions; all the functional linkages are like a web.

1.4 Research Range and Limitation

The research scope locked at a few famous countries such as USA, UK, Japan, South of Korea, and Taiwan, due to the research unit is Covid-19, we did not focus on the "country", instead to focus on the "event". The research limitations followed the principles with no involvements in politics; negative judgments; negative critiques; vaccine's research and developments; or vaccine's marketing and prices. Defining scopes and limitations helped us promoting the accuracy of this research.

1.5 Research Gap

This paper reviewed articles that related Covid-19, and found most of the references focused on the latest; and we also found that no articles adopted SST theory to discuss Covid-19 before; lastly, we hoped to fill the gaps by 2 thoughts: (1) referring to the old literatures to help exploring the discussion; (2) adopting SST to develop strategies under this environment. SST was focused and discussed by many scholars in 20 years ago, and was the knowledge with a great fame in critical thinking, this paper tried to develop strategies through SST, because flexible and effective strategies are important under the severe situations.

1.6 Contribution

We tried to make at least 7 contributions which included: (1) the review can be a good reference for the future researches; (2) the review can help more people to know more about the antecedents and consequences of Covid-19; (3) the quarantine model can help the countries of which lacked the preventive skills; (4) the paper expanded SST & SSM knowledge in academic field; (5) the paper reinforced strategic management; (6) the paper suggested taking transformation under epidemic in business implication field; (7) the paper developed effective strategies for pandemic decreasing in preventive care field..

Inductively, this paper intended to make contributions on academic by exploring strategic management and the application of SST; the frameworks are also worthy for the reference by its specific characteristics; the practical implication focused on being an evaluation and reference for health care and medical services domestically and overseas; more, the greatest hope was to make cooperation and integration of technology information and medical resources in the whole world, because it firmly helped pandemic decreasing. Ultimately, Taiwan's quarantine model also contributed on the prevention with the high-tech.

Ch 2 Literature Review

Literature review included exploring the definitions of the key words, we defined 3 supported theories and discussed SST & SSM; current global situations become an important data collection; and cultural differences helped understanding the differentiations of the spreading.

2.1 Pandemic

(1) The Definition

A "pandemic" is defined as "an epidemic occurring worldwide, or over a very wide area, crossing international boundaries and usually affecting a large number of people" (Doshi P., 2011); WHO defined "pandemic" is "the worldwide spread of a new disease". The more information of "pandemic" from CDC of USA is "Pandemics happen when new (novel) influenza A viruses emerge which are able to infect people easily and spread from person to person in an efficient and sustained way."

Pandemic involves 3 conditions: a global outbreak; an infectious disease; transmit from person to person. CDC indicates that influenza pandemics are uncommon, only occurred during the 20th century. The extended period of pandemic happened because very few people have immunity against the virus, and normally R&D of vaccine might not be widely available in time, especially the variant goes quickly.

The differences between "epidemic" and "pandemic" are: an epidemic is a disease that affects a large number of people within a community, population, or a region; a pandemic is an epidemic that spreads over multiple countries or continents (Intermountain Healthcare[7]); a pandemic was normally gradually resulted by epidemic.

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[7] Accessed: Apr, 2nd, 2020: https://intermountainhealthcare.org/blogs

(2) The Standard of Formation

The emerging evidence for A(H1N1) is that transmissibility, as estimated by the effective reproduction number (R, or average number of people infected by a single infectious person) ranged from 1.2 to 1.3 for the general population but was around 1.5 in children (Kathryn[8] Glass,2021). Severity, as estimated by the case fatality ratio, probably ranged from 0.01 to 0.03%. These values are very similar to those normally seen in the case of seasonal influenza. However, the number of deaths was higher in younger people.

In 2010, during the H1N1 pandemic, WHO defined Trusted Source a pandemic as the worldwide spread of a new disease. At the time, WHO described six phases in the development of a pandemic: a virus circulates among animals not known to spread the disease to humans; the virus is detected in animals known to have spread viral diseases to humans; animal-to-human contact causes a human to develop the disease; human-to-human contact makes it clear a community outbreak could happen; human-to-human spread of the virus happens in at least two countries in the same region; community level outbreaks happen in a third country in another region. Phase six meant that a pandemic was occurring (Healthline[9]).

(3) The Past Cases

The history can be traced as following: In 1918, Spanish flu killed 50-100 million of people; In 1957, Asian flu killed 1.1 million of people; In 1968, Hong Kong flu killed 1 million of people; In early 1980s, HIV/AIDS killed 35 million of people; and In 2009, Swine flu killed 151-575 thousand of people; more, SARS, H7N9, Ebola, and Zika killed millions of people around the world (WHO, 2011b). Totally, H1N1 virus; H2N2 virus; H3N2 virus; and H1N1 pdm09 virus have killed 35 million of people in the past 40 years. (WHO, Apr, 2020,)

2.2 Prevention

(1) Prevention System

Prevention can be self-protection or protection by means. In this paper, "*prevention*" is to prevent disease; prevention means detecting disease in the earlier stage. Anne H. Outwater (2016) quoted that primary prevention[10] aims to avoid the intrusion of disease; and the secondary prevention includes detecting the disease in asymptomatic patients with screening or diagnostic testing and preventing the spread of communicable diseases; therefore, prevent Covid-19 is the second level of preventive care.

Prevention needs detection; while detection needs strategies; and all the functions of prevention are to solve the problems in managerial field. In health and medical field, the purpose of prevention is to minimize complications and limit disabilities before the disease become severe and worse. Some studies showed that problem-solving has relationships with creativity (Ackoff,1978) and imaginization (Morgan,1993).

In systematic view, Ackoff illustrated that the aspect of "*system*" is considered by inputs, outputs, social, and technical processes; he created "idealized design" under the assumption, and he supported that problem-solving needs creativity. Morgan proposed the process of imaginization as a key managerial tool. One side of problem-solving needs people to collect information and search effective ways; while the other side needs people to put creativity and imaginization under the assumptions. We extended both Ackoff & Morgan's ideas: creativity helps developing strategies to solve problems; creativity needs thinking and imagination; and assumption focuses on the logical inferences.

Covid-19 is a serious problem and need both hard systems (high-tech) and soft systems (systematic thinking) to solve. This tough environment needs leaders potentially to develop and implement strategies to control, meant a leader should potentially create strategies under creativity and imagination, such as: finding out the reasons why people refused to put on a mask? A leader should offer education as a learning chance for citizens, as education helps people recognizing the current situations and focusing on the awareness of risk and prevention. Education here embraced preventive knowledge, protective skills, culture learning & exchange; respect government policies, abide law regulations, cooperations, and support weak trends. Education makes a country strong, and a strong country is with good prevention.

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[8] A professor, teaching at Australian National University: http://prism.edu.au/staff/kathryn-glass/

[9] Accessed: Apr, 20, 2020, https://www.healthline.com/health/pandemic-vs-epidemic

[10] Accessed: Feb, 20, 2021, DOI: 10.1016/B978-0-12-803678-5.00117-X

(2) Contingency System

Contingency means taking a flexible, adjustable, and emergent plan to defense. Michael C. Jackson (2000) declared that the importance of principles in contingent circumstances: "different organizing principles are appropriate to different contextual circumstances; it all depends on certain key strategic contingencies." Further, he believed that the key strategic contingencies influenced organizational structure. This research inductively integrated the definitions of "contingency" and divided it into 3 dimensions: (1) prevention & detection; (2) emergency & accident; (3) problem-solving & systematic thinking. The purposes of building the dimensions were to strengthen the key factors and develop strategies with more prospective views.

Jackson (1991) treated "*system*" as an organization, he mentioned that theoretical innovation treated organization as a series of interdependent subsystems; and he explained that these subsystems are "opened". Jackson also shared "emergence" and "unification" perspectives, and he created 4 dimensions (goal, technical, human, and managerial) to explain the meaning of "open". From his views, we learned that contingency system involved the components of emergence, accidents, flexible decisions, multiple choices, totally decision making, strategic views, functional imperative, transformation process, control & communication, and technology & production…etc.

Taiwan conducted 2 practical contingency systems: (1) entry quarantine system; and (2) epidemic preventive tracking system. Taiwan performed successfully in prevention and contingency. At the primary stage, Taiwan used electronic declaration of personal entry data; and at the second stage, government cooperated with the related public agencies to carry out quarantine and health care tracking. Nowadays, Taiwan added another more effective system-using genetic sequence to trace the original cases. Taiwan is impeccable in epidemic prevention.

In this research, the contingency system was set for blocking the community infections in order to increase social stabilities.

(3) Control System

A control system is like a human body; brain and heart mainly control human's thoughts and behaviors. Similarly, a control system controls an organization by taking a surveillance system to control the actions and responses. David Patching (1990) proposed 4 categorized systems: natural systems; designed systems; social and cultural systems; and human activity systems; these 4 types of systems become the core concepts of this research.

Natural systems meant those that occur naturally in the universe, from the lowest minute system form up to the galaxy, including human beings and animals; the definition coincides with part of the scopes of observing current epidemic situations in this paper; *designed systems* involved man-made, this category is taken to include abstract system forms, and the purpose matched the stage of transformation in this paper; *social and cultural systems* meant those formed by human beings coming together, such as: communities and nations, the description related the discussion of this paper; *human activity systems* meant that systems where human beings are undertaking activities that achieve some purposes; we thought that the linkage between activity and thinking strengthened the developed thinking in this paper.

"Hard" system controls a system by protocols and rules, while "soft" system controls a system by systematic thinking. "Thinking" starts from building a concept, and "concept" develops logical methods to control a system. Our opinion is that, in systematic field, control is not for practical application, it is for mentality. "A human activity system is only a concept, and the form of the associated model will depend on the viewpoint selected by the analyst." (David Patching, 1990, p.9)

As to our personal views, "control" has 2 frames: *first*, control the systems and make them better internally; *second,* extend to subsystems and create efficiencies for new systems externally. A system control approach, in this paper, contained 3 systems: prevention, contingency, and control; 3 processes: problems solving, decision making, and strategy implementation; and 2 systematic reviews: SST & SSM. The functions of the control system are to develop strategies, build surveillance systems, and adopt monitoring and tracking systems; eventually, the purpose of system control is to decrease pandemic spreading.

In this research, the control system was set for blocking the local disease cases in order to increase economic stabilities.

6

2.3 Cultural Differences

Countries have their own culture, and different countries show the differentiations; Barker (2003) expressed that culture has no correct or absolute definitions. Edward B. Tylor (1871) was the first person to use "culture", he said culture means the patterns and characteristics of *human behavior*. Other scholars supported that culture has a connection with spirit and mind, such as: Geert Hofstede (2001) explained that culture is the collective programming of the *human mind*; Ralph Linton (1945) indicated that culture is a behavior; he mentioned about the relationships between culture, ideas, and habits; and he emphasized that culture can be learned, shared, and transmitted; Another scholar-Edgar Schein shared his ideas, he clarified that culture are assumptions and *beliefs* (1980); he further suggested and explained the relationships between culture and artifacts, behaviors, and *values* (2004).

Cultural differences are globally existed, and the differentiation becomes one of the vital factors to influence the spreading, such as: the importance of wearing masks; the advice of keeping social distances; the precaution of eating food; the regulation of greeting forms; and the limitation of tourisms and entertainments….etc; all of these are habits of a routine life, thus cultural habits may display a gap for preventing diseases.

Culture is a representative of human life, and culture is a body language of national people; different culture has varied habits, and caused different damages under the epidemic. One of the best learning models under epidemic-"learning from culture exchange"; in sum, a new culture must firstly be coming from cultural exchange, and people learn and make up from the shortcomings under the interactions, while interactions bring people advantages in learning and cooperation, so we believed that cultural exchange helps countries with the capabilities of prevention.

Through the above discussion, we rationally treated culture as a "life structure" that relates routines, normal lifes, and habits; and defined culture as a "life style", a "learning process", and the "processes of human's activities". This research concluded by supporting that "culture" related to human's behaviors, beliefs, and habits; and thought that culture is provided with the nature of learning, sharing, and communication; we believed that culture also includes interpersonal relationships, communicative styles, self-disciplined behaviors and attitudes, country and local's history; or even the abilities of human's interactions.

Robertson (1992) proposed "global localization", he focused on differentiation, and he strengthened the characteristics of "local"; it meant that each country has its inherent culture, and country should protect and develop it. Robertson's view showed that both *learning* and *imitating* are vital. This research extendedly defined Robertson's idea to ours: to treasure the culture but learn other cultures, and make exchanging through the communications. Accordingly, we believed that "culture", inductively, is the *living performance* of people.

Beck (2002) proposed "repeat localization" to highlight the importance of local culture. This research believed that the local culture is the main culture of a country. To cultural differences, we suggested that countries could link culture with learning to become a preventive strategy, culture is a foundation, while learning is an effective weapon, and the strategy may become the strength to reduce pandemic. Countries can internally introduce other cultures for promoting preventive skills. However, culture can be destroyed as well, if people rejected learning, it meant people refused changing; when the exchanged-processes failed, the epidemic would be severely expanded, and conflicts may arise.

The environments of Covid-19 need each country to experience and reflect through cultural differences to mend the gaps; to copy and absorb the success from other countries; and to play an important role in culture learning. "The new strain primarily transmitted through respiratory droplets and is able to survive in the airway mucosa." (Briguglio et al, 2020a). From this warning and the past medical proves, people should be aware of wearing masks are relatively important for preventing Covid-19, this may also reveal that habit is a factor to influence the differentiation of epidemic spreading in cultural difference.

It would be more mortality and people will feel hopeless and helpless under such serious spreading. The important and practical strategies to overcome the threatened crises are: to be a thinker, a learner, and a practitioner; thinking helps inspiring more practical methods and skills in prevention; learning brings more progresses in contingency; and practice develops more motivations in implementing strategies in control. The above discussion revealed that people need to be educated on preventing knowledge and protective skills urgently.

7

2.4 Soft Systems Thinking (SST)

David Patching (1990) explained "soft" is concerned with defining the options for improvement; he also defined the division of soft and hard systems; he claimed that hard systems related something to meet the need, and soft systems involved variable thinking under the assumption. We grabbed the points and defined "soft" is related a flexible decision making. The knowledge of systems thinking inspired this research developing questions and searching problem-solving methods; pandemic is a real problem to threaten the world, the environment needs methods and strategies to solve and protect.

"System"- a group of things or parts working together or connected in some way as to form a whole (Collins Standard Reference Dictionary) . Robert L. Flood and Michael C. Jackson (1991) explained the meaning of "systems" in their published book 《Creative Problem Solving-Total Systems Intervention》, they treated a system as a "filter", and doubted how the filter could be filled with content? They mentioned about providing with different "flavorings" to produce a number of systems "metaphors[11]". They explained that the metaphors are not mutually exclusive, and they believed that the filter can reveal results. This research supported the above ideas and thought that systems are "active" and "alive", and believed that systems are "flexible" and "adjustable".

Systems are like parts of organization (Michael C. Jackson, 2000), his studies displayed that systems' functions deeply influenced the development of organization. Brusoni et al(2001) admitted that the evolving resources and capabilities of organizations shape their boundaries. This research supported that system is an opened machine with boundaries, and believed that a nation is similar to a big system, and this big system can develop strategies effectively through SST perspectives.

This research treated SST as a reflective scheme, and proposed the views that people reflect self-thinking, self-behavior, self-attitudes, and self-control within that scheme. How to keep energetic and create capabilities under this divergent and variant environment? This research suggested that the strategy would be: changing the way of thinking; people should think about the real-life situations during the pandemic; and that is a flexible thinking dissociated under the pandemic.

This research reviewed the knowledge of problems-solving, decision making, and systems thinking, they are correlated by the function and sequence; problem-solving needs a well decision making, while systems thinking help the decision makers developing strategies. Base on the functions and relationships between those 3 parts, finally, we built the conceptual models to explain the correlations and answer the research questions in the next chapter.

2.5 Soft Systems Methodology (SSM)

Peter Checkland is the developer of SSM; Checkland (1981) explained that SSM is a methodology based on a way of systems thinking and systems practice; he also pointed that systems practice is the idea that real-world problems could be improved with solutions that were both systematically desirable and culturally feasible. This research supported Checkland's idea that system is a method to improve and solve the problems.

Peter Checkland and Jim Scholes (1999) narrated more in their published book 《Soft Systems Methodology in Action》 that soft systems methodology is an approach to organizational process modeling; the systematic method can be dealing with solving problems and dominant in managerial change. They also detailed the emergence of SST and the development of SSM. Checkland proposed the ideas-"Towards a systems-based methodology for real-world problem solving." SST is an analytical process, an approach, and a method, SST helps doing the research, such as SAST[12] method. Checkland developed SSM through a circular learning process-"the 7-stage model"; Forrester's SDM (System Dynamics Model) performed extensive application in extremely diverse areas. Jackson (2000) described that systems dynamics in its broadest sense sees systems as " feedback processes" demonstrating a specific and orderly structure; further, three systems methodologies involved participation: VSM (Viable System Model), SSM (Soft Systems Methodology), and CSH (Critical Systems Heuristics).These methodologies represent different paradigms within systems thinking (Jackson & Keys, 1984; Flood & Jackson,1991; Flood.1995).

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[11] The meaning of metaphors is complications and problems.

[12] A strategic assumption surfacing and testing investigation

Soft Systems Methodology (SSM) has been developed to deal specifically with unstructured problem situations, where it is recognized that issues exist but they are difficult to define (Mandy Brown[13], 1997). Checkland (1981) identified these problem situations with human activity systems, being systems with a constantly changing agenda. Consequently, people have some freedom to select responses and actions. Checkland considers SSM to be a systematic methodology, viewing situations holistically, and being a process of inquiry that seeks to improve messy situations.

More, Checkland discussed about "resilience" in this methodology-"the seven-stage model of SSM has proved resilient." He also described three virtues of SSM: *first*, he believed that it is intangible, aesthetic, and important; *second*, he treated the seven stages as a happy chance for the changes and improvements; *last*, he advised to develop thinking. Additionally, Checkland mentioned "strategic rules" of SSM, and explained the method allowed a number of options among which the user could choose. Furthermore, he emphasized "analysis is not enough", he encouraged "action". The main points of SSM are lined with problem situation, real situation, and systems thinking; and the four main activities of SSM are: (1) find out a problem situation, including culturally or politically; (2) formulating some relevant purposeful activity models; (3) debating the situation; and (4) take action to bring the improvement. Through the comparison of SST & SSM, we found that SST focused on analysis and solving problems, while SSM focused on building models for the debate and taking action. As a whole, SSM is a method for doing action research or literature review, Checkland most suggested using it in action research, and the literatures showed that most of the important parts performed a well connection with SST necessarily.

Jackson (1991) also defined the functions of systems methodology, "Systems Metholdology for the Management Sciences had modest success in rebuilding confidence in systems thinking in both the academic and practitioner communities." Another reference-《*The Fifth Discipline*》[14]mentioned about capturing the imagination of the practitioners, Peter M. Senge (1994) and Morgan (1993) have the same idea of creating the imagination in systematic review. The literatures showed that SSM was extended and developed by SST, yet they supported for each other. It cannot be denied their importance in the literature review or in action research field.

Ch 3 Research Method

This research conducted literature review as the method, we reviewed the important findings, related theories, and adopted methods of the literatures that related Covid-19; and referred the severe current situations; we thus formed a basis for newer research and discussion which included: analyzed the context; transformed the definitions; proposed the inferred questions; and developed the strategies as the answers. The purposes of this research were to explore the antecedents and consequences of Covid-19, develop effective strategies for pandemic decreasing, and provide predictions and suggestions. We conducted SST as a systematic thinking process and adopted SSM as a systematic reflective approach to adjust our thoughts repeatedly. The transformed new definitions were similar to the operational definitions in empirical research, and helped developing the inferred questions and analytic & practical answers; the frameworks were developed for the illustrations and explanations; and the samples were also fully detailed. A discussion for revealing the processes and reflecting the contexts was remaining vital in Chapter 4.

3.1 Seven Stages of SSM

The SSM is not a technique, David Patching (1990) explained that SSM like a method that requires certain procedures to be followed in order to obtain a predictable outcome, but is a set of guidelines applying systems ideas to problem situations. The following paragraphs give a brief introduction of the different processes of SSM:

(1)The first book discussed about SSM in 1981 by Checkland from STSP[15] in the engineering field, his "7- stage model" was being presented as a cluster of seven activities in a

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[13] A Professor of Hull University, the studies were collected in: 《Critical Systems Thinking-Current Research and Practice》, Ch 11, (1996)

[14] Peter M. Senge (1994), 《*The Fifth Discipline-The ART and Practice of the Learning Organization*》. Commomwealth publishing Co. Ltd. UK.

[15] 《*Systems Thinking, Systems Practice*》 (STSP) (Checkland, 1981)

circular learning process, and it contained: entering the problem situation; finding out the problem, and expressing its nature; exploring root definitions; building models; structuring the further questions; comparison-to seek and define the changes for improving; desirable in principle and feasible to implement. This version becomes a learning model for the expansion of knowledge in system world in the following decades.

(2)David Patching (1990) proposed "7 stages of SSM" which included the processes below: problem situation unstructured; problem situation expressed; root definition of relevant systems; conceptual models (formal systems model & other systems thinking); real world/ systems world comparison; feasible/ desirable changes; and action to improve. The contents of the stages are similar to Checkland's 7-stage model.

(3)Peter Checkland and Jim Scholes (1999) discussed the "7 stages of SSM" in SST field, and which included: analysis; root definition of relevant systems; conceptualization; comparison & definition of changes; selection of change to implement; design of change and implementation; and appraisal; they focused on the "change" in their model.

(4)Other related references showed 7 stages included: enter situation considered problematical; express the problem situation; formulate root definitions of relevant systems of purposeful activity; build conceptual models of the systems named in the root definitions; compare models with real-world situations; define possible changes which are both possible and feasible; take action to improve the problem situation. The points of this reference are: building the conceptual models for comparing and improving.

On the whole, the contents of the seven stages changed with the authors' knowledge and systematic concept, and the reference to the current situation are also great determinants.

3.2 Innovative Systems Thinking(IST)

(1) The New 7-Stage Processes

The authors of SSM treated "change" as a result from the comparison, and "change" also represented the development and the improvement of the system; more, "change" may have the meaning of evaluation and assessment. The above concepts helped modifying the contents of 7 stages, and we made the new processes matching the subject of this paper: reference & analysis; meaning & definition; dimension & key factor; transformation & inference; answer & strategy; evaluation & assessment; and reflection & implementation; and the purposes of these innovated 7 stages are to develop and implement the strategies. The research processes firstly observing the real world of current situation; secondly finding out the needs to match the subject; thirdly brainstorming the flexible thoughts through SST; and lastly implementing the feasible strategies under SSM. We took these new stages to develop the inferred questions and the answers.

(2) The Core Concept of Transformation

Transformation is an important process for creating the new definition, the necessary conditions included the key words and the related meanings, a wide thinking can be flexible and correlated, SST can help searching more new definitions, it's available for using this method for any key words to create more flexible and newer definitions, and this is a significance of this paper.

(3) The Example of Conceptualization

We cited a key word- "control" as an example for creating a newer and flexible meaning: C: culture exchange makes learning and cooperation; O: offering enough medical resources; N: necessary for teaching people with preventive knowledge; T: technological quarantine systems prevents local disease cases and blocks community infections; R: research & development for the vaccine; O: official severe policies helps social stabilities; and L: learning experiences from other countries for pandemic decreasing. This example was proposed for proving that SSM is an effective methodology for this research; and the main transformed skill is the linkage between the meanings and subjects.

3.3 Research Methodology

Following the above changes, we innovatively explained more about the meanings and processes of the new 7 SSM stages: (1) referring to the literature; observing the current situations; and analyzing the existed problems by broadening the mind; the process like creating problematic situations; (2) finding out more related meanings and definitions about the key words from the references, the process like preparing for doing the transformation; (3) building dimensions by giving the root definitions of the key factors, the process like

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selecting key words as the variables; (4) developing the inferred questions by transforming the definitions, the process like proposing propositions in empirical research; (5) developing analytic & practical answers for the questions, the process like validating from propositions to hypotheses empirically; (6) finding out a proper and an effective strategy by using SST under SSM, the process like obtaining the results through a methodology in quantitative research ; (7) implementing all the effective strategies by making a reflection, the process like taking actions for all the thinking and planning.

The above processes helped clearly understanding the antecedents and consequences of the main discussion, logically building the questions, and systematically developing the strategies; all the logical inferences are the core spirits of this paper. In sum, our research methodologies are: creating new definitions through SST; developing effective strategies through observations and inferences; and creating 7 new stages of SSM through literature review and current situations.

3.4 Research Process

Due to Covid-19 is a special event, this research took different processes in developing the inferred questions and analytic & practical answers, during the period, real situations have also become the solid consequences. We *firstly* linked the literature with the real situations under the pandemic; conducted the "key points" as a frame to build inferred questions like developing propositions; *then* developed the correlative items through the possible factors like building hypotheses within the dimensions. The purposes of the inferences are to test and support the strategies. In the process of developing the strategies, we integrated the definitions for the key words by according to the current situations; all the developments were under a principle for matching the subjects and questions; and the whole processes demonstrated an effective linkage through SST under SSM. Except considering the current global situations, 3 supported theories - Prevention Theory, Contingency Theory, and Control Theory have been used as the strategic policies for the transformation in this research.

3.5 Transformation / Inferred Question / Analytical & Practical Answer

(1) *New Definitions of Pandemic*

Pandemic is a global health crisis; the definition of pandemic from Cambridge Dictionary is "a disease existing in almost all of an area or in almost all of a group of people, animals, or plants"; while the definition from the USA Dictionary is "a dangerous disease that infects many people at time"; "pandemic" is the worldwide spread of a new disease (WHO); pandemic can be divided by its nature into national and international (CDC[16]).

WHO made an announcement that Covid-19 is a pandemic; the definition of pandemic includes the key features: wide geographic extension, disease movement, novelty, severity, high attack rates and explosiveness, minimal population immunity, infectiousness and contagiousness (W. Qiu et al, 2016). Through the above definitions, this research integrated the definitions of "pandemic" which contains deadly, infectious, and transmit from person to person. In this research, the new definition of "pandemic" is "a disease with *highly risk* to kill people and fast spread; and the disease can infect people easily and spread efficiently from person to person". Because pandemic threatened human's life, an essential basis to isolate highly-risk people and develop effective strategies for decreasing pandemic are utmost of importance. The concepts helped developing the Inferred Question 1 and Analytical & Practical Answer 1:

Q1: *Covid-19 is a pandemic, it is essential to develop effective strategies to decrease spreading; can countries find out the practical strategies with a systematic review from soft systems thinking?*

A1: *Isolating highly-risk group of people is the first essential strategy for decreasing pandemic spreading, such as: isolating elderly people and chronic patients.*

Proof: dangerous disease (the original definition); highly risk (SST); isolation (SSM-Take actions).

(2) *New Definitions of Prevention*

Prevention involves preventive measures or strategies, and it aims to avoid the infection of a disease. Disease can be prevented in many cases and ways, it could prevent situation of

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[16] Centers of Disease Control and Prevention

disease with effective strategies. 3 levels[17] of preventive care are primary, secondary, and tertiary in medical field. Primary prevention aims to avoid the development of a disease or disability in healthy individuals; secondary prevention is early disease detection, making it possible to prevent the worsening of the disease and the emergence of symptoms, or to minimize complications and limit disabilities before the disease becomes severe; tertiary prevention aims to reduce negative impact of an already-established disease by restoring function and reducing disease-related complications, tertiary prevention also aims to improve the quality of life for people with disease. As the above quote, Covid-19 was to be prevented as the secondary prevention, with this level the definitions appeared by 3 key words: prevention, detection, and emergence.

To Covid-19, vaccination is the second effective prevention for the infection; and cultural learning, education, and awareness are relatively important. This research inductively integrated the strategies of prevention such as: detect source of infection; avoid virus developing and spreading; abide government policies; start vaccination, ban imported cases, dispose of asymptomatic infections…etc. Thus in this research, the new definition of "prevention" is "a systematic thinking to explore the effective ways to avoid disease infecting and spreading; it's a preventive, detective, and emergent scheme to avoid the infection, and protect human lives before the situations become worse and severe." The concepts helped developing the Inferred Question 2 and Analytical & Practical Answers 2-5:

Q2: Before Covid-19 becomes severe, it is essential to develop effective strategies to avoid infecting and spreading, can practical preventive strategies with a systematic review from soft systems thinking be helpful?

A2: Vaccination is the second essential strategy for decreasing pandemic spreading, such as strengthen immune system and fight against with the virus.

A3: Culture is the third essential strategy for decreasing pandemic spreading, such as culture exchange and culture education.

A4: Education is the fourth essential strategy for decreasing pandemic spreading, such as teaching citizens with preventive knowledge and protective skills.

A5: Awareness is the fifth essential strategy for decreasing pandemic spreading, such as crisis awareness and preventive awareness.

Proof: prevention, detection, emergency (original definition); vaccination, culture, education, awareness (SST); problem solving, real world, feasible changes (SSM).

(3) *New Definitions of Contingency*

The definition of "contingency" from the Cambridge Dictionary is: "something that might possibly happen in the future, usually causing problems or making further arrangements necessary." The definition of "contingency" from the Oxford Dictionary is: "a future event or circumstance which is possible but cannot be predicted with certainty." "Contingency" is a case, an emergency case; an event, an unforeseen event; or an accident, an unpredicted accident. Other definitions come from dictionaries such as: "contingency" implies an emergency or exigency that is regarded as possible but uncertain of occurrence; "contingency" is a significant concurrence or convergence of events urgency of demands created by a special situation; while "emergency" is good and proper for explaining contingency: "applies to a sudden unforeseen situation requiring prompt action to avoid disaster." From the above references, we produced 3 key words for "contingency": emergency, uncertainty, and prompt action.

The meaning of "contingency" from systematic view is: "tend to throw doubt on traditional and human relations thinking about management."(Michael C. Jackson, 1991), Jackson emphasized that contingency system treats organization as an opened system with independent subsystems, he supported the interaction between the main system and subsystems, and he mentioned about "uncertainty" and "diversity task" in explaining "contingency". We hold our meaning - "the important utility of functions" through Jackson's ideas and inductively integrated more related meanings of "contingency" as below: possibilities, accident, emergency, changing, diversity, occasionally, opened space, dangerous situations, speedy, union, connection, processing, problem-solving, prevented construction,

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[17] https://courses.lumenlearning.com/diseaseprevention/chapter/three-levels-of-health-promotiondisease-prevention/

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variety of plans, and functional approaches….etc; and the points are: emergency, dangerous situation, speedy, and problem-solving.

More, Checkland (1999) reflected from literature and shared his view point regarding the differences between "hard" and "soft": "hard" system thinking is appropriate in well-defined technical problems and that "soft" system thinking is more appropriate in fuzzy ill-defined situations involving human beings and cultural consideration. The above natures of references involved human's behaviors & attitudes and displayed the key definition of contingency: "a dangerous situation needs a speedy problem-solving strategies"; the transformed definitions of "contingency" in this research are: "an opened system with emergent functions for pandemic decreasing, it helps problems-solving under dangerous situation with a speedy response, and it's an emergent and a rescued system." Through these concepts, the Inferred Question 3 and Analytical & Practical Answers 6-7 were developed:

Q3: *Covid-19 is a pandemic, it is essential to develop effective strategies to reduce the negative impacts; can a practical contingency strategy with a systematic review from soft systems thinking be helpful?*

A6: *Behavior is the sixth essential strategy for decreasing pandemic spreading, such as self-disciplined behavior and law-abide behavior.*

A7: *Attitude is the seventh essential strategy for decreasing pandemic spreading, such as respect government policies and order-abide attitude.*

Proof: emergency, uncertainty, prompt action (original definition); behavior, attitude, speedy response, rescued system (SST); problematic situation, root definition, action to improve (SSM)

(4) *New Definitions of Control*

The definition of "control" is a person or thing used as a standard of comparison for checking the results of a survey or experiment; we took the definition and made the linkage with current situations and obtained the first point: *standard*; the other definition of "control" is the governing or limitation of certain objects, events, or physical responses; we grabbed the second points: *power* and *authority*; others' like adjusting a requirement, holding in restraint, and reducing or preventing the spread of diseases; we kept the points: *adjusting*, *restraint*, *reducing*, and *preventing*; finally, another definition of "control" is the power to influence or direct people's behavior or the course of events; and we caught the points: *manage* and *direct*; specially, the definition of "control" in science & technology is: *isolation*.

"Control" means to solve the problems with precision that otherwise be impossible, we inductively integrated the meaning of "control" which involved: the meaning of command, dominance, containing, confinement, order, instruction, *detection*, *tracking*, and charge; and it related with the factors of range, purpose, timing, process, method, cooperation, risk, variant, strategy, and leaderships…etc.

In systematic views, "control" is that the systems or subsystems receive inputs and produce outputs (Checkland, 1990); Checkland defined "control" by giving the definition as "the means by which a whole entity retains its identity and / or performance under changing circumstances."; we hold the points through Checkland's ideas: means and changing; this research defined "control" as a tool or method for doing something to achieve the goal, and we hereby linked the above definitions with "technology". Checkland also explained that a system can continue to accomplish a given purpose despite disturbances by taking control action once a deviation from preset parameters occurs. Checkland's definitions inspired this research inferring more related meaning of "control" such as: purpose, action, command, approach, leadership, information, protocol, rules, cooperation, interaction, examination, and reflection…etc. A research, additionally, also focused on the importance of "control" from explaining exchange relationships (Pfeffer & Salancik,1978; Thompson,1967). The above meaning "protocol" and "rules" are selected for concerning social and economic stabilities. The research thus defined "control" as "an approach that leaders take actions to decrease pandemic according to the protocol, rules, and information under the commands; and the approach must be functional, cooperative, and reflected." These concepts helped inferring the Inferred Question 4 and Analytical & Practical Answers 8-10:

Q4: *Covid-19 is a pandemic, it is essential to develop effective strategies to reduce the dangerous situation; can a practical control strategy with a systematic review from soft systems thinking be helpful?.*

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A8: Social stability is the eighth essential strategy for decreasing pandemic spreading, such as blocking community infections.

A9: Economic stability is the ninth essential strategy for decreasing pandemic spreading, such as preventing local disease cases.

A10: High technology is the tenth essential strategy for decreasing pandemic spreading, such as detection, tracking, and isolation.

Proof: standard, adjusting, restraint, reducing, and preventing (original definitions); power, authority, detection, tracking, isolation, technology (SST); formal system models, conceptual models, other systems thinking, real world / systems world comparison, feasible / desirable changes, action to improve (SSM)

(5) New *Definitions of Soft Systems Thinking*

The definition of "*soft*" includes gentle, weak, flexible, facile, elastic…etc; "soft" helps solving problems with a more flexible method; and "soft" sometimes creates unexpected effects. A simple explanation from this research between "soft" and "hard" is that "hard is cold", while "soft is active" and "soft is warm"; soft thinking influences human's behaviors and attitudes, and sometimes brings amazing consequences. We believed that a system relies on "soft nature" to be active. The definitions of "*system*" are: an organization, an approach, a machine, a filter, or a method (Jackson, 1991, 1999, 2000) ; scholars supported "organization-as-systems" perspective can be traced from McEwan(1958), Etzioni(1960), and Perrow(1961); "system" is alive, and creates value; system is opened, and with functional goals; system can be copied, and with correlated attributes…etc. In this research, we treated "system" as a tool for *learning, sharing,* and *communication.*

The definitions of "*thinking*" are: a deep thought for valuable creation in human's life that linked human's behaviors, attitudes, learning, communication, and interaction…etc. "Thinking" is a way of reflection, and people obtained success and creativity from constant reflection; "thinking" is important, essential, and valuable. In this research, we defined "thinking" is dynamic and need to take actions to complete the mission.

"Soft systems thinking" is an instrument for developing the methods or strategies with flexible, purposeful, and systematic views to solve the problems. "Hard" systems solve the problems through the regulation, protocol, and rules; while "soft" systems solve the problems through a positive, flexible, systematic, and functional thinking. "Hard" systems are limited by factors and conditions, and "soft" systems make the solution more diverse, accurate, logical, and efficient; it's worthy of attention to one point that soft systems bring greater enrichments in developing strategies. The definition of soft systems thinking from this research is "a system with functional characters, boundaries, and goals; it's independent, correlated, interacted, and cooperative; and systems' characteristics helped developing the strategies to solve the problems and achieve the goals." The above definitions, concepts, and inferences eventually helped deriving the frameworks.

3.6 Framework

The disease intruded and caused the influences which included: Economic decrease, social instability, education disruption, political conflicts, health care collapse, and uneven in medical resources; and the influences caused the global problems under the pandemic which included: deaths rate increase, severe unemployment, hopeless isolation, food crisis, epidemic pollution, conflicts, and wars. The influences and global problems need a system control to solve with a systematic view of SST. This research believed that a system control through SST is effective for developing strategies to decrease spreading, and we supported that a whole "system control" includes 3 important systems (prevention, contingency, and control), problems solving, decisions making, and strategies implementation. The functions of these 3 systems in this paper is to integrate epidemic situations and decrease pandemic spreading; the functions of decision making is to develop effective strategies and solve the problems; while strategies implementation is the last part to functionally implement all the effective strategies. These concepts helped developing Framework I (Figure 1, p15).

The primary descriptions come from data collection, phenomenon observing, and evidenced records revealing. The secondary descriptions involved systematic thinking which included 3 main subjects: problems solving, decision making, and strategy implementation. In the first subject, we set 3 main systems (prevention, contingency, and control); in the second subject, we analyzed the factors and conditions for disease spreading, community infections,

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and local disease cases; and in the last subject, we clearly pointed that cultural learning, education, medical resources, social stability, and economic stability are effective strategy for implementation. After giving the secondary logical descriptions, this research produced framework II (Figure 2, p16). Framework II introduced strategic methods and analyzed the appropriate directions and factors for decreasing pandemic; Framework II also involved the important and effective strategic choices, we proposed the second part of the Inferred Questions 5-7 through the concepts of system control:

Q5: *Effective prevention system has a positive correlation with disease spreading rate, indirectly influences medical resources supplements, can enough of medical resources supplements help decreasing the disease spreading?*

A11: Education, awareness, behavior, and attitude are 4 factors that help decision makers setting preventive knowledge, crisis awareness, law-abide behaviors, and respect policies attitudes for decreasing disease spreading rate, and enough of medical resources such as control production chain, use real-name system, ban export, and fair distribution can help decreasing the disease spreading. .

Q6: *Effective contingency system has a positive correlation with community infections rate, indirectly influences social stability, can high social stability decrease the disease spreading?*

A12: Monitoring, tracking, quarantine, and isolation are 4 factors that help decision makers setting home quarantine, home isolation, centralized quarantine, and police monitoring system for blocking community infections, and social stability such as vaccination policy, issued mitigate program, enough medical supplies, and rescue SMEs can help increasing social stability.

Q7: *Effective control system has a positive correlation with local disease cases rate, indirectly influences economic stability, can high economic stability decrease the disease spreading?*

A13: High Technology, genomic testing, artificial intelligence, and health care systems are 4 factors that help decision makers setting severe government policies, isolation control, citizens cooperation, and quarantine tracking system for blocking local disease cases, and economic stability such as transformation, collaboration, perseverance & resilience, and rescue SEMs can help increasing economic

(1) Framework I:

A Black-Box Engine
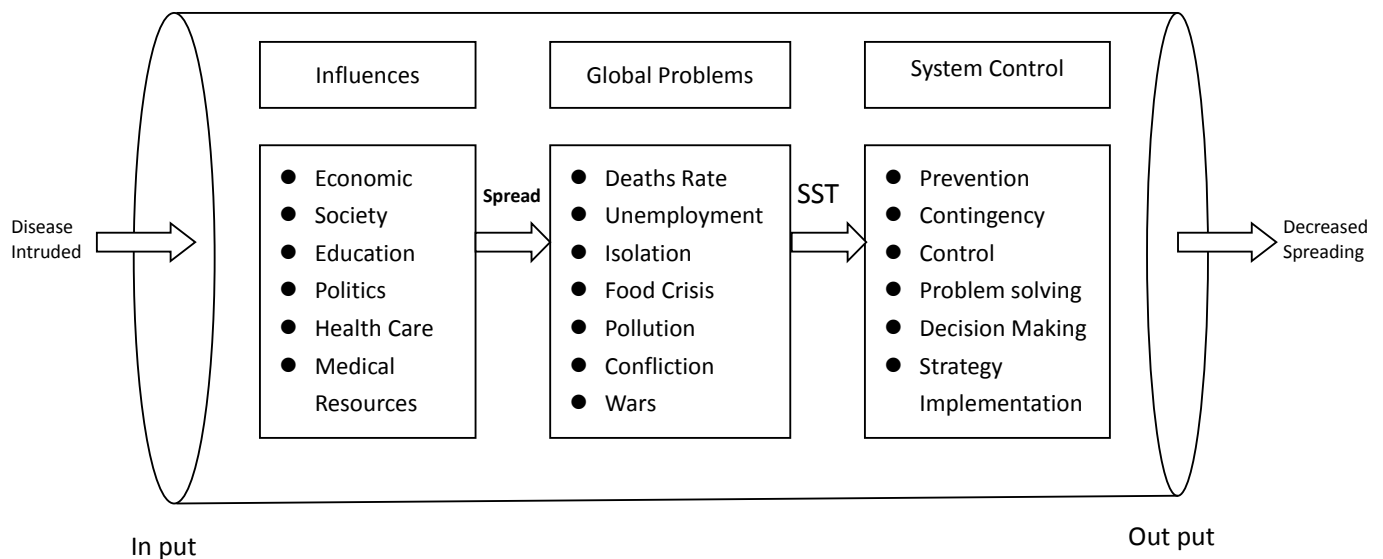
Figure 1: A black-box engine designed for developing strategies
Source: refer to (David Patching, 1990) 《*Practical soft systems analysis*》
Revised by: Maxine (Nov, 2020)

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(2) Framework II:

A System Control Approach

Problem Solving	Decision Making	Strategy Implementation
Prevention ●Education ●Awareness ●Behavior ●Attitude	**Disease Spreading** ●Preventive knowledge ●Crisis awareness ●Law-abide behaviors ●Respect policies attitudes	**Medical Resources** ●Control production chain ●Real-name system control ●Ban export severely ●Equal distribution
Contingency ●Monitoring ●Tracking ●Quarantine ●Isolation	**Community Infections** ●Home quarantine ●Home isolation ●Centralized quarantine ●Police monitoring system	**Social Stability** ●Vaccination policy ●Issue mitigate program ●Enough medical supplies ●Support weak trends
Control ●High Technology ●Genomic testing ●Artificial intelligence ●Health care system	**Local Disease Cases** ●Severe government policies ●Isolation control ●Citizens' cooperation ●Quarantine tracking system	**Economic Stability** ●Transformation ●Collaboration ●Perseverance & resilience ●Rescue SMEs

Decreased Spreading

Figure 2: A system control approach for implementing strategies through SST
Source: (Maxine, 2020)

Regarding the tertiary descriptions, we inductively integrated the *antecedents* of virus spreading: (1) people with low-educated and weak for prevention; (2) people with no medical supplies for protection; (3) countries with no good, practical, and severe policies for controlling; and (4) people with special diseases and took medicine for a long time. Next, we inductively integrated the *consequences* of pandemic spreading: (1) brought people deaths and isolations; (2) changed human's life hugely; (3) hit economics severely; and (4) blocked global communication; importantly, the virus treated people as a host for a speedy transmission also in the frame. A significant normal thing showed that the virus attacked people who were with special diseases and took medicine for a long time, probably because medicine changed chronic patients' body tissue and weakened their immune systems.

In medical and public hygiene field, when dealing with this subject, positive and logical inferences maybe include observing and investigating the relationships between the virus and medicine, food types, or genomic structures; these 3 factors may possibly be concerned and evaluated as causality assessments; thus under the above discussion, we developed the Inferred Questions 8-9 and Analytic & Practical Answers 14-15, and eventually, framework III was produced. (Figure 3, p17)

Q8: The virus seeks 4 ways to spread: (1) people with low-educated and weak for prevention; (2) people with no medical supplies for protection; (3) countries with no good, practical, and severe policies for controlling; and (4) people with special diseases and took medicine for a long time; and which one is the key reason for the main and speedy transmission?

A14: The virus attacks patients more with chronic diseases and people who take medicine for a long time, because medicine changed human's immune system, and low immunity is easily intruded by the virus.

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Q9: The virus has become a pandemic, brought people deaths and isolations, changed human's life, hit economic severely, and blocked global communications; eventually the virus is spreading to the whole world, what should global people do?

A15: People should unite and cooperate under the epidemic, share medical resources and information, and avoid conflictions and wars in order to effectively fight against with the pandemic.

(3) Framework III:

People with low-educated and weak
for prevention

Countries with no good,
practical, and severe
policies for controlling | Virus | People with no medical
supplies for protection

People with special diseases and took
medicine for a long time

Treats people as a host for transmission

The Key

Deaths and isolations

Changed human's lifes hugely | Pandemic | Hit economics severely

Blocked global communications

Spreading to the
whole world

Figure 3: The possible key reason for pandemic spreading
Source: A Docking Effect (Maxine, Dec, 2020)

(3) Explanation

Framework I is a *Black-Box Engine*, means the processes from disease intruding to decrease spreading by an in-put / out-put approach, the key points contain the processes with SST functions and 6 conditions within a system control. Framework I is to describe the influences and global problems, explain that the world has to develop effective strategies to minimize the negative impacts, and propose solving global problems through SST under Covid-19.

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Framework II is a *System Control Approach* with a *systematic thinking structure*, means the processes from problem solving and decision making to strategy implementation, the key points contain the correlations between each dimension and the impacts between each subject, and the descriptions fully detailed by systematic thinking. Framework II is to suggest that the world need to integrate the information and share the resources to solve the problems through SST, and illustrate that the system need to implement strategies through a whole systematic review.

Framework III is a *Docking Effect* with a *systematic prediction structure,* means the processes from the infection to the spreading, the key points contain inferring the causality of the infection, and predicting that medicine might be the key reason helped spreading and made losing control eventually. Framework III is to predict that pharmacological ingredients coincidently matched the intruded structures of the virus. The motivation of the prediction is from observing the differentiation of the spreading, and according to the current situations of the real world.

3.5 New Finding

(1) *A Docking Effect*

Everything possessed causal and effect; people usually observed and examined phenomenon from antecedents to consequences. The observation can strengthen human's thoughts. Ex: A boat docked, water is the first condition; and wave is the second condition; the wave is a power to assist docking a boat. The air is similar (or equal) to the wave, and maybe the necessary intermediary in disease spreading. Why the example can be inferred to the disease spreading? The evidences were from the coincidences below: (1) the deaths rate significantly focused on aging, weak, chronic, and cardiovascular people; (2) all the above types of people have to take medicine to control their illness; (3) medicine changed body tissues; (4) medicine broke immune systems; and (5) patients are the best medium because they are weak and cannot be alone. The inferences were also based on a principle: even the virus knows how to hit human body; they need a suitable environment to live. The Causation Theory and The Effectuation Theory also inspired the inferences, in spite of the theories were usually discussed in business field. A docking effect displays the coincident matching, and such coincidence may illustrate that people possibly created the receptor by themselves and hurt themselves coincidently, because many people involved taking medicine, including drug abuse; more, the quarantine systems did not severely limit and block such types of people as the first consideration in countries, and the ignorance helped the serious spreading.

We cited another example: a cancer patient needs a special medicine and medical treatment, and they have no need in taking headache or stomachache medicine. Logically, medicine's components maybe coincidently matched the intruding structure of the virus; the supports also come from: (1) the differentiations of the spreading; (2) the differentiations of the deaths rate. From the inferences, we may support the aspect that the virus maybe from the lived animal, because if no part of similarities in human tissues or any living tissues, the virus can only attack people or animals shortly, but will exclude serious host behaviors; we further explained the points: with no part of similarities, no docking effect would happen; meant a docking processes won't be completed. Under these inferred circumstances, we predicted that vaccine maybe ineffective, because medical and scientific fields have to clarify the related structures firstly, then they would have the effective vaccine to against the speedy variants.

(2) *Research Gap*

In scientific field, any evidence must be fully linked with science, both predictions and inferences cannot be treated as a real consequence; the expansion of knowledge always come from the discussion and sharing. The part of the discussion may become a gap for the future medical researchers, because scientific proves and explanations are necessary, and they are priceless for always.

3.6 Data Collection

(1)*The Source:* Data comes from primary and secondary resources; literatures review; news, media, reports, and journals; current situations; Ministry of Health &Welfare of Taiwan; CDC[18] of USA & CDC of Taiwan[19]; on line references[20]; knowledge networks[21]; and master

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[18] Centers for Disease Control and Prevention: https://www.cdc.gov/about/organization/cio.htm

[19] Taiwan Centers for Disease Control: https://www.cdc.gov.tw/

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& doctorate webs[22] are also helpful. Because Covid-19 is a special and severe case, we need professional knowledge, skills, experiences, medical information, public insights and visions, decision makings, and effective strategies to help going through the whole research, and we gained utilities from the above listed references.

(2)*Data Analysis Strategy:* The analysis focused on 2 strategies: (1) developed the root definition of the key words; (2) developed the transformed new definition. The analysis strategy performed by 6 stages: (1) focused on the key words, searched and integrated the original definitions; (2) transformed into the new definitions; (3) picked up the new key words from the definitions; (4) developed the inferred questions and analytic & practical answers; (5) developed the answers through SST, and linked them with current situations; (6) evaluated, examined, and reflected these answers, and made them into effective strategies. The analysis strategies controlled the transformed definitions, and the definitions are from the literature review of SST as well as the processes of SSM. How to define a real definition? How to make the definitions coinciding with the real situations? The answer is that we took strategic skills to find root definitions through SST, and developed strategies through SSM.

(3)*Data Analysis Tool*: The analysis tool included literature review and current global situations, especially referred to the knowledge and skills of 4 fields: SST & SSM, Problem Solving, Decision Making, and Systems Control. SSM is the main tool of this research, the tool helped planning the processes of the analysis, and conducting the descriptions of the research. In the meantime, SST guided for searching and defining root definitions; technically, definitive transformed-processes are important steps for developing the strategies.

Ch4 Discussion

Thinking is like a loop, thinking is a way to solve the questions, and "soft" thinking is more flexible and more effective to solve the dilemmas. This is a qualitative paper and "the loop will be back and forth between multiple steps" (Maxwell, 1996). The purpose of empirical analysis normally is to confirm the relationships and correlations between variables, while we proved the correlations between the dimensions, and treated all the factors as the variables. This paper focused on observing the current situations, defining the meanings of the key words, analyzing the antecedents and consequences, and extracting relevant essences from the literatures. The processes of the whole research involved SST & SSM.

This paper took literature review as the method, the highlight of the whole paper focused on the processes of: (1) exploring the antecedents and consequences of the pandemic; (2) developing the strategies through SST; (3) implementing the strategies under SSM. The proportions of the analyses are higher than the reviews. The significant parts included: (1) *transformation*: generated the transformed new definitions; (2) *inferences*: developed the inferred questions and analytic & practical answers; (3) *construction*: built 3 frameworks; and (4) *conclusion*: stated the suggestions and predictions.

The forms of Q &A were similar to propositions and hypotheses in empirical research, most of the strategies were developed by reviewing the literatures and referring to the current global situations, especially referring to Taiwan's quarantine model. The beliefs and inferred spirits potentially linked with SST, we allowed the thinking actively under 3 principles: (1) flexible & effective; (2) logical & reasonable; (3) systematic & thoughtful. Eventually, we explained that this is a paper to develop effective strategies with a systematic review.

In the processes of the *analyses*, the transformed definitions were from SST, the developed strategies were from SSM, and we combined these 2 interfaces with epidemic current situations (media reports); in the processes of the *developments*, different strategies were based on different decision-makings; decision-makings were from according to the observations; and strategy implementation is for solving the problems ; while the first condition to solve the problem is to know the situations; basically, this is a thinking loop, and the whole differentiations were from the different attributes of the strategies.

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[20] Bureau of Animal and Plant Health Inspection and Quarantine Council of Agriculture Executive Yuan: https://ahis.baphiq.gov.tw/app/
[21] National Health Research Institute: https://www.nhri.edu.tw/
[22] National Digital Library of Theses and Dissertations in Taiwan: https://ndltd.ncl.edu.tw/cgi-bin/gs32/gsweb.cgi?o=d

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We took Taiwan's quarantine model as the example to discuss and share. This paper contributed on strategic quarantine and preventive skills; we do believe and hope that the medical treatments, quarantine methods, preventive skills, contingent strategies, epidemic information, and medical resources under pandemic are vital to every country and every one.

Ch5 Conclusion

In this chapter, we integrated and selected the most important strategies to answer the research and inferred questions; additionally, this research gave suggestions to future researches; and helped forecasting the prospects.

5.1 Conclusion

This research built the inferred questions via the transformed definitions and developed the answers through SST, then linked the answers with current situations to develop the effective strategies; in terms of the results, the supported evidences were from literature reviews, supported theories, current situations, referenced methods, and personal research experiences; and the positive and final solutions were as following:

(1) We integrated the *influences* of Covid-19: economic collapse; social instability; political confliction; education interruption; health care overburdening; and medical resources were uneven-distribution. The most important strategy is to ensure medical resources are evenly and adequately supplied.

(2) The emerged *global problems* under Covid-19: deaths rate increased; unemployment led to riots; isolation resulted in helplessness; epidemic pollution affected the environment; food crisis appeared; finally, conflictions may arise; and wars may happen. The most effective strategies are learning and cooperation; learning is from culture exchange, while cooperation is from sharing the medical information and resources globally.

(3) The effective strategy for *systems control* through SST: prevention; contingency; control; problem solving; decision making; and strategy implementation. The most effective strategy is to build a systematic perspective through SST; and 6 important factor conditions directly impact decreasing the disease spreading under the systems control.

Next, a systematic thinking structure-*a System Control Approach* included 3 parts: problem solving, decision making, and strategy implementation. Problem solving contained 3 systems (prevention, contingency, and control); decision making complied with 3 topics (disease spreading, community infections, and local disease cases); and strategy implementation embodied 3 conditions (medical resources, social stability, and economic stability). A systematic thinking structure orientated *prevention system* with effective strategies which included: education, awareness, behavior, and attitude; a systematic thinking structure orientated *contingency system* with effective strategies which included: monitoring, tracking, quarantine, and isolation; a systematic thinking structure orientated *control system* with effective strategies which included: high technology, genomic testing, artificial intelligence, and health care system. The most important strategy is using high-technology for epidemic prevention, quarantine, and emergency response. We took the results with referring to the global situations and integrated the points below:

(1) The best *prevention* strategies are: vaccination; and isolation. The best preventive strategies through SST would be: teaching citizens with preventive knowledge and protective skills; helping people with recognizing cultural differences, and guiding people with a learning scheme.

(2) The best *contingency* strategies are: holding the defense, and information transparency. The best contingency strategies through SST would be: monitoring & tracking systems; and quarantine & isolation systems.

(3) The best *control* strategies are: avoiding local cases; and blocking community infections. The best control strategies through SST would be: using high technology; and adopting artificial intelligence.

(4) Other effective strategies through SST would be: cooperation and transformation, such as: transform thinking from negative to positive; encourage enterprises transforming by taking the spirit of perseverance and resilience.

The purpose of *decision making* is to develop strategies optionally, the decision makers guided people respecting the policies; blocked community infections by taking police monitoring & tracking systems and adopting centralized quarantine; and blocked local disease cases by taking home quarantine & isolation and issuing severe government policies.

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While strategy implementation focused on enough medical resources, social stability, and economic stability; and the loop displayed that fair distributions, enough medical supplies, and transformation are vital to decrease the spreading. The above discussion showed that high-tech, genomic testing, and artificial intelligence are most important to implement, and SST & SSM are also the important guidelines.

5.2 Suggestion

What's in the future about commercial under Covid-19? The suggested strategies to the *epidemic era*: (1) enterprises have to be transformed; (2) services have to be reformed & innovated; (3) timing will be the key and have to be treasured; (4) perseverance & resilience are the necessary spirits and sentiments and have to be practiced; (5) innovative DNA have to be switched; and (6) high-technology in all-around have to be adopted…etc. Business models have been changed, enterprises have to realize the environmental conditions have also been changed, sharing economic mode and fast delivery mode have been increased, and some important questions combined with the strategies cannot be ignored, such as: How to link effectively between customers and enterprises? How to continually create deep values for the brand? How to promote new normal of service lives? "Positive emotions are following a tragedy defends resilient people against depression and can actually cause them to thrive in the face of crisis" (Fredrickson et al, 2003). People need to be carefully to break through with top perseverance and resilience under the epidemic era.

Pandemic hit economics severely, economic down normally appeared through a global crisis and economic cycles, the factors of uncertainty may cause rich people release stocks and assets, and middle classes would take over quickly and pleasantly. After 3-5 cycles, economic bubbles would be emerged; at that time, the gaps between rich and poor would be greater, the trends would increase social instabilities. Economic is a second killer to this world, while Covid-19 is the first killer. Responding to the post-epidemic needs, the strategic suggestions to the *post-epidemic era*: enterprises should be transformed and innovated; the investors should be more conservative; and the government should be issuing more mitigated programs to rescue the SMEs.

5.3 Logical Prediction

If global political issues become more and more serious under the pandemic, conflictions and wars may happen, the reasons may from the changes of humanity, a feeling with no security would make emotion instable, and the instabilities are inevitably from fighting with the pandemic in a long term, these are invisible harms and potential struggles for human beings. A pandemic may kill 1-2/10 global population, but nuclear wars may kill 3-5/10 global population or even more. Peace, same as economic crisis, needs perseverance and resilience, and such 2 conditions are spirits to go toward the world stability necessarily.

Regarding the R&D of vaccine, we hoped that the related researchers, scientists, or inventors can search the relationships and connections between the *virus structures* and the *components of medicine*, from this key point, maybe a new finding about "why kinds of people are easily to infect or die?" would be revealed; the supported perspectives are from the differentiation of hitting records in countries. The vaccine may impact economic markets, and the war of the vaccine may possibly happen under the pandemic, and the most effective strategies are: avoiding monopoly and making collaboration worldwide.

5.4 Future Research

Covid-19 is a serious problem, and both people and enterprises are under the crises. It's practical to overturn the thoughts from a crisis to an opportunity, we analyzed 4 indexes of current situations: (1) the change under the post-epidemic era; (2) the change of social structures; (3) the change of economic structures; and (4) the uncertainty of political conflictions. Pandemic impacts families, societies, enterprises, and human lives, all the factors and conditions can accrete a research motivation, subject, or question. Such as 3 related topics are shared for the references: (1) Can new ventures get out of the haze under pandemic? (2) How is the crisis management under Covid-19? (3) What are entrepreneurial decisions under a crisis in post-epidemic era? More, we take SST as the method to develop the strategies, future researchers may take HST (Hard Systems Thinking) as a method, or take ISI (Integrated Service Innovation) as a supported theory to explore, and surprising results would be expected.

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-Thank you-

Supply Chain Management and Logistics

A ROUST MODEL TO DESIGN GREEN CLOSED LOOP SUPPLY CHAIN NETWORK

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Abstract

This paper addresses the problem of designing a green closed loop supply chain network. We propose a model that considers multiple-periods and products from different generations. These products include new and remanufactured products where product substitution is allowed according to a pre-determined policy. The model considers different uncertainties including product demand, the number of returned products and product substitution fraction. The objectives of the proposed model are to minimize the total cost of the network, minimize carbon emission resulted from different activities in the network and maximize the service level of the market location. To model this problem, we integrated robust optimization uncertainty set theory and non-preemptive goal programming approached.

Keywords: *Green Closed Loop Supply Chain, Product substitution, Robust Goal programming, Customer satisfaction*.

Introduction and related work

As environmental issues have become a real concern recently, Closed Loop Supply Chain (CLSC) has become a promising solution to mitigate them. CLSC is an integration of the forward and reverse supply chain. Generally, the forward supply chain includes the flow of all processes and activities involved in converting raw materials to final products and deliver them to the consumers. The reverse supply chain involves recovery processes applied on end of life (EOL) products, which are returned due to upgrading purposes, dissatisfaction or when it is unprofitable to repair damaged products (Ilgin & Gupta, 2013).

Green Closed Loop Supply Chain (GCLSC) is a new terminology that has been used in recent years. It is called GCLSC as CLSC has taken into consideration the issue of global warming, which is a serious threat that has raisin in the recent years as a result from the emission of

Greenhouse Gases (GHG) (Du, Hu, & Song, 2016). Designing a network has been discussed widely in the area of CLSC (Gupta & Ilgin, 2018; Ilgin & Gupta, 2010; Ilgin, Gupta, & Battaïa, 2015). On the other hand, only a few studies have discussed the network design of GCLSC (Mardan, Govindan, Mina, & Gholami-Zanjani, 2019; Soleimani, Govindan, Saghafi, & Jafari, 2017; Zhen, Huang, & Wang, 2019; Zohal & Soleimani, 2016).

In this paper, we extend our previous work done by (Aldoukhi & Gupta, 2018, 2019b, 2019c, 2019a, 2020a, 2020b). Here, we use goal programming and uncertainty set theory of robust optimization to design GCLSC network considering multiple objectives and under the uncertainty of different parameters.

Problem description

A network of CLSC includes a set of plant centers, warehouses and collection centers and market locations. The plant center is responsible to manufacture new products and remanufacture returned products. The finished products are shipped to the different market locations through the warehouses. The returned products are delivered to the collection centers where they are tested and based on their condition, either shipped to be remanufactured or disposed of. There are two generations of products. The first generation represents the first edition of the product and the second generation represents the second edition of the product. Figure 1 represents the product demand pattern in multiple periods. For the first half period, the product demand of the first generation gradually increases and then decreases for the second half period. For the second generation of the product, the demand occurs in the second half period. Both products, the new and remanufactured products, follow this pattern. However, for the remanufactured product, there is no demand at the beginning of the period demand since only new products being produced and distributed. The two generations of the new products are allowed to substitute. Similarly, with the remanufactured products, it is allowed to substitute between the two generations. This is to avoid losing the customers and to maximize customer satisfaction as it is allowed for a new product to substitute a remanufactured product if they belong to the same generation. Uncertainties are observed in the demand for the new and remanufactured products, the number of returned products and the fraction of product substitution. Under the above circumstances, we try to determine the optimal number of facility centers and the quantity of products to transport within the network that guarantees the minimum cost, minimum carbon

emitted and maximum service level. The considered cost is the total cost of the CLSC including opening facilities cost, production cost, transportation cost, inventory cost and product substitution cost. For minimizing carbon emission, we use the carbon tax policy as one of the carbon regulatory policies is to reduce the carbon emitted from production, transportation and disposal activities. To maximize the service level, we use the Maximal Covering Location Problem (MCLP) to measure the service level score assigned to each market location and multiplied by the number of products shipped to satisfy the market location.
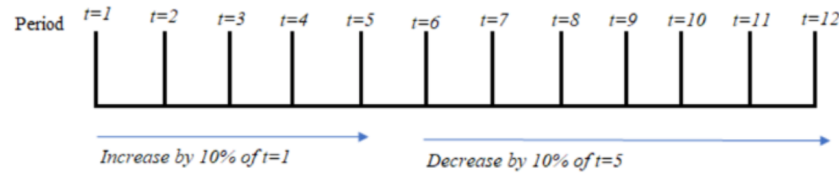
Figure 1: pattern of product demand over the time (Almaraj & Trafalis, 2019).

Methodology

Since formulating this problem considers uncertainties and multiple objectives, we present an integrated approach using the uncertainty set theory of robust optimization and non-preemptive goal programming.

Despite of the several techniques that are available to solve uncertainties in optimization models, robust optimization uncertainty set theory does not require the decision-maker to assume a probability distribution for the uncertainty parameters. However, the uncertainty parameter is represented in a set that takes different shapes. For more information about this technique, we refer the reader to (Ben-Tal, El Ghaoui, & Nemirovski, 2008; Ben-Tal & Nemirovski, 1999, 2002; Bertsimas, Brown, & Caramanis, 2010)

The non-preemptive goal programming is a Multiple Criteria Decision Making (MCDM) technique, which is one of the traditional techniques used to solve multiple objective problems in the area of environmentally conscious manufacturing and product design (ECMPR) (Gupta & Ilgin, 2018; Ilgin et al., 2015).

The proposed model is formulated as follow;

$$Min\ Z = \sum_i W_i\ (d_i^+ + d_i^-) \tag{1}$$

Subjected to:

$$f_i(X) - d_i^+ + d_i^- = y_i \tag{2}$$

$$Kx = b \tag{3}$$

$$\bar{A}x + P_A . G_A x \geq \bar{S} + P_s . G_s \tag{4}$$

$$Hx \geq \bar{r} - P_r . G_r \tag{5}$$

$$Hx \leq \bar{r} + P_r . G_r \tag{6}$$

Where in equation (1), which is the overall objective, d_i^+ represent overachievement of the objective function i, d_i^- represents underachievement of the objective function i and W_i represents the weight of each objective function i. In equation (2), $f_i(X)$ is the ith objective function and y_i is the aspiration level of the objective function i. Equation (3) is a constraint that do not involve in uncertainty. Equation (4), (5) and (6) are a constraint that considers uncertainty, where $\bar{A}$, $\bar{S}$ and $\bar{r}$ are nominal values for the uncertainty parameters A, s and r, respectively. P represents the uncertainty level and G represent the uncertainty scale for the uncertainty parameters.

Numerical example

Here, we consider a network of a CLSC that consists of 3 manufacturing centers, 3 distribution centers, 3 collection centers and 10 market locations. There are 2 generations of a new product, where the 2nd generations is a newer version/updated from the 1st generation of the product. The remanufactured product has also 2 generations, where the 1st generation is produced from remanufacturing the returned 1st generation new product, and similarly with the 2nd generation. By following the above-mentioned demand pattern, the planning horizon is assumed to be over 12 time periods where the new product 1st generation demand is allocated in each time period while the 2nd generation demand of the new product starts from period 7. The demand of the 1st generation of the remanufactured product starts from time period 2 while the 2nd generation demand starts after launching the 2nd generation.   In   It is assumed that .5, .3 and .2 are the weights for the economical, the environmental and the service level objectives, respectively. More information about the data used are shown in table 1.

Table 1: Data used in the model

Parameters	Values
Demand of each product per market locations	Uniform (120, 3000)
Returned product of each product	Uniform (60, 1500)
Fraction of substituting a product	Uniform (0, 1)
Capacity at manufacturing center	50,000 unit
Capacity at distribution center	50,000 unit
Capacity at collection center	24,000 unit
Quality level of returned product	50% very light damage, 30% light damage, 10% medium damage, 10% extreme damage
Carbon cap	800,000 kg
Price of carbon credit purchased	25 $ / kg

Results

Our findings indicate that the results obtained from running a deterministic model is $ 67,394,090, $ 16,252,760 and 254,988 unit for the economic objective, the environmental objective and the service level objective, respectively. However, the results obtained from running the proposed model is $ 60,685,050, $ 14,709,100 and 227,420 unit for the economic objective, the environmental objective and the service level objective, respectively.

We also vary the uncertainty level in which we consider .1, .5 and .9 uncertainty levels. 5 random realizations are generated as the nominal value for the uncertainty parameters using the distribution specified in table 1. We find then the mean and the standard deviation of each objective function as shown in figure 3, 4 and 5.
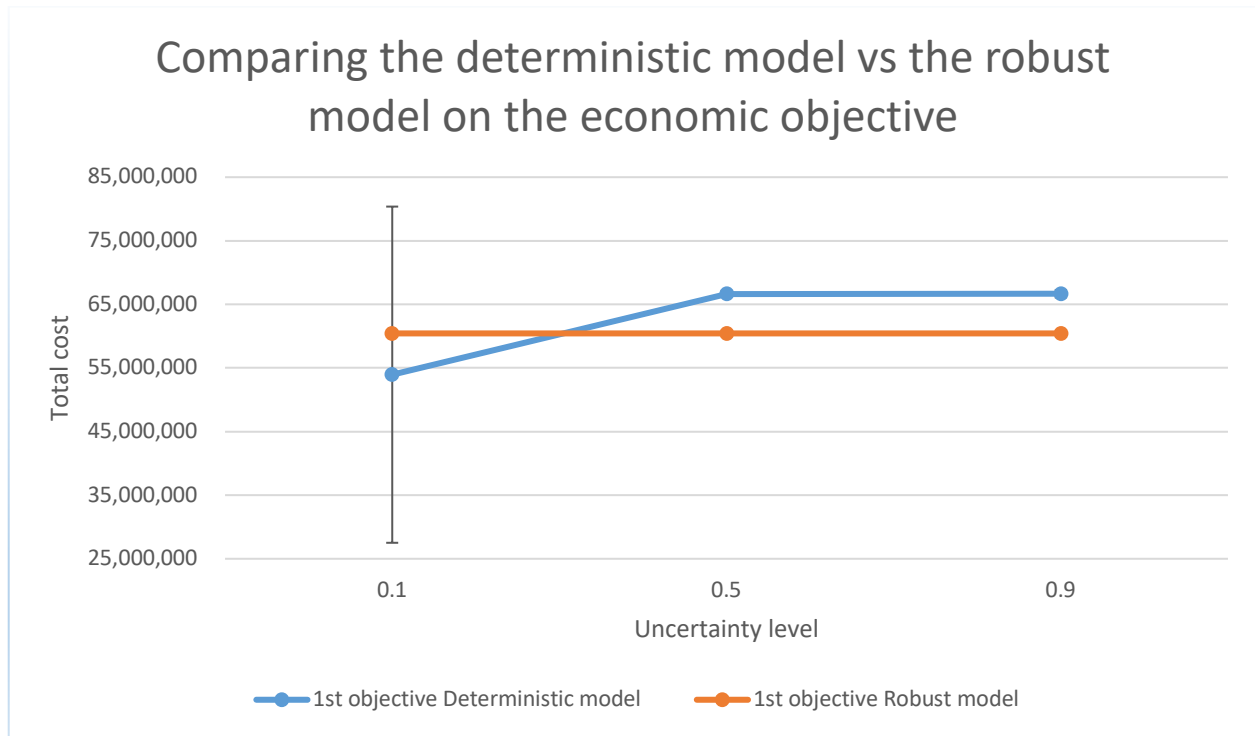
Figure 2: Results of the economical objective for the deterministic model and the proposed model
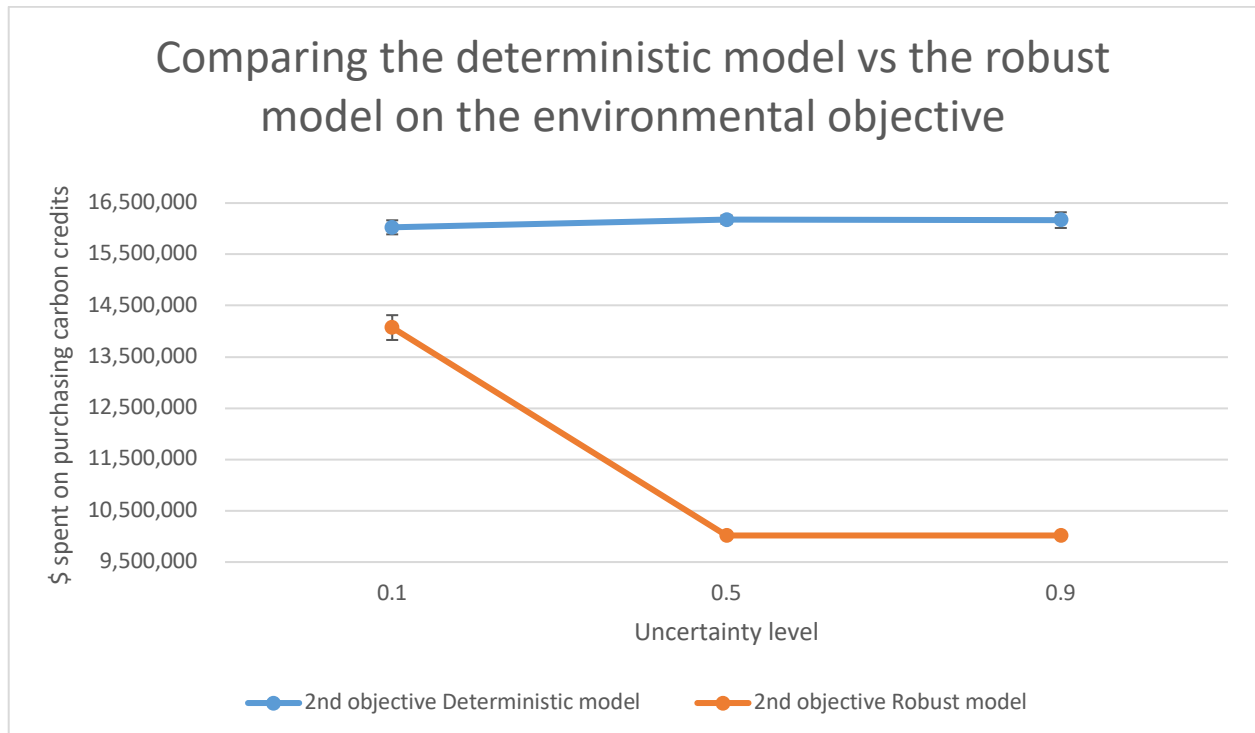
Figure 3: Results of the environmental objective for the deterministic model and the proposed model
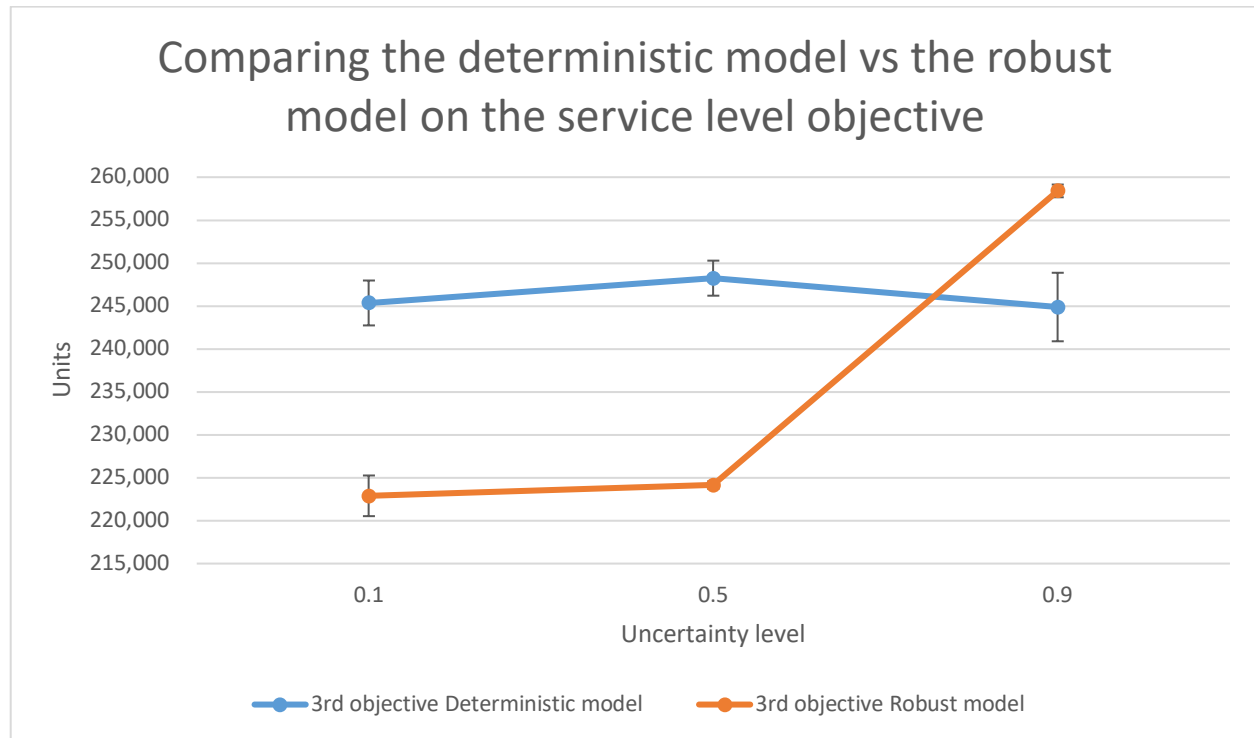
Figure 4: Results of the service level objective for the deterministic model and the proposed model

Conclusion

This paper discussed a problem of designing a CLSC network for different generations of products, under uncertainties, considering multiple objectives and allowing products to be substituted. The uncertainties considered in this study were product demand, the number of returned products and the fraction of product substitution. The objectives considered in this paper were economic, environmental and service level objectives. We used a model that integrates goal programming and robust optimization approaches.

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DEVELOPMENT OF SUSTAINABLE DESIGN METHODS ON ENVIRONMENTAL AND ECONOMICAL DISASSEMBLY SYSTEMS

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ABSTRACT

Design methods on environmental and economical disassembly system are required for sustainable material recycling from numerous end-of-life assembled products [1]. These design methods consider disassembly line balancing that assigns disassembly tasks to each work station [2]. On the other hand, each part has environmental and economic characteristics such as recycling rates, CO_2 emissions during manufacturing, material selling profits and disassembly costs of materials contained in the product. Therefore, line balancing with selecting disassembled or disposed parts are also required [3]. This study develops sustainable design methods on disassembly system that balance lines with selected environmental and economical parts.

Keywords: Recycling, Environmentally-conscious Manufacturing, Low-Carbon manufacturing, Line Balancing, Integer Programming

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Evaluation of Manufacturing and Remanufacturing Mixed Production Systems for Environmental, Economical and Equipment Stability

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ABSTRACT

Designing a system to remanufacture electronic devices can help reuse the resources contained in the discarded devices. However, the reuse of discarded products is costly in terms of collection and processing. In addition, the construction of a remanufacturing facility would not only increase the cost significantly, but would also reduce the availability of the production facility. However, few studies have dealt with remanufacturing systems considering the stability of production facilities in addition to environmental and economic evaluations. The decrease in the utilization rate of production facilities causes the generation of wasted electricity, which is an environmental burden, and economic losses due to out-of-stocks. To improve the environmental and economic performance of the production system, stable facilities are required. The purpose of this study is to model a mixed production line for manufacturing and remanufacturing, in which used products collected from the market are recovered and reprocessed in the same factory as new products, and to propose an optimal production strategy to manage the system from the viewpoints of environment, economics, and facility stability.

Keywords: Remanufacturing system; Inventory control; Just-in-time; Probabilistic demand; Idling power

INTRODUCTION

In recent years, environmental degradation and depletion of energy resources have led to the need for sustainable production in the industrial world (MOE white paper, 2020). In the manufacturing industry, the environmental impact of the disposal of electronic products has become an issue due to government regulations and a growing awareness of environmental problems among customers. For products like smartphones and tablets, which have a short development period and for which new models are launched in quick succession, a large number of discarded products accompany the launch of new products, which has become a problem (Shiratori, 2007). To reduce the amount of discarded products and the

environmental impact, remanufacturing systems have been studied for the collection of used products and their reuse as parts or raw materials to effectively utilize resources (Ilgin, 2010).

To evaluate the remanufacturing system in terms of the environment, economics, and facility stability, it is necessary to model a production system for manufacturing and remanufacturing. Studies on remanufacturing have been conducted from various perspectives, such as production planning, scheduling, inventory control in material and product recovery, and pull strategies for inventory control (Zhou, 2020; Feng, 2019). Studies have been examines the design of remanufacturing systems based on deterministic demand and the number of end-of-life products recovered. Rubio et al. (2008) performed optimization based on deterministic demand in the development of manufacturing and remanufacturing systems. Tang et al. (2005) showed that Tang et al. (2005) developed an inventory system for a manufacturing and remanufacturing system when the lead time is stochastic and the demand is deterministic. In these studies, stochastic demand is not considered. In the case of electronic devices with short life cycles, the demand for old products may change with the sale of new products. In addition, if remanufactured products made from recovered used products are sold at the same time as new products, cannibalization may occur, in which the demand for new products decreases due to the demand for remanufactured products with lower prices. A remanufacturing system based on deterministic demand cannot cope with such fluctuations in demand.

In a study on cannibalization, Okuda et al. (2018) designed a non-stationary demand model for newly manufactured and remanufactured products considering the cannibalization effect, where the demand for new products is reduced by the sale of reused products with lower prices when discarded products are reused and sold. Furthermore, this model is used to develop an optimal production plan that accounts for differences in the timing of demand for each of the newly manufactured and remanufactured products and to evaluate the impact of the system on environmental factors and economic efficiency.

Takahashi et al. (2014) proposed a method of adaptive inventory control for remanufacturing systems that can control the manufacturing and remanufacturing rates in remanufacturing systems. In their study, Takahashi et al. (2014) used a pull strategy to prioritize the manufacturing of new products and remanufactured products. In this study, the pull strategy is a method that determines whether or not to carry out manufacturing based on the number of items in stock, and it is widely used in manufacturing, especially the pull strategy using the Kanban method developed by Toyota Industries Corporation. Van et al. (2006) developed heuristics based on the push, pull, and hybrid strategies and compared them to show the superiority of the pull strategy.

The aforementioned studies deal with manufacturing and remanufacturing systems based on the deterministic and stochastic demand. However, there is no research on remanufacturing systems that consider the stochastic recovery of used products. In a remanufacturing system, the used products required to manufacture the remanufactured products do not provide a definitive supply. End-of-life products are collected from consumers who give them away, and they are supplied from the market to the factory, which has the manufacturing and remanufacturing system. In this case, there is uncertainty about the interval between the arrival of used products and the amount of supply at any given time. Therefore, to evaluate and optimize the manufacturing and remanufacturing systems, it is

necessary to consider and model the uncertainty of the amount of used products collected in addition to the demand.

The reuse of waste products involves costs, such as processing for recovery and reprocessing. In addition, the construction of a remanufacturing facility will not only increase the cost significantly, but also reduce the availability of the production facility; however, few studies have dealt with remanufacturing systems considering the stability of the production facility in addition to environmental and economic evaluations. The decrease in the utilization rate of production facilities is a factor that causes the generation of wasted electricity, which is an environmental burden, and economic losses due to out-of-stocks. To improve the environmental and economic performance of the production system, stable facilities are required.

Some modeling studies predict the recovery rate of end-of-life products. Turki et al. (2018) proposed a model in which the recovery rate of used products is determined by the sales of the past period, to determine the optimal value of the length of the manufacturing and remanufacturing periods and the available inventory capacity of newly manufactured and remanufactured items. Decision making based on the recovery rate of used products, which depends on the sales of the past period, may not be able to adequately take into account events like shortage or concentration of recovery in a short period of time, which may cause equipment standby. Therefore, it is necessary to design a system that accounts for the recovery rate of end-of-life products, which is more uncertain.

The purpose of this study is to model a mixed production line for manufacturing and remanufacturing, in which used products collected from the market are recovered and reprocessed in the same factory as new products, and to propose an optimal production strategy to manage the system from environmental, economic, and facility-stability viewpoints.

MANUFACTURING AND REMANUFACTURING SYSTEMS

This study deals with a manufacturing and remanufacturing system, in which the products of an old model are collected, disassembled, and reprocessed when a new product is sold, and manufactured and sold simultaneously, with the new product, as a remanufactured product.

In the remanufacturing system, when a consumer returns an old model existing in the market, a part of it is considered a used product. The collected products are treated as parts and materials to produce remanufactured products. Since the timing of when consumers return their products is indefinite, the interval between the arrival of used products to be employed as parts and materials to the factory is uncertain.

Remanufactured products that utilize used products as parts are less expensive than new products of the same type. By simultaneously selling remanufactured products of older models and new products, a demand for cheaper remanufactured products is generated. Additional profits can be expected by simultaneously selling remanufactured and new products. In this study, we analyze the manufacturing and remanufacturing system of a factory that manufactures and sells new and remanufactured products simultaneously.
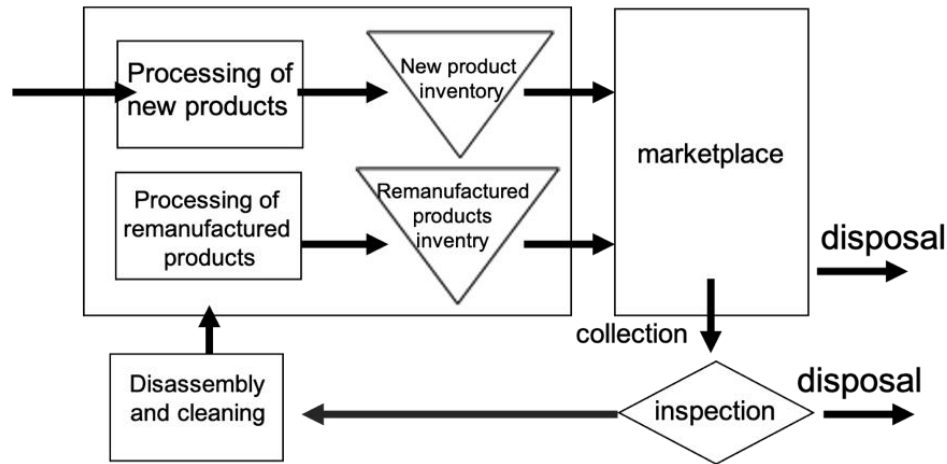
Figure. 1 Manufacturing and remanufacturing systems

MANUFACTURING AND REMANUFACTURING SYSTEMS
IN PRODUCTION LINES THAT MANUFACTURE A SINGLE PRODUCT

In the remanufacturing system, used products collected from consumers are disassembled, cleaned, and used as parts and materials for the manufacture of remanufactured products. The supply of parts made from used products is indeterminate over a period of time compared to the stable supply of new parts.

If a remanufacturing system is designed to handle only remanufactured parts, to remanufacture used products with low recovery, the production capacity of the remanufacturing facility may exceed the number of parts supplied. In a production line that produces only remanufactured goods, the jobs given to the processing facilities will never exceed the supply of parts. When the production capacity of a machining facility exceeds the number of jobs given to it, the facility will remain idle, waiting for parts to be supplied, without machining or setup changes. The idling state caused by waiting for parts supply does not contribute to the product value, while the facilities state has added value, such as product processing and setup change. As idle facilities generate idling power, unnecessary power costs are incurred while the facility remains idle, waiting for parts to be supplied. In a machining facility with a low utilization rate, as shown in Figure 2, there is a long idling time, which results in a large amount of wasted power. The generation of idling power creates a wasteful environmental impact and there is an economic loss due to idle costs. It is necessary to design a production system that is appropriate for the number of used products collected, to reduce the wasteful power consumption caused by idling power.

Figure 2 shows a conceptual diagram of the biomass plant used in this study. In this case, biomass raw materials are charged every day, and the charged raw materials are sent to the mixing tank through the pump. Finally, syngas is produced in the fermenter.
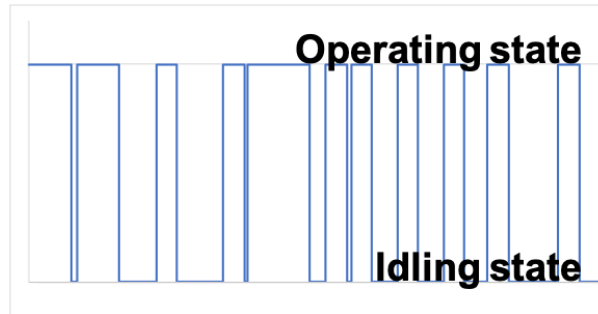
Figure. 2 Operating conditions of underutilized processing facilities (expected)

MANUFACTURING AND REMANUFACTURING SYSTEMS IN MIXED PRODUCTION LINES THAT MANUFACTURE MULTIPLE PRODUCTS

When a new product and a remanufactured product are produced on the same production line, the new product can be processed during the period when the used product is not supplied. In such a mixed production line where multiple products can be processed, the operating status of the processing facility does not depend on the supply of used products, so there is no waiting state due to lack of parts supply. However, in a production line for a single product, it is sufficient to continue producing that product, whereas in a production line for two products, it is necessary to produce the product to meet the demand for each product. Since the number of used products collected is indeterminate, when the amount of reclaimed products is small and the demand is large, the remanufactured products tend to go out of stock. Therefore, it is desirable to keep a certain number of remanufactured products in stock considering the demand.

If the stock of remanufactured products is insufficient and many used products are collected, the remanufactured products are processed until the minimum stock is secured. In this case, a large number of remanufacturing jobs are given to the machining facility, which reduces the facility's resources to process the new product. As a result, there may be a decrease in the production of the new product. If the production capacity of the processing facility is insufficient, there may be a reduction in the production of the new product or an inability to maintain sufficient stock of remanufactured products. If either or both products are out of stock, an opportunity loss will occur.

To reduce the opportunity loss due to out-of-stocks in a mixed production line, it is necessary to design a production line with the capacity to meet the demand for both new and remanufactured products. However, the timing of the peak in the processing facility, when remanufactured products are given a large number of processing jobs, is uncertain because it is determined by the market demand and the number of used products recovered from the market. The average steady-state demand and yield forecasts cannot account for the concentration of jobs on the processing facility during such a short period. In this study, a factory model is designed and evaluated using a production system simulation, to consider the concentration of jobs over a short period of time in a mixed production line where two products, a new product and a remanufactured product, are manufactured simultaneously.

MANUFACTURING AND REMANUFACTURING SYSTEM MODEL

In this study, we modeled two types of factories that operate manufacturing and remanufacturing systems: a manufacturing and remanufacturing system in a production line that manufactures a single product and a manufacturing and remanufacturing system in a mixed production line that manufactures multiple products. The symbols used in this study are as follows:

TP : Total profit
M_n: Volume of production of new products
M_r: Production quantity of remanufactured products
$R(t)$: Number of used products collected in period t
$R'(t)$: Number of used products that can be reused in period t
$W(t)$: Amount of waste in period t
$S_n(t)$: Sales volume of new products in period t
$S_r(t)$: Sales volume of remanufactured products in period t
$I_n(t)$: Inventory of new products in period t
$I_r(t)$: Inventory of remanufactured products in period t
$Iip_n(t)$: Intermediate stock quantity of new products in period t
$Iip_r(t)$: Interim inventory of remanufactured goods in period t
$L_n(t)$: Out-of-stock quantity of new products in period t
$L_r(t)$: Out-of-stock quantity of remanufactured goods in period t
C : Total cost
C_h : Inventory storage cost
C_s : Opportunity loss cost
C_{run} : Processing cost, such as processing power
C_{wait} : Idle cost, such as idling power
$Trun_m$: Total processing time in facility m
$Twait_m$: Total waiting time in facility m
M : Number of processing facilities in the manufacturing and remanufacturing system
H : Planning period

CT_n : Production lead time of new product
CT_r: Manufacturing lead time of remanufactured product
p_n: Price of new product
p_r: Price of remanufactured product
$D_n(t)$: Demand for new product in period t
$D_r(t)$: Demand for the remanufactured product in period t
r_1: Recovery rate of used products
r_2: Yield rate of the recovered used products
rp: Ordering point for remanufactured products
c_h: Inventory storage cost per unit time and product quantity
c_s : Out-of-stock cost per unit of product quantity
c_{run}: Processing power cost per unit time
c_{wait} : Standby power cost per unit time

A manufacturing and remanufacturing system consisting of a production line manufacturing a single product is shown in Figure 3, and one consisting of a mixed production line that manufactures multiple products is shown in Figure 4.

It is assumed that sufficient quantities of parts for new products are always supplied in a stable manner. In addition, there are buffers before and after each machining facility, and sufficient capacity shall exist. (There shall be no waiting for processing facilities due to blocking between processes.)

Remanufactured products are remanufactured using products collected from the market. In this model, the number of used products that the consumers return to the market according to the probability function, multiplied by the recovery rate r_1, is the recovered amount $R(t)$. The collected products go through the inspection process and are supplied to the production line for remanufactured products as the number of available used products, $R'(t)$, which is obtained by multiplying the recovery amount $R(t)$ by the yield rate r_2, depending on the degree of wear of the parts.

In a production line that manufactures a single product type, the product is produced according to the quantity supplied. The parts to manufacture a new product are always supplied to the first process in sufficient quantities to meet the demand. The production line that manufactures the new product manufactures the product as the parts arrive. Products used to produce remanufactured products are supplied according to the behavior of consumers in the market, so that stochastic quantities are supplied to the first process. Since the supply is not stable, remanufacturing is done to produce excess inventory, even when demand is met.

In a production line that manufactures multiple products, a pull strategy is used to determine whether to manufacture new products or remanufactured products based on the number of remanufactured products in stock at that time, $L_r(t)$.

Using an arbitrary number of order points rp for remanufactured products, if $L_r(t) < rp$ is satisfied, the remanufactured products are processed at the processing facility in the mixed production line. If $L_r(t) \geqq rp$, the processing facility processes the new product.

When a manufacturing and remanufacturing system has two or more production lines, one for a single product type and the other for multiple product types, the buffers for storing the available used products are shared and the used products are supplied simultaneously to the single-product-type production line handling the remanufactured products and to the multiple-product-type production line. Conversely, when the production capacity for new products is limited, the buffer is shared. However, it is difficult to imagine that the production capacity for remanufactured products is insufficient when that for new products is sufficient. When a single-product production line is added to a manufacturing or remanufacturing production line that manufactures multiple products, it is expected to handle a single-product production line that manufactures new products. In such a case, the manufacturing and remanufacturing lines that manufacture multiple products and the single-product line that manufactures remanufactured products will not operate simultaneously, meaning that buffer sharing will not occur.
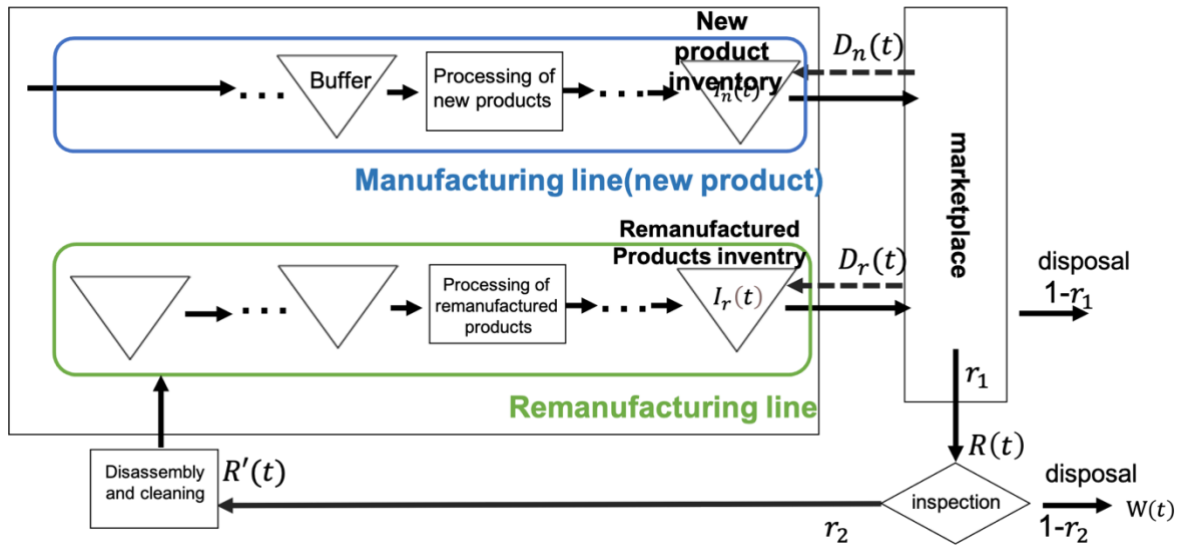
Figure. 3 Manufacturing and remanufacturing systems in production lines that manufacture a single product
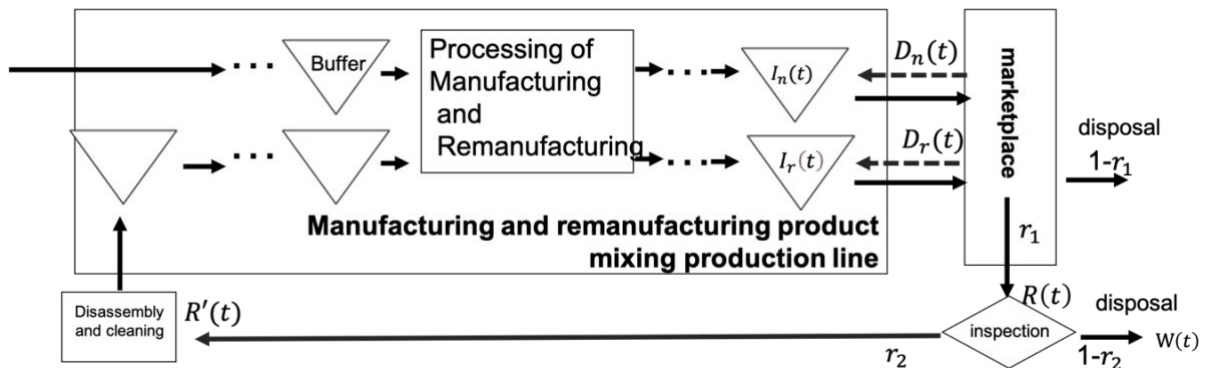
Figure. 4 Manufacturing and remanufacturing systems in production lines that manufacture multiple products

EVALUATION OF MANUFACTURING AND REMANUFACTURING SYSTEMS

The manufacturing and remanufacturing systems presented in the previous two chapters are evaluated in terms of environmental friendliness, economic efficiency, and facility stability.

In this study, we evaluate the manufacturing and remanufacturing system by incorporating standby power consumption, which increases due to a decrease in facility availability, opportunity cost due to product shortage, which increases when facility capacity is insufficient, and several other costs into the total profit.

The total profit TP is calculated by subtracting the total cost C from the product sales volume and the unit price multiplied by period H.

$$\text{TP} = \sum_{t=1}^{H} (p_n S_n(t) + p_r S_r(t)) - C \tag{1}$$

Total cost C is the sum of inventory storage cost C_h, opportunity loss cost C_s, processing cost C_{run}, and idle cost C_{wait}.

$$C = C_h + C_s + C_{run} + C_{wait} \tag{2}$$

The inventory storage cost C_h can be obtained from the number of new and remanufactured products in stock $I_n(t), I_r(t)$, the amount of work-in-process inventory $Iip_n(t)$, $Iip_r(t)$, and the inventory storage cost c_h per unit time and piece, as shown in Equation (3).

$$C_h = \sum_{t=1}^{H} (I_n(t) + I_r(t) + Iip_n(t) + Iip_r(t)) ch \tag{3}$$

The opportunity loss cost C_s is obtained from the out-of-stock quantity of new products and remanufactured products $L_n(t), L_r(t)$ and the out-of-stock cost per unit quantity c_s, as shown in Equation (4).

$$C_s = \sum_{t=1}^{H} L_n(t) \cdot c_{s\_n} + \sum_{t=1}^{H} L_r(t) \cdot c_{s\_r} \tag{4}$$

The processing cost C_{run} is obtained from the processing power c_{run} per unit time and the total processing time in facility m, $Trun_m$, as shown in Equation (5).

$$C_{run} = \sum_{m=1}^{M} c_{run} Trun_m \tag{5}$$

The idle cost C_{wait} can be obtained from the standby power c_{wait} per unit time and the sum of standby time at facility m, $Trun_m$, as shown in Equation (6).

$$C_{wait} = \sum_{m=1}^{M} c_{wait} Twait_m \tag{6}$$

Therefore, the total cost C can be obtained as shown in Equation (7).

$$
\begin{aligned}
C &= C_h + C_s + C_{run} + C_{wait} \\
&= \sum_{t=1}^{H} (I_n(t) + I_r(t) + Iip_n(t) + Iip_r(t)) ch \\
&\qquad + \sum_{t=1}^{H} (L_n(t) + L_r(t)) cs + \sum_{m=1}^{M} c_{run} Trun_m + \sum_{m=1}^{M} c_{wait} T_{run\_m} \\
&= \sum_{t=1}^{H} \Big((I_n(t) + I_r(t) + Iip_n(t) + Iip_r(t)) ch + (L_n(t) + L_r(t)) cs \Big) \\
&\qquad + \sum_{m=1}^{M} (c_{run} Trun_m + c_{wait} Twait_m)
\end{aligned}
\tag{7}
$$

Using the aforementioned equation, we evaluate the manufacturing and remanufacturing system. We implement multiple such systems on the simulation by combining the single-product production line set out in section 3 and the mixed production line, and we evaluate the results obtained according to our objectives.

The economic evaluation of the system can be done by referring to the value of the total profit TP from Equation (1). It is also possible to analyze where any large costs are located by indicating the value of each cost.

The evaluation of the system in terms of environmental aspects can be done by referring to the value of idle cost C_{wait} from Equation (6). As idle cost is the cost caused by the generation of wasted energy that does not add value to the product, it can be applied as an indicator to evaluate the impact of production activities on the environment. The number of remanufactured products produced and sold obtained from the simulation results can also be used for environmental evaluation. There is a worldwide demand for remanufacturing from used products. Therefore, the design of a production system that can ensure adequate production volume of remanufactured products is recognized as having an environmental impact.

The evaluation of the system in terms of equipment stability is based on the utilization rate of each equipment obtained from the simulation results. When the utilization rate of a facility is low, it has negative economic and environmental impacts due to the generation of idle costs. Even in the case of a high utilization rate, if it is close to 100%, there is a possibility that jobs are offered beyond the processing capacity of the facilities. In such a case, economic losses are expected to occur due to opportunity losses. In addition, the occurrence of starving or blocking may reduce the utilization rate of the production facilities before and after, thereby reducing the utilization rate of the entire system.

CASE STUDY

Using production system simulation, we evaluate the following four scenarios.

Scenario 1 is a single-species production line for new products and remanufactured products, respectively. Scenario 2 is a mixed production line that can produce both new and remanufactured products. Scenario 3 is a mixed production line that can produce both new and remanufactured products, and the order point is sufficiently large in this scenario that the pull strategy does not work. Scenario 4 is a reduced-order point scenario in Scenario 2. The simulation software used is S^4 Simulation, which implements the manufacturing and remanufacturing system model described in section 3 using Python.

The environment in which the simulation is run is described below.

OS: Windows 10 pro
Processor: Core i7-6700
RAM: 16GB

The common values are as follows.
$r_1 = 0.5$, $r_2 = 1.0$, $p_n = 5000$ yen, $p_r = 4000$ yen, $c_h = 10$ yen/min ・ unit, $c_s = p_n, p_r$, $c_{wait} = 10$ yen/min, $H = 10080$ min

Scenario 1: Single-product production line scenario
- The manufacturing and remanufacturing system consists of a new product manufacturing line, with two processing machines arranged in series, and a remanufacturing line, with two processing machines arranged in series.
- $CT_n = CT_r = 10$ min/piece, c_{run}= 20 yen/min

Scenario 2: Mixed production line scenario
- The manufacturing and remanufacturing system consists of a mixed production line, with two processing units arranged in series.
- $CT_n = CT_r = 5$ min/piece, c_{run}= 40 yen/min, $rp = 300$

Scenario 3: Mixed production line order point reduction scenario
- The manufacturing and remanufacturing system consists of a mixed production line, with two processing facilities in series.
- $CT_n = CT_r = 5$ min/piece, c_{run}= 40 yen/min, $rp = 100$

Scenario 4: Single-product production line addition scenario
- The manufacturing and remanufacturing system consists of a new product manufacturing line, with two processing machines in series, and two remanufacturing lines, with two processing machines in series.
- $CT_n = CT_r = 10$ min/piece, c_{run}= 20 yen/min

ECONOMIC EVALUATION

Scenario 1: Single-product production line scenario

In Scenario 1, we varied the number of remanufactured products collected from the market and supplied to the factory and looked at the impact on costs and profits (Figure 5).

The results show that the cost of standby power and opportunity loss tends to decrease as the quantity supplied increases. Since the standby power increases, over time, in proportion to the standby time, the effect is more pronounced for machines with a large standby power per unit time. As the amount of available used product increases, the processing power cost increases, owing to the increase in production volume. However, the increase in processing cost indicates that sales are increasing simultaneously, so the total profit shows that the higher the amount of available used products, the higher the profit.
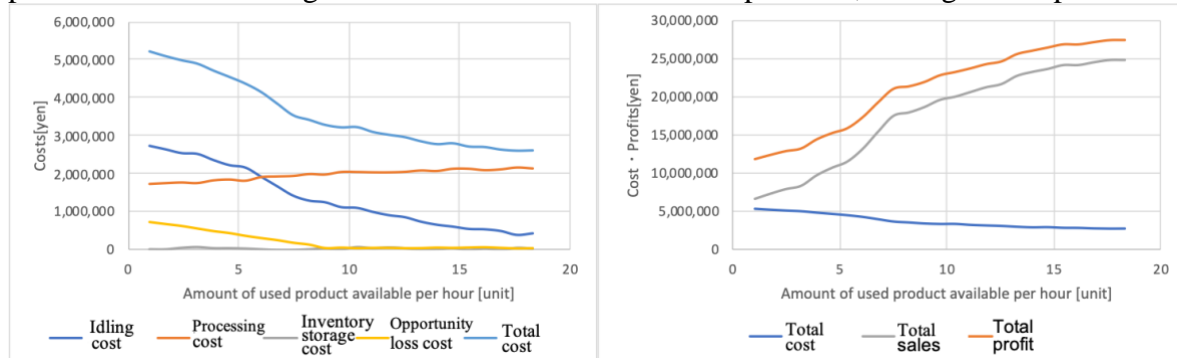
Figure. 5 Results of single-product production line scenario, variation of cost, and total benefit with the amount of available end-of-life products

Scenario 2 Mixed production line scenario

In this scenario, the opportunity loss cost decreases until a certain period and then increases significantly (Figure 6). During the period when the opportunity loss cost is decreasing, the value of the opportunity loss cost is decreasing because the opportunity loss of remanufactured products is decreasing, due to the increase in the production volume of remanufactured products. Conversely, as the production volume of remanufactured products increases, the unit price and the production volume of new products with high opportunity loss cost decrease, resulting in a large opportunity loss cost during the period. Although the hourly electricity cost is higher than in the other scenarios, due to the small number of facilities, the overall electricity cost for the plant is smaller than in the other scenarios. The total profit is affected by the total cost, which increases once and then decreases, with an increase in the amount of reusable end-of-life products.
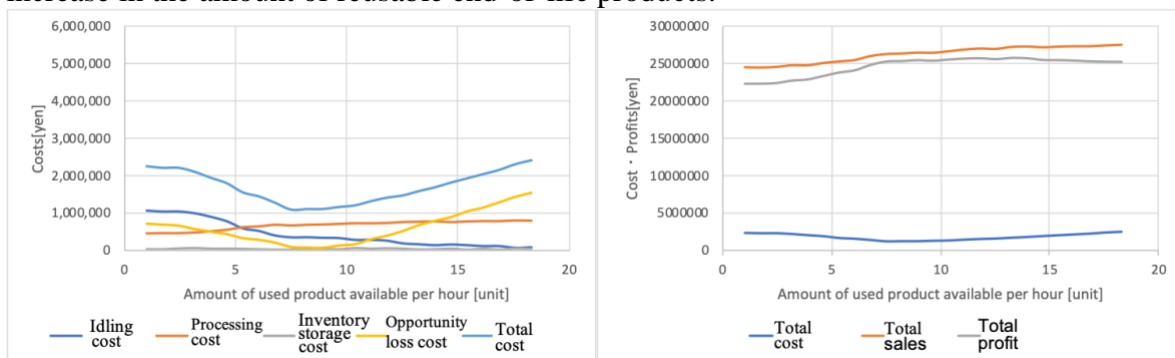
Figure. 6 Results of the mixed production line scenario

Scenario 3: Mixed production line, order point reduction scenario

In this scenario, we looked at the impact of increasing the order point of remanufactured products for the factory in Scenario 2. Since the number of remanufactured products processed for new products has been reduced, the opportunity cost due to out-of-stock new products that occurred in Scenario 2 has not occurred (Figure 7).

By controlling the amount of inventory using the pull strategy, it was confirmed that it is possible to execute production to meet demand in a mixed production line that handles new products and remanufactured products, taking into account the stochastic number of used products recovered.
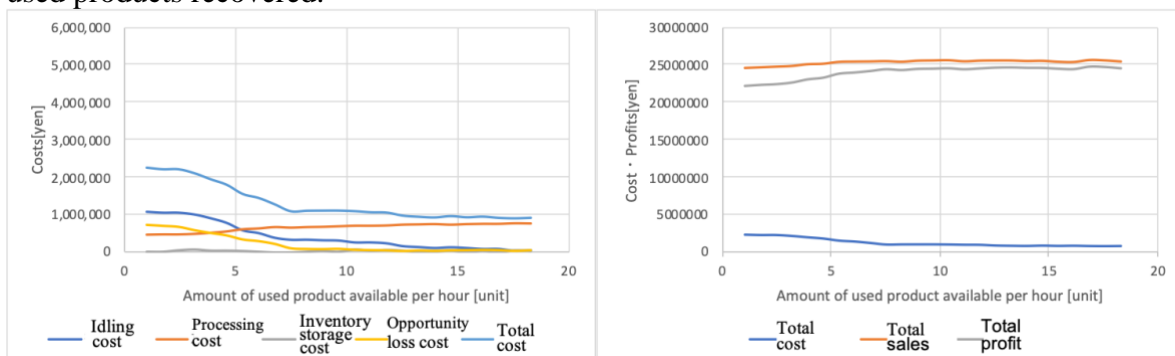
Figure. 7 Results of the mixed production line, order point reduction scenario

Scenario 4: Adding a single-product production line scenario

In this scenario, a production line for remanufactured products is added to the factory in Scenario 1. As can be seen from Figure 5, the remanufacturing production line of Scenario 1 does not cause any opportunity loss due to insufficient production capacity in this case, and it has sufficient production capacity. Comparing Figures 8 and 5, it can be seen that the standby power increased overall and the profit did not increase. As for the assembly line that handles remanufactured products, the results show that simply adding facilities does not increase the production volume of the products because of the limited supply of parts.
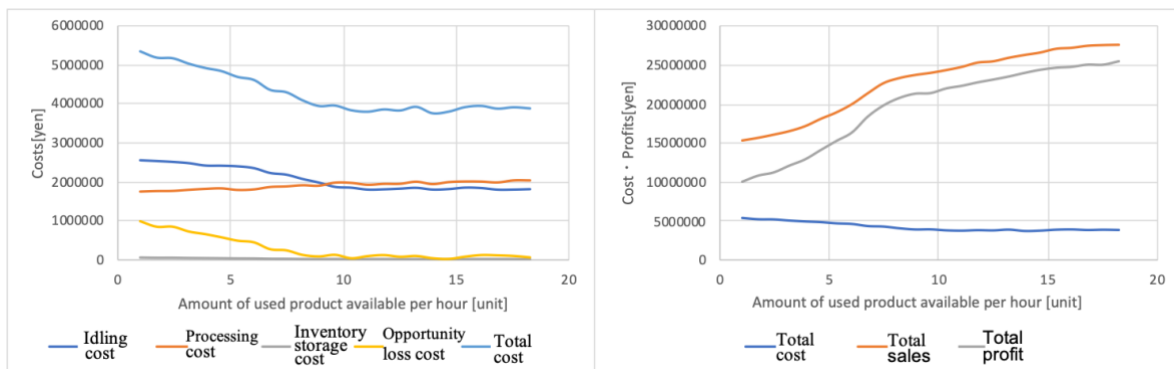
Figure. 8 Results of adding a single-product production line scenario

Comparison of scenarios

An economic comparison is made between the four scenarios in terms of cost and total profit. When the number of available end-of-life products for the plant is small, the total profit of Scenario 2 is the highest. Conversely, when there are sufficient used products available, the total profit of Scenario 1 is highest. For the mixed production line, the results show that opportunity loss can be reduced by producing the appropriate variety for the demand.

ENVIRONMENTAL EVALUATION

In this study, we evaluate the production system with the aim of reducing the number of remanufactured products, which will lead to a reduction in the environmental load, due to a decrease in the number of discarded products, and reducing the amount of standby power, which is useless electricity.

Figure 9 shows the production volume of the remanufactured products in each scenario. The production volume of remanufactured products is lower in Scenarios 1 and 4, which deal with a remanufacturing system using a single-product production line, than in Scenarios 2 and 3, which deal with a remanufacturing system using a mixed production line. However, in Scenario 3, which has the lowest production volume, the production volume is considered to be sufficient in each scenario because the production is based on the pull strategy to meet the demand. This can be similarly determined from the fact that there is no

opportunity loss due to shortage of remanufactured products, except for the shortage of supply of used products in Scenario 3 (Figure 9).

Figures 5 and 7 show the change in standby power according to the number of used products supplied in each scenario. In all scenarios, the standby power tends to decrease as the number of used products supplied increases. In the scenario using a mixed production line, the standby power is smaller than in the scenario using a single-product production line. This indicates that the use of mixed production lines can reduce the environmental impact of electricity.
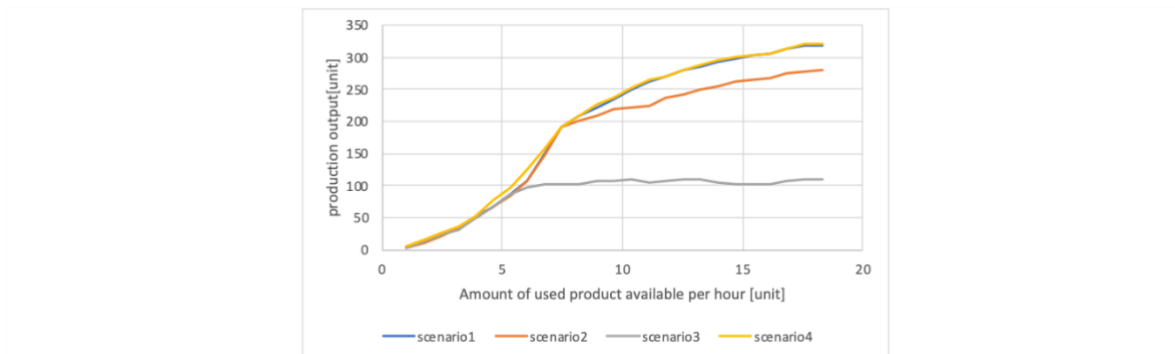
Figure. 9 Production volume of remanufactured goods in each scenario

FACILITY-STABILITY EVALUATION

In this study, the stability of the facilities was evaluated, to improve the economic and environmental performance. The utilization rates of the final process in each production line in each scenario are shown in Figure 10, which indicates that the utilization rates of the
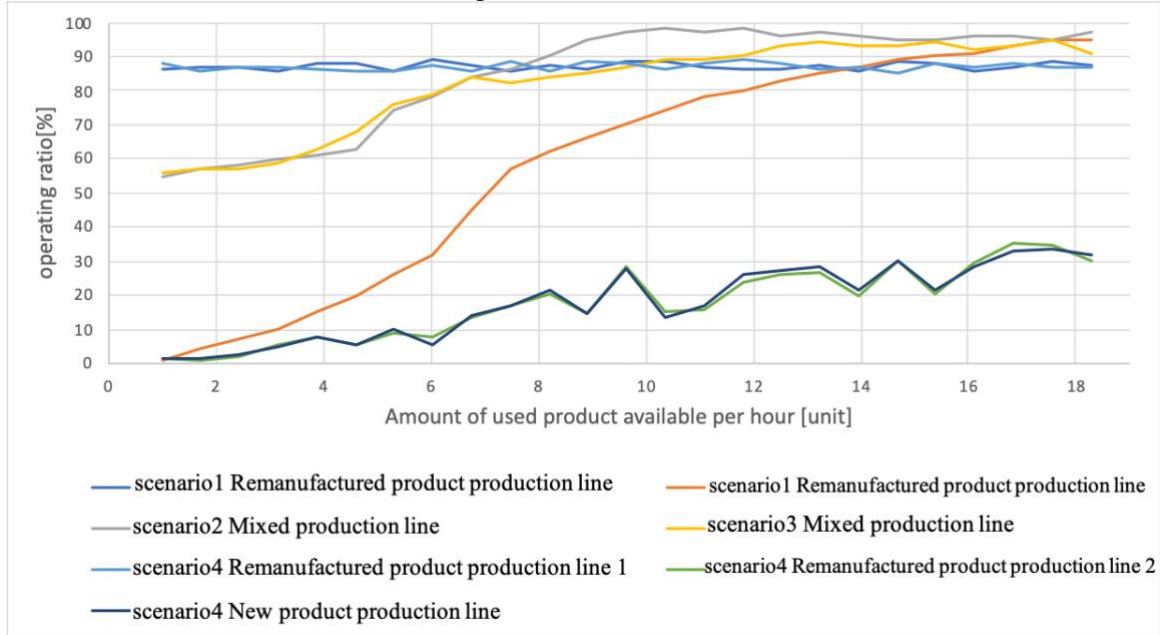
Figure. 10 Operating rate of the final process in each production line

single-species production line handling remanufactured products in Scenario 1 and Scenario 4 are low, and the stability of the remanufactured-product production line in Scenario 4 is low. Conversely, in Scenario 2, there is no decrease in the utilization rate, but it can be seen from Figure 7 that many out-of-stocks occur. Thus, Scenario 3 has the highest stability in terms of facility utilization rate and stable product supply cleaning.

SUMMARY

In this study, we modeled and simulated a manufacturing and remanufacturing system for reusing used products to reduce the environmental impact of waste products, to evaluate its economic efficiency and facility stability. We evaluated several scenarios based on the cost and were able to select an appropriate manufacturing and remanufacturing system according to the number of used products collected.

In the future, we would like to evaluate a system that incorporates the initial investment in facilities, considering the design phase of the manufacturing and remanufacturing system. In addition, evaluation of scenarios that incorporate scheduling and production instructions will make it possible to propose more optimal systems.

ACKNOWLEDGMENTS

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Fostering Sustainability in Supply Chain via MSMEs: A Conceptual Framework

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Abstract

Purpose: The study strives to understand the antecedents for the adoption of Triple Bottom Line (TBL) practices and the impact of these practices on the firm performance, holistically, in the case of micro, small, and medium enterprises (MSMEs).

Design/Methodology/Approach: The study applies organizational theories to develop a conceptual framework for understanding the drivers of adopting sustainability and the impact of sustainability practices on MSME performance.

Practical Implications: Most of the extant literature on TBL or sustainability practices focuses on the bigger firms and those in the developed geographies. This study leverages the institutional theory to identify the antecedents for adopting TBL practices and the stakeholder theory to analyze these practices' impact on firm performance. Also, the social aspect of sustainability has somewhat been overlooked in the extant literature, and more emphasis has been accorded to the environmental and economic aspects. Thus, this study is expected to have significant practical relevance.

Originality/Value: To the best of my knowledge, the extant literature either focuses on the antecedents of adopting TBL practices or the impact of these on the firm performance, but not both together. Therefore, this attempt to integrate these two facets and develop more rigorous insights to benefit MSMEs would add value to the extant research.

Keywords: Triple Bottom Line, Sustainability, MSME, SME, Conceptual Framework

"The historic slowdown in energy efficiency in 2018 - the lowest rate of improvement since the start of the decade – calls for bold action by policymakers and investors."

- Fatih Birol, Executive Director, IEA

in IEA (2019a)

Introduction

The economics of profit maximization has traditionally propelled academic research and practice. However, this perspective does not recognize that economies can exist only with the environment and society, as mooted by the Triple Bottom Line (TBL) (Walker, Yu, & Zhang, 2020). TBL has gained acceptance over the last two decades. It has been widely used in accountancy as a sustainability framework for assessing firms' performance within their specific contexts (Slaper & Hall, 2011). It transcends traditional financial metrics and includes social and environmental dimensions (Elkington, 1994). It is therefore related to sustainable development (Hammer & Pivo, 2017), which the World Commission on Environment and Development (WCED) defines as "*the development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (Kono, 2014).

These terms are pertinent in today's global supply chain as the production processes are often spread with suppliers and focal firms in different geographies. Along with the product value, there are environmental and social burdens that tag along at the different production process stages (Seuring & Müller, 2008). The 2013 Rana Plaza collapse raised serious concerns around workplace safety in developing nations and nudged policy discussions at the firm, country, and trans-national levels to improve safety and labor working conditions (Schuessler, Frenkel, & Wright, 2019). Concerns have also been raised on the manufacturing firms' lack of adherence to environment-friendly policies, and indulgence in over-exploitation of natural resources, besides generating vast amounts of toxic wastes (Villena & Gioia, 2020). However, the focal firms, i.e., the big multinationals, are held responsible for their suppliers' social and environmental negligence (Seuring & Müller, 2008). Renowned brands have been blamed for poor working conditions (Graafland, 2002) and the adverse impact on the environment by their suppliers (Seuring, 2001).

Studies have proved that climatic changes are human creations (Rashid, Ahmad, & Khan, 2011). For example, carbon emissions are one of the causes of climatic changes. Energy efficiency-related concerns have also been raised in recent years. According to the International Energy Agency (IEA), energy efficiency can boost economic growth and prevent greenhouse gas emissions, but the global rate of progress is a concern (IEA, 2019b). For the past three years, the rate of global primary energy intensity improvement, which indicates how heavily energy is used by global economic activity, has been below the 3 percent threshold needed for achieving global climate and energy goals. The 3 percent threshold could generate an additional USD 2.6 billion of economic output – nearly the French economy's size (IEA, 2019a; IEA, 2019b). The IEA defines[1] sustainable manufacturing as creating manufactured products via economically-sound processes, which conserve energy and natural resources, thereby raising employee, community, and product safety.

Across the different echelons of the supply chain, multiple entities consume energy and contribute to issues across the social, environmental, and economic dimensions by their sub-sustainable practices such as waste disposal (Mittal & Sangwan, 2014). There is a notion that SMEs tend to be less involved with environmental management practices (Malesios, Dey, & Abdelaziz, 2018) and are less likely to have sustainability goals. Severe environmental and social violations often happen at tier-2 & higher-level suppliers (Meinlschmidt, Schleper, & Foerstl, 2018). They are considered a significant contributor to environmental pollution. The current economic activities are increasingly becoming unsustainable; the negative externalities are being borne globally, while the economic benefits are gained locally only (Büyüközkan & Karabulut, 2018). MSMEs contribute to 60 percent of all CO_2 emissions and 70 percent of all pollution (Parker, Redmond, & Simpson, 2009). Therefore, on the one hand, MSMEs are considered a key driver in a nation's progress; on the contrary, they also cause environmental hazards (Virmani, Bera, & Kumar, 2020). Hence, it is imperative to access their operations from the lens of sustainability (Shashi, Cerchione, Centobelli, & Shabani, 2018). This would also help in supplier selection, which is a key task in supply chain management.

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[1] https://www.epa.gov/sustainability/sustainable-manufacturing

A question that comes to mind is, can the sustainability practices applicable to larger firms be applied easily to the smaller ones? The extant literature argues that the assumptions that small firms are scaled-down versions of larger ones are questionable (Darcy, Hill, McCabe, & McGovern, 2014). The smaller firms have unique features that impact the way they operate (Doern, 2011). Besides size, legal form, orientation towards profit, national context, institutional structures, and historical evolution distinguish smaller firms from their bigger counterparts (Spence, 1999; Spence & Rutherfoord, 2003). For example, they have a reduced inclination to communicate their CSR practices externally (Cantele & Zardini, 2020). MSMEs significantly impact achieving sustainability at the societal level (Singh, Modgil, & Tiwari, 2019), and there are several stakeholders with whom the SMEs have a stronger relationship than do bigger organizations (Perrini, 2006).

Yet, little attention has been given to sustainability reporting in these firms (Bijlani & Mierzwa, 2011). Their contribution to ensuring sustainable manufacturing practices (SMP) across the value chain is a growing research area (Virmani et al., 2020). While discussions on sustainability pertaining to SMEs are steadily gaining momentum (see, for example, Halme and Korpela (2014); Machanado et al. (2020); Prashar (2019); Shashi et al. (2018)), the focus has generally been on developed economies or just a single industry vertical. Within the developing economies, the understanding of environmental responsibility is limited due to lax government regulations and inadequately organized pressure groups and consumer awareness to motivate the firms towards sustainable practices (Ngwakwe, 2009).

No doubt, there are myriad benefits of ensuring sustainability-related best practices by MSMEs; the implementation of the same is not easy (Virmani et al., 2020). For example, implementing TBL ethos is very tedious and complicated (Malek & Desai, 2019). For the reasons mentioned above, it is essential to understand the antecedents for adopting sustainability-related best practices by MSMEs and their impact on firm performance holistically. With this background, the current study will be guided by these research objectives to investigate how MSMEs pursue the tenets of sustainability/TBL framework and how it impacts their performance holistically. It will leverage the institutional and stakeholder theories and driven by the following research questions:

RQ1: What are the antecendents for MSMEs to embrace the triple bottom line-based practices?

RQ2: How are the different sustainability dimensions related to each other?

RQ3: How do sustainability practices impact an MSME's performance holistically?

RQ1 is expected to improve the understanding of the factors that MSME-related policies should consider. RQ2 is likely to deliver insights around the inter-relationships between the three pillars of TBL – Economic, Social, and Environmental. RQ3 would contribute to the studies that examine the relationship between firm performance and sustainability practices. Thus, this paper aims to contribute to a better understanding of antecedents of adoption of sustainability practices and their impact on the MSME performance holistically. The conceptual framework is expected to guide future empirical work in the field. It would assist in building the theory of sustainability grounded in the experiences of MSME owners and managers while capturing the heterogeneity and attributes of these small firms.

The paper is structured as follows. The next section discusses the extant literature. The description of the organizational theories follows this. Then the paper illustrates the proposed conceptual framework, which is followed by the discussion and conclusion.

Literature Review and Background

The extant literature has been borrowed from different research strands – sustainability, TBL, MSMEs, and organizational theories.

Sustainability

The literature mentions that sustainability was coined in 1713 in forestry with the word 'Nachhaltigkeit,' a German concept for sustainability (Qeke, 2019). Sustainability became a common political goal when the whole world realized the importance of the issue of the environment (McKenzie, 2004). The Brundtland 1987 report ushered in the wave of sustainability. It strived to develop goals that pushed sustainability endeavors' progress alongside

sustaining the economic progress, social justice, and ability of natural ecosystems (Finkbeiner, Schau, Lehmann, & Traverso, 2010). The Earth Summit at Rio De Janeiro in 1992 formulated Agenda 21 to be a blueprint for sustainable development (Qeke, 2019). It aimed at global collaborations on sustainability (Spangenberg, Pfahl, & Deller, 2002) and guiding sustainable development across sectors within their contexts (Du Plessis, 2002).

The advent of globalization has given rise to environmental issues. Therefore, it is critical to adopt sustainable manufacturing (Kishawy, Hegab, & Saad, 2018). Sustainability strategies also create synergistic benefits for SMEs working together (Moore & Manring, 2009). However, there are shortcomings and challenges in the implementation of these practices. Managers emphasize more on environmental and economic sustainability (Kusi-Sarpong, Gupta, & Sarkis, 2019). There is little focus on what to measure for interpreting sustainable performance (Büyüközkan & Karabulut, 2018). The social sustainability aspect has received lesser attention than the environmental aspect (Yawar & Seuring, 2018). Before Elkington pioneered the TBL, environmentalists found it difficult to develop frameworks for measuring sustainability (Slaper & Hall, 2011). The challenge was to envisage an evaluative system amidst multiple research outputs, certification systems, and assessment frameworks (Goh, 2018).

Various researchers have provided their definition of sustainability. For this study, I consider that sustainability can be defined by Elkington's TBL, which incorporates social, economic, and environmental aspects (Elkington, 1994), and sustainable development is a process to achieve human development in a secure, wise, inclusive, and equitable manner (Hart & Milstein, 2003). Therefore, a sustainable MSME is one that contributes to sustainable development while providing social, economic, and environmental benefits.

The Triple Bottom Line

The TBL was mooted by Elkington (1994) to refine the financial and social aspects of sustainability that were historically consumed by sustainability's environmental measures (Govindan, Khodaverdi, & Jafarian, 2013). It operationalizes the theory of corporate sustainability (Chang et al., 2017). Unlike in the past, profit is not the only aim of a firm, and

other aspects of non-financial performance such as social and environmental issues should also be considered (Hubbard, 2009). Researchers have argued that firms that absorb activities intersecting social, environmental, and economic performance have a positive impact on the society and natural environment (Öztürk & Özçelik, 2014). Therefore, firms can be eco-efficient and address socio-economic issues by taking care of the socio-environment (Qeke, 2019). While some researchers have praised TBL, its critics pinpoint issues with it. For example, it has been considered as incoherent, confronting, and complicated for managers (Hubbard, 2009; Slaper & Hall, 2011); there is a perception of having to compute three bottom lines (Norman & MacDonald, 2004); concern has been raised around the competing nature of the three dimensions of TBL (Sridhar & Jones, 2013), and it is insufficient to capture the entire concept of sustainability (Tseng et al., 2020).

Table 1 lists the dimensions considered in the TBL. The economic dimension of TBL is about financial feasibility, which focuses on competitiveness, employment generation, and marketing spaces for long-run profits (Jamali, 2006). The social dimension of TBL is akin to corporate social responsibility (CSR) (Norman & MacDonald, 2004), and firms should follow practices that uphold their employees' human rights and respect (Phillips, 2006). The social aspect of TBL is less understood, and firms tend to struggle to articulate their social duties and impacts (Hubbard, 2009). For this study, I consider the TBL metrics to build appropriate constructs and items. Some extant research recommends focusing on just one dimension to address the TBL dimensions' tension (Walker et al., 2020). However, I think it is much better to consider all the three TBL dimensions to get a holistic understanding instead of giving them unequal importance. Viewing them as independent of each other could lead to oversimplification of their inter-relationships and portray an incomplete picture of sustainability.

Table 1: Dimensions in the TBL

Economic	Environmental	Social
Sales, profit, ROI	Pollutants emitted	Health & safety
Taxes paid	Carbon footprint	Community impact
Monetary flows	Recycling & reuse	Human rights, privacy
Jobs created	Water & energy use	Product responsibility
Supplier relations	Product impact	Employee relations

Source: Savitz (2013)

Micro, Small, and Medium Enterprises

MSMEs are, no doubt, the growth accelerators of any economy. They provide the highest proportion of employment in most geographies (Khurana, Haleem, & Mannan, 2019). The majority of the studies on MSMEs have considered only one sustainability dimension and had a narrowed focus on the industry vertical and region. The extant research on sustainability in MSMEs offers an opportunity to expand the scope beyond one industry vertical, region and make it methodologically more robust. The existing literature has explored the barriers to sustainability as well as the impact of sustainability on firm performance on a standalone basis. Therefore, this study would immensely add value to the growing body of research on MSMEs.

The concept of "commitment to sustainability" has been researched with varying perspectives (Schrettle, Hinz, Scherrer-Rathje, & Friedli, 2014). However, sustainability inclusion within a supply chain is not straight forward (Jaehn, 2016). The current organizational sustainability models need to be recalibrated to incorporate the context and situation in which the SMEs reside (Darcy et al., 2014). According to Mohanty and Prakash (2014), extant research has not fully explained why green practices should be manifested in supply chain management due to internal and external pressures. They also asserted that the lower level of green supply chain management in Indian MSMEs is due to a lack of necessary internal and external pressures (Mohanty & Prakash, 2014). The barriers to undertaking sustainable manufacturing range from collaboration-, organization- and production-related aspects and Government rules (Virmani et al., 2020).

In terms of the impact of sustainability-related practices, extant research has shown promising results. There is a significant mediation effect of organization sustainability on MSME's business performance (Singh, Chakraborty, & Roy, 2016). Environmental responsibility leads to financial improvements and better rapport with employees and customers (Nejati, Amran, & Ahmad, 2014). As SMEs integrate social and environmental sustainability performance into their financial and strategic goals, they will also increase the opportunities to innovate (Moore & Manring, 2009). So, smaller firms need to rectify this perception that they are less involved with TBL-related practices or less likely to have sustainability goals.

Some of the bigger firms have started putting stringent sustainability-related conditions on their suppliers. For example, in 2010, Walmart insisted its suppliers reduce their carbon emissions by 20 metric tons in the subsequent five years (Dauvergne & Lister, 2013). Bigger brands have also stressed sustainability measures in their code of conduct and launched supplier sustainability scorecard programs to measure their suppliers' sustainability progress. The majority of the functions in a supply chain have been studied under the lens of sustainability, be it sustainable procurement (Giunipero, Hooker, & Denslow, 2012), product design life cycle (Chiu & Chu, 2012), sustainable business development in manufacturing (Gunasekaran & Spalanzani, 2012), or manufacturing facility location (Chen, Olhager, & Tang, 2014), etc. Therefore, it will be helpful to undertake this study wherein sustainability would be studied at the MSME level.

Theoretical Foundations and Conceptual Framework

It is a known practice to leverage theories from other disciplines to enrich and widen a discipline (Koulikoff-Souviron & Harrison, 2008). I have identified institutional and stakeholder theories for this study owing to their relevance.

Institutional Theory

The institutional theory has been identified for its value in the ecosystem of operations management (OM) and supply chain management (SCM) (Ketokivi & Schroeder, 2004). It is

becoming a preferred research direction to investigate environmental-related practices in SCM (Sarkis, Zhu, & Lai, 2011). It provides a framework to encompass the different perspectives of different practices about OM and SCM (Koulikoff-Souviron & Harrison, 2008). It posits how organizational structures and practices are influenced by changes due to pressures from internal and external sources (Mihret, James, & Mula, 2010). The institutional theory has variants (Scott, 1987). According to Ketokivi and Schroeder (2004), the institutional theory has two variants – economic and social – in the realm of OM and SCM. The economic variant emphasizes that the mimickers have economic motivation while the social variant considers legitimacy as the rationale (Ketokivi & Schroeder, 2004). The social variant includes three types of isomorphism – coercive, normative, and mimetic (DiMaggio & Powell, 1983), while the economic aspect considers frequency-based, trait-based, and outcome-based imitations (Haunschild & Miner, 1997).

DiMaggio and Powell (1983) asserted that as a set of organizations emerge as a field, rational actors strive to make their organizations similar. DiMaggio and Powell (1983) also argued that organizations tend to conform to regulations out of expedience. For instance, in uncertain situations, the institutional pressure motivates them to organize similar to others in the same ecosystem to exhibit conformity. The isomorphism could happen to legal sanctions (coercive), morality (normative), or cultural factors (mimetic) (DiMaggio & Powell, 1983). A powerful organization can coerce its partners to adopt favorable operations practices (Liu, Ke, Wei, Gu, & Chen, 2010). Organizations are also under pressure from the government to adopt economic, social, and environmental best practices into their operations (Sarkis et al., 2011).

Mimetic isomorphism arises from the uncertainty which motivates imitation (Zsidisin, Melnyk, & Ragatz, 2005). More the uncertainty between means and ends, the higher the chance that an organization will model itself after organizations that are considered successful (DiMaggio & Powell, 1983). Normative isomorphism comes from professionalization, i.e., members of an occupation define their methods and work conditions (Gopal & Gao, 2009). Having similar educational and professional backgrounds can lead to a similarity in problem definition and information screening (DiMaggio & Powell, 1983). According to Haunschild and Miner (1997), frequency-based imitation may happen through a more unconscious form of

influence, wherein practices are taken for granted. For example, ISO certification. Trait-based imitation involves mimicking organizations that have selected features – size, performance, and outcome-based imitation involves mimicking actions that led to the success of other organizations (Haunschild & Miner, 1997). For example, the lean practices of Toyota.

The proposed conceptual framework would leverage the nuances of institutional theory – myths, de-coupling, and legitimacy, etc. – to identify and understand the antecedents of adoption of TBL best practices by MSMEs. Suchman (1995) defined legitimacy as "*generalized perception that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, beliefs, and definitions*." In the case of MSMEs, committing towards sustainability has been perceived as a conscious effort, mostly to gain legitimacy in their external milieu (Jayanti & Raghunath, 2018). Also, gaining legitimacy is related to the validity of the MSMEs strategic goals (Rao, Chandy, & Prabhu, 2008). Examples of legitimacy-seeking pursuits could be initiatives towards sustainability, rewards, and engagement mechanisms for employees, and clearly laid out communication for awareness (Johnson & Schaltegger, 2016).

Stakeholder Theory

The stakeholder theory posited by Freeman (1984) describes, prescribes, and derives the alternatives for corporate governance that include as well as balance several interests. According to Freeman (1984), a firm resides within a web of groups having different stakes in its activities. The web is critical as it represents ties that may become complex and lead to ignoring one group's agenda over others (Weidner, Nakata, & Zhu, 2020). For example, firms may have to choose between cost and environmental impacts. So, they may have to choose between using low cost but environmentally hazardous raw materials and high cost but environmentally safe ingredients. Parmar et al. (2010) term these as moral dilemmas. The optimal functioning of firms occurs when they address these dilemmas consciously instead of just focusing on the shareholders (Freeman, 1984). The economistic school of thought focuses on short-term goals and shareholder wealth maximization without balancing them against the humanitarian aspects (Pirson & Lawrence, 2010). In contrast, Freeman asserted that firms flourish when they consciously focus on interests outside their boundaries (Freeman, 1984).

Rowley (1997) argued that the stakeholder theory of a firm should define as well as forecast how firms operate during different situations. Three theoretical lines associated with the stakeholder theory are – instrumental, descriptive, and normative. The instrumental dimension believes that managers should take cognizance of the stakeholders' interests to maximize the firm's objectives. The descriptive dimension posits how the stakeholders, firms, and their managers interact, while the normative aspect provides courses of action for managers (Amarah, 2015). As the sustainability of a firm relies on the sustainability of its stakeholder relationships, the quality of this relationship should be the guiding principle for managerial decision-making (Perrini & Tencati, 2006).

As guided by the Stakeholders' theory, TBL advocated the firm's responsibility to be with stakeholders instead of shareholders. It emerged as a tool to measure business performance based on the stakeholders' theory (Qeke, 2019). This research study applies stakeholder theory to develop hypotheses and constructs that reflect that MSMEs should cater to multiple stakeholders. So, the MSMEs' performance should be evaluated against multiple metrics and not just the economic ones. For MSMEs, the stakeholders, i.e., those who directly or indirectly influence the firm's actions, include big firm buyers, government agencies, workers, consumers, and those whom the business owes. There is a lack of understanding that all sustainability-relevant stakeholders are essential, due to which they are not considered during a firm's decision-making process. Hence, some sustainability areas get neglected (Amarah, 2015). Thus, it is crucial not just to identify the stakeholders but also to manage them efficiently. However, despite the significance of the relationship between stakeholders and sustainability, there are gaps in understanding how these could improve a firm's opportunities in environmental, social, and economic areas (Amarah, 2015). Therefore, this study leverages the stakeholder perspective for analyzing the impact of TBL dimensions on the firm performance.

Conceptual Framework

I propose the conceptual framework in Figure 2 for this analysis.

The drivers and obstacles are the antecedents for adopting the three TBL dimensions; the latter impact the firm performance. I also consider a holistic definition of firm performance and not just limit it to financial performance. The existing research shows that a holistic accomplishment of sustainability goals needs multiple factors such as constant innovation, regulatory compliance (Schaltegger, 2011), being in sync with industry practices (Wheelen, Hunger, Hoffman, & Bamford, 2017), and realigning firm strategy (Hillman & Keim, 2001). Unlike larger firms, MSMEs tend to rely on informal relations and a less structured HR, which are hindrances to gain employee support (Jiang, Lepak, Hu, & Baer, 2012). Their interactions impact the employee-employer relationship. The employee's perception of leadership plays a critical role in the MSMEs' commitment to sustainability (Maheshwari, Samal, & Bhamoriya, 2020). Secondly, firms depend on the environment for resources, and society provides them to their stakeholders – employees, customers, and regulations. Thus, TBL dimensions do not exist in a vacuum (Walker et al., 2020). Therefore, it is critical to understand how these dimensions are associated with each other and impact firm performance.

Figure 2: Proposed Conceptual Framework
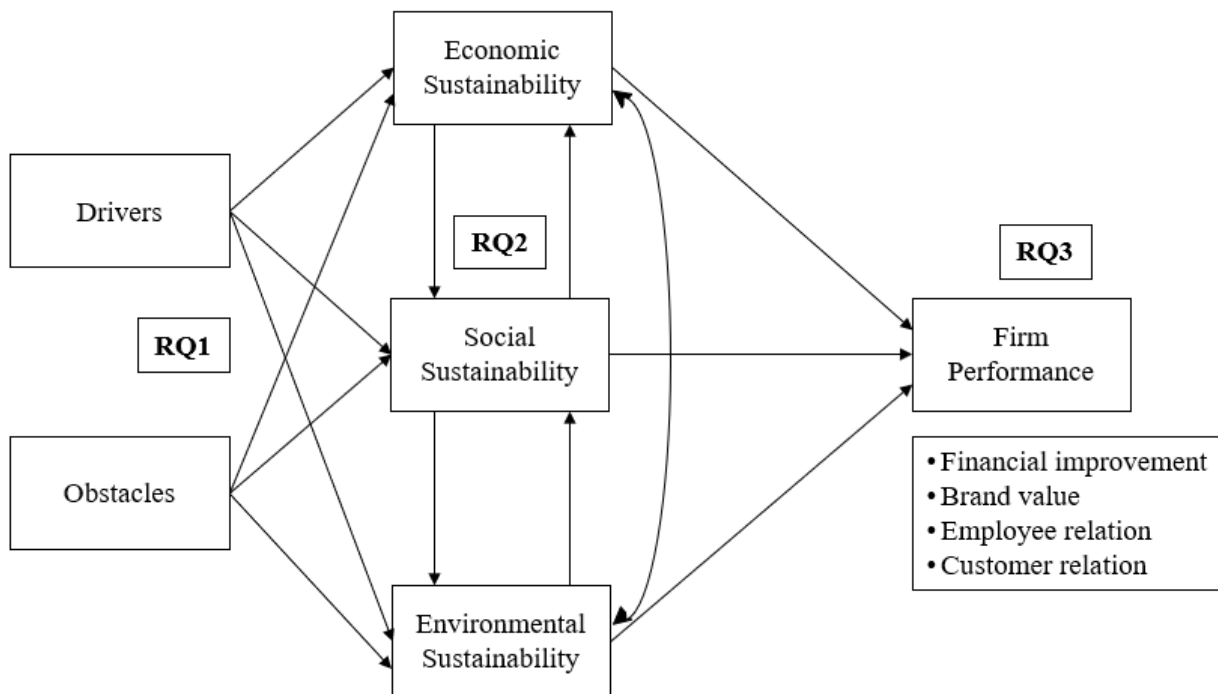
Hypotheses Development

Rehman, Seth, and Shrivastava (2016) found government initiatives to be one of the enablers for green manufacturing. It is also believed that MSME leaders gain their employees' trust via family-like relationships and informal HR practices (Bartram, 2005). However, there is also contrary evidence that economic goals take precedence and limit the role of HR towards sustainability (Markman & Baron, 2002). Thus, it is imperative to delve into these aspects much deeper. Schemes initiated by the government also give a significant push to embrace sustainability-oriented best practices (Khurana et al., 2019). The push for environmental management has been attributed to competitiveness, legitimacy, and ecological responsibility (owner's values) (Bansal & Roth, 2000). Therefore, our first hypothesis would test the antecedents for the adoption of sustainability best practices.

H1: Peer pressure, leaders' influence, and mandates from buyers positively affects the adoption of sustainable practices – economic, social, and environmental.

The critical barriers to adoption of sustainability-related practices include lack of funds (Xia, Govindan, & Zhu, 2015); absence of expertise to handle sustainability practices; obliviousness about sustainability norms; low incentives to comply with the best practices, and being located in economies having lax laws on sustainability (Villena & Gioia, 2020). Mittal and Sangwan (2014) suggested that the internal barriers are the root cause for not adopting environmentally conscious manufacturing. There is a concern that barriers in SME's social or environmental systems have usually been analyzed qualitatively (Cantele & Zardini, 2020). Thus, this proposed framework would help mitigate this issue w.r.t. the method via the second hypothesis.

H2: Lack of awareness about sustainability and paucity of funds hinder the adoption of sustainable business behavior.

The paradox theory integrates the three dimensions of TBL and recommends that managers can transcend the tensions between the three dimensions by considering the nature of

the relationship to be dynamic, i.e., a virtuous cycle (Walker et al., 2020). Firms' adherence to sustainability practices may make them transparent and build up trust and rapport with the community (Khurana et al., 2019). So, firms that invest in social and environmental dimensions can build a better reputation to fulfill their stakeholders' implicit needs and are more attractive for a long-term business (Deng, Kang, & Low, 2013). This good rapport would reduce transaction costs and boost financial performance (Walker et al., 2020). Such a perspective can be related to an economic shock wherein mutual trust built with the stakeholders due to social and environmental dimensions would help sustain the business relationship even during turbulent economic scenarios (Lins, Servaes, & Tamayo, 2017).

Therefore, the third hypothesis investigates the relationships between the three dimensions of TBL to understand how they are associated with each other. For example, the adoption of processes that reduce pollution and improve the working condition in the MSMEs could also positively affect the external environment. Therefore, these are expected to improve the MSMEs social reputation also. Likewise, the third hypothesis would also highlight if environmental performance and socially oriented activities are positively related.

H3: The three dimensions of TBL are interdependent and affect each other positively.

The fourth hypothesis evaluates the impact of these practices on the firm performance holistically. For example, using environmentally friendly raw materials and adopting best practices could increase efficiency and, thereby, decrease manufacturing costs (Gimenez, Sierra, & Rodon, 2012). Waste is generated during the product life cycle when the product is discarded and waste management is adopted by firms to improve material flows and meet the stipulations of their stakeholders (Heidrich, Harvey, & Tollin, 2009). Heidrich et al. (2009) cite the example of Nike which reduced its waste disposed to landfill from 25% in 2007 to 13% in 2009 by working with its material suppliers to recycle factory wastes. Therefore, this fourth hypothesis also reveals what an MSME's relationships with its stakeholders tell about the moral philosophy of a firm. It is thus important to investigate these hypotheses, and a clear understanding of these would have policy implications also.

H4: There is a positive relationship between firm performance and sustainability dimensions.

Discussion

Sustainable suppliers appear to be in scarcity (Hollos, Blome, & Foerstl, 2012). This makes it pertinent to ensure that the MSMEs, especially in developing economies, adopt sustainable practices. The suppliers in these developing economies tend to create higher idiosyncratic sustainability risks (Reuter, Foerstl, Hartmann, & Blome, 2010). The TBL perspective has been recommended in the extant literature, especially for bigger firms. This perspective outlines the strategic and philosophical outlook of firms seeking balanced consumption and regeneration of resources needed in the future (Laszlo & Zhexembayeva, 2011). However, to undertake this pragmatic approach, firms may need to make significant changes to their processes, culture, and people to align with the best practices (Ehnert & Harry, 2012).

Prior research on drivers to adopt sustainability or the impact of sustainability practices on firm performance has mostly focused on larger firms or MSMEs in developed economies. The analyses on larger firms may not be replicable on the smaller ones. For example, unlike the MSMEs, bigger firms may have resources that could be devoted to purposes other than routine operations (Bryson & White, 2019). However, there is an incomplete understanding of MSMEs' commitment to sustainability (Johnson & Schaltegger, 2016). Therefore, the MSME context allows exploring and analyzing the antecedents of embracing sustainable behavior and its impact on firm performance under unique settings. This understanding is important as the small firms are expected to play a key role in fulfilling the Sustainable Development Goals (SDGs) set by the United Nations in 2015 (Cantele & Zardini, 2020).

This study would make multiple contributions. To the best of my knowledge, it is the first attempt to integrate antecedents of adoption of TBL/sustainability practices with the latter's impact on the firm performance. The findings would help policymakers devise appropriate policies for the MSMEs to improve their operational efficiency and adoption of TBL ethos. The

study is also expected to add to the literature on applying organizational theories in SCM and contribute to theory-building. A probable shortcoming in implementing the proposed conceptual framework could be the dependence on a self-diagnostic primary survey of the MSMEs. Unlike listed firms, for which relevant data might be available on sources such as annual reports, Bloomberg, Capitaline, and Carbon Disclosure Project (CDP) database, similar data for most MSMEs are not available through secondary sources. However, a self-diagnostic CSR questionnaire is common in SME studies (Coppa & Sriramesh, 2013), so I think it is fine to conduct a primary survey for implementing this framework. Future research directions could include bringing in more dimensions such as technology and applying the framework across geographies and diverse industry verticals. The network impact of MSMEs in a multi-tier supply chain could also be a prospective future research area.

Conclusion

The availability of resources for competitive advantage would get limited as there is more visibility about access to competitors' raw materials and suppliers. Therefore, to remain competitive, MSMEs should seek the route of sustainability, integrate social, economic, and environmental responsibilities, and shed the tag of being ignorant and lackadaisical about it. The unidimensional view of sustainability has been critiqued, and it is being envisaged as multi-dimensional, comprising environmental and social aspects, besides the economic one. The extant research has advocated that social and environmental factors are strategic considerations for organizations irrespective of their size. MSMEs are a key cog in the supply chain. So, it is imperative to understand the practical challenges they face while applying and managing the TBL dimensions, the drivers which propel them to adopt the sustainability best practices, and how their holistic performance is affected by these practices. The current study proposes an integrated conceptual framework that utilizes the institutional and stakeholder perspectives. Its implementation is expected to be useful for policymakers, academic researchers, and practitioners alike.

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IMPROVING THE FOOD WASTE MANAGEMENT IN THE DESIGN OF A SUSTAINABLE FOOD SUPPLY NETWORK

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Abstract

In this paper, we will investigate the problem of designing a food donation distribution network in the context of nonprofit organizations. A mixed-integer linear programming (MILP) model is formulated for optimizing the distribution operations. The developed model is utilized to analyze the existing network of the Saudi Food Bank organization. By solving the model at different combinations of budgets, we obtain an optimal alternative solution that reduces the required budget by 26.7 %. Improvements in this field will address social issues such as food access equality. Finally, we discuss the best food waste management practices and discuss future research areas.

Keywords: Sustainability, Food Donation, Network Design, Food Waste

1 Introduction

Sustainability is improving living standards not only for current society but also for future generations. It aims to balance the economic, environmental, and social impact of implementing supply chain goals in the long term (A. W. Fadhel & Gupta, 2019). It incorporates objectives wider than just efficient and profitable production and consumption including socially

fair and environmentally friendly products (Soysal, Bloemhof-Ruwaard, Meuwissen, & van der Vorst, 2012). The sustainability of the food supply chain is facing so many challenges. First, food insecurity presents in different parts of the world. In India for example, about 24% of families have days with no food at all. At the same time, it is estimated that one-third of global food production is wasted per year. food production processes consume more than 10% of the total US energy budget, about 80% of fresh water in the US, and about 50% of U.S lands. However, more than 50% of all produced food is wasted before or after reaching consumers. This is estimated to cause a loss of more than $165 billion, 25% of freshwater, and huge yearly losses of energy, lands, and other resources (Govindan, Jafarian, Khodaverdi, & Devika, 2014). As new challenges have emerged such as climate change, fair trade, food waste, and food security, all different actors in the food industry should consider ways to produce, process, distribute and consume food more sustainably without compromising costs (Adel W Fadhel & Gupta, 2020).

In this study, we will investigate the management procedure and policy prospects of designing a food waste distribution network in the context of nonprofit organizations. We aim to determine the number and location of the distribution centers to cover the determined areas with the least cost and best utilization of the food bank resources. A mixed-integer linear programming (MILP) model is formulated for returned excess food. The delivered model is utilized to analyze the existing network of the Saudi Food Bank organization. This organization aims to reduce food waste by adopting this initiative from the worldwide idea of food banks. By solving the model at different combinations of budgets, we obtain a better alternative solution that reduces the required budget by 26.7 %. Improvements in this field will lead to social consolidation and solve many social problems such as food access equality. At the same time, the advances in this area of study will motive donators to support nonprofit organizations and increase funds. However, it is not an easy task to overcome the challenges that face the food supply chain which needs to achieve "getting the right food to the right people at the right time". The cornerstone of the resolution of these challenges is to model supply network design that leads to an efficient and effective collection and redistribution of food waste to beneficiaries (Adel W Fadhel, Ndiaye, Khumawala, & Gupta, 2017).

2   Management procedures and policy prospects

2.1   Landfill Diversion

Landfills are undesirable solutions to the problem of waste disposal. a landfill does not close any life cycles. It leaves all of them open. Landfills are accepted to be permanent depositories of mixed waste, carefully isolated from their environment by appropriate impermeable layers at the bottom and methane scavenging vegetation at the top. As a result, landfill creates Planet Trash instead of returning to the original state to be part of the Planet earth nature in the foreseeable future. (Fehr, Calçado, & Romão, 2002)

2.2   Food Donation

The donations are accounted for as waste in some studies as no revenue is derived from them. However, the overall value of donations and other sustainable food waste diversion options can only be evaluated by encountering the macroscopic assessment at regional and national levels concerning social and environmental implications (Fehr et al., 2002). The USDA has supported food donation practices through various initiatives such as tax incentives and liability protection. Examples of such initiatives include the U.S. Federal Food Donation Act of 2008 and the Bill Emerson Good Samaritan Food Donation Act (Thyberg & Tonjes, 2016).

2.3   Across the FSC stages

On the production level. farmers are ought to pinpoint the factors leading to losses on harvesting, packaging, loading, and transportation. wholesalers need to be conscious about the convenience of maintaining air-conditioned storage areas and of hiring appropriate manpower. Retailers and traders are encouraged to exercise control over cost structure and to optimize purchasing schedules and to follow good practices of manipulating produce in the stores (Fehr et al., 2002).

When addressing food waste prevention policies, we must keep in mind that there is no one-size-fits-all solution to this issue. Rather, policy measures are dependent on the social, regulatory, and political atmosphere at which such policies would be implemented. Therefore, holistic custom-tailored approaches that integrate all aspects of sustainability across food waste systems are ideal. Next, we discuss food waste prevention policies both in developed and developing countries.

2.4 Policies for Developed Countries

2.4.1 Policies driving the generation of FW

Certain policies can lead to generating food waste by mandating food disposal or preventing food redistribution due to litigation, safety, and public health concerns (Duman, Tozanli, Kongar, & Gupta, 2017). Therefore, there is a conflict between food safety concerns and the goal to mitigate the food waste issue. One example of such policies is the Hunger-Free Kids Act which mandates nutritional quality improvements for student meals by increasing the fruit and vegetable content. However, students dislike new meals which result in increasing food waste.

2.4.2 Driving factors of food waste in the foodservice and public level

- Over or poorly prepared food or large portion that is not consumed.
- Imperfect food appearance, date label confusion, or damaged packaging.

To prevent and reduce food waste the following mechanisms can be implemented:

- Increasing the awareness and education regarding proper food preparation, food storage, date labeling and the redistribution of excess food can reduce the impact of the wasted food.
- Improve the packaging quality of the redistribution system of food waste for donation purposes.
- Improving the logistical aspects of food waste recovery in terms of stock management and optimal ordering policies.
- food waste prevention can be approached through a package of three key aspects:
  - Values: addresses the perceptions behind reducing food waste including the fact that food waste is a waste of resources and impacts the environment.
  - Skills: provide stakeholders of the food waste process with training to better handle the wasted food in all stages of the FSC.
  - Logistics: preventing food waste can only be feasible by improving forecasting practices and updated data mining models. Further, improving packing quality and storage operations and redistribution systems would encourage optimal food waste utilization.

2.5 Policies for Developing Countries

The food waste issue in developing countries is mainly attributed to the poor management of the food supply chain and the lack of an integrated approach to address such an issue. In particular, the food waste in developing countries occurs mostly in the early and middle stages of the food supply chain where it's caused by the lack of professional managerial and technical harvesting processes, cold chain facilities, and logistics infrastructure. Any reduction in food waste would have a great impact on farmers and society as a whole in developing countries who are living on the boundaries of food insecurity (Balaji & Arshinder, 2016). The driving causes of food waste in developing countries are as follows in descending order from importance and contribution to the food waste issue.

1. Lack of integrated IT systems and poor training in handling the food items.
2. Lack of logistical infrastructure and coordination in harvesting and distribution stages of the FSC
3. Lack of cold storage facilities and poor packaging standards.
4. Lack of quality control procedures and the existence of a large number of intermediaries between the farmer and the consumer.

To prevent and move towards better food waste handling practices in developing countries, the following policies are recommended:

- Minimize the number of intermediaries in the FSC through creating markets and transparent business transactions by government incentives.
- Increasing the awareness about scientific harvesting techniques through education and government initiatives.
- Develop the agricultural and logistics infrastructure by building the necessary facilities such as food processing units and cold storage centers.
- Adopt communication and coordination standards between all players of the FSC to implement sustainable disposal practices.
- Ensuring food traceability techniques to improve the food quality the increase food security.

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MULTI-OBJECTIVE PROBLEM OF REVERSE SUPPLY CHAIN NETWORK DESIGN WITH INDIVIDUAL MATERIAL WEIGHT RECOVERED BY USING LINEAR PHYSICAL PROGRAMMING

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ABSTRACT

The reverse supply chain is a network for transportation of the End-of-Life (EOL) products from collection centers to a recovery and/or disposal facility. In recent years, the collection and recovery materials by each material type should be treated. For example, the Marine-Plastic-Issue has become a serious global problem, where plastic garbage pollutes oceans and harms marine wildlife.

Moreover, the relationship between recycling rate and total cost is often a tradeoff that should be considered in designing the reverse supply chain. The decision maker (DM) who designs a reverse supply chain network has to solve the multi-objective problem economically and environmentally-friendly manner simultaneously. Linear Physical Programming (LPP) is one of the effective methods for solving multi-objective problems. By using LPP, the DM can express desirable ranges for each criterion. Furthermore, he does not need to specify the mathematical weights for each criterion. This study designed a multi-objective reverse supply chain network using LPP to collect and recycle EOL assembly products (1) to minimize the total cost, (2) to maximize the recycling rate, and (3) to the collected and recovered material weight of each material.

Keywords: Reverse Logistics, Environmentally Conscious Manufacturing, Multi-Criteria Decision Making, End-of-Life Product, Recycling

1. INTRODUCTION

In recent years, plastic waste is a growing concern [1]. This is because Marine-Plastic-Issue has become a serious global problem, where plastic garbage pollutes oceans and harms marine wildlife [2]. Focusing on plastic waste, the average global recycling rate of the world is 12% [3]. This fact means that most of plastic waste has been disposed of in landfills. One of the reasons of it is that the recycling cost of plastic waste is higher than the purchasing virgin materials. Therefore, manufacturing companies might not consider recycled materials waste. However, to save environment and life, many countries are started to reduce plastic waste. Against the background of it, EU adopts regulation on plastic products. According to that law, single-use plastic which is not recycled will be eliminated by 2050 [4]. Such social requirements for saving environment have influenced corporate management. For example, the Coca-Cola company joined the New Plastic Economy Global Commitment to ensure that plastic package and containers will become recyclable materials by 2025 [5]. As activities of government and company around the world for environmental friendliness, they should be design circulating resources plan which means to mining resources from end-of-life (EOL) products instead of mining materials from nature. To obtain resources from EOL products, EOL products are collected through the reverse supply chain network. The

reverse supply chain network is a network for transportation of the EOL products from collection centers to a recovery and/or disposal facility [6].

On the other hand, the relationship between the recycling rate and the total cost is often a tradeoff that should be considered in designing the reverse supply chain. The decision maker (DM) who designs a reverse supply chain network has to solve the multi-objective problem economically and environmentally-friendly manner simultaneously. Linear Physical Programming (LPP) [7] is one of the effective methods for solving multi-objective problems. By using LPP, the DM can express desirable ranges for each criterion without weight parameters.

In a previous study on LPP and product recovery, Imtanavanich et. al. [8] designed a disassembly system for laptop PCs using LPP. However, they did not apply environmental indicators. Listers et. al. [9] designed reverse supply chain network for building waste materials. However, they did not consider the recovered material obtained from recycling.

This study designs reverse supply chain network with multi-objective functions economically and environmentally-friendly by using LPP.

2. MODEL &FOMULATION
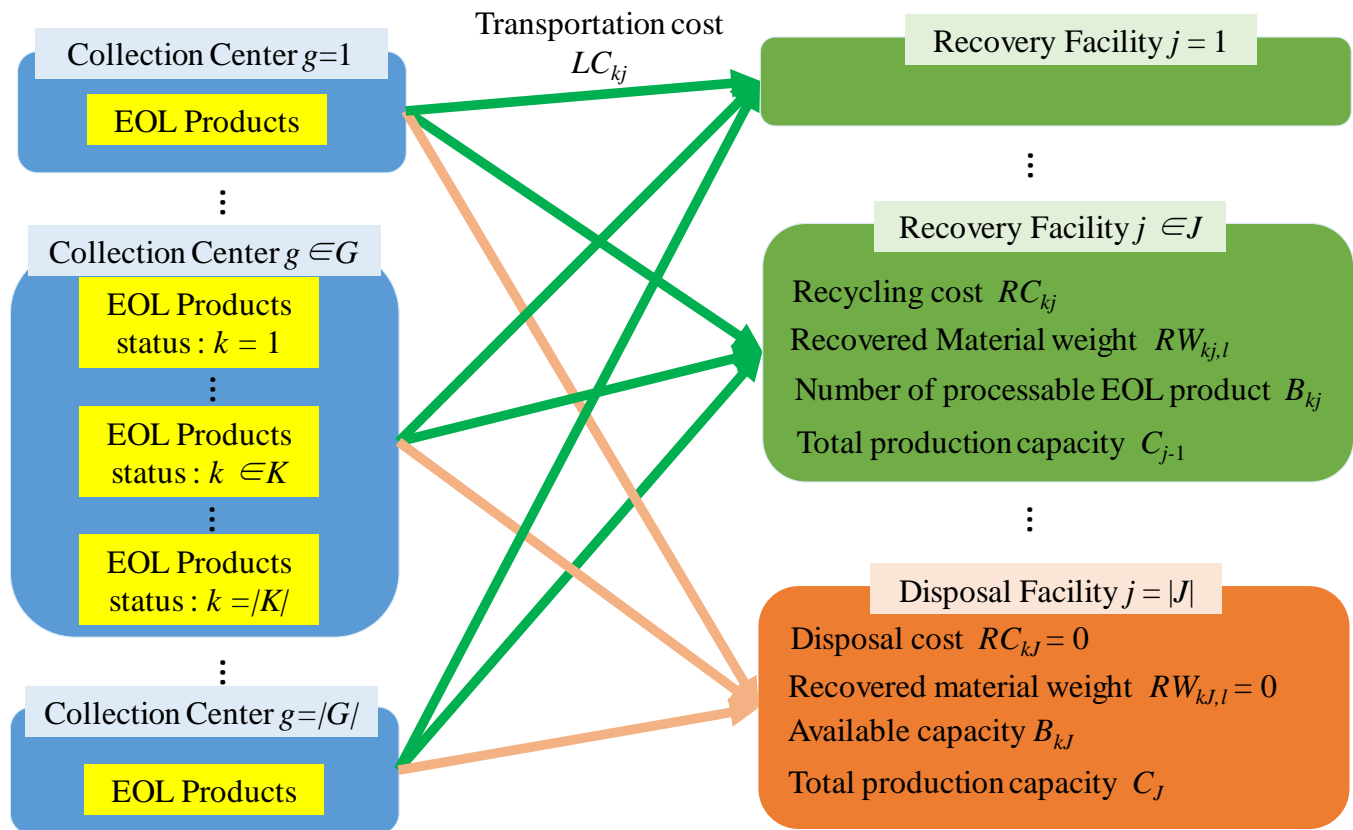
Figure 1: Model of the reverse supply chain network with EOL product status

Figure 1 shows a reverse supply chain network model for EOL products including each material collection and is based on a previous research [6]. Each EOL product in collection center g has status k. The status k determines recycling cost RC_{kj}, possible recycling rate R_{kj} and recovered material weight of polypropylene $RW_{kj,PP}$ and aluminum $RW_{kj,AL}$ estimated using the recyclability evaluation method (REM) [10], [11]. The possible recycling rate R_{kj} means percentage of the recyclable materials out of the total weight within the EOL product. In collection center g, all EOL products with status k are transported to the appropriate recovery

facility j or disposal facility J with transportation cost LC_{gj}. When an EOL product is transported to recovered facility j, the recovered materials such as polypropylene and aluminum are obtained based on status k. However, when the EOL product is transported to disposal facility J, the EOL product is disposed of so that no materials are obtained. Using this model, the obtained network is evaluated with the objective functions such as the total cost TC, the average recycling rate AR and each recovered material weight TW_l for material type l.

The total cost of the whole network TC means the sum of costs associated with transporting, recycling EOL products, and opening recovery facilities. The average recycling rate of the entire reverse supply chain AR represents the average recycling rate per EOL product. Therefore, when the EOL products are processed recovery facility j, the average recycling rate AR is increased based on each status k of the EOL products. On the other hand, when the EOL products are processed at disposal facility J, the average recycling rate AR is not increased.

The recovered material weight $RW_{kj,l}$ means the recovered weight obtained by recycling the EOL products. As the case of the average recycling rate AR, when the recovery facility j processes the EOL products, the recovered material weight $RW_{kj,l}$ is increased based on each status k of the EOL products. However, when disposal facility J processes the EOL products, the recovered material weight $RW_{kj,l}$ is not increased.

This model determines the appropriate quantities of EOL products to be transported from the collection center to the recycling and/or disposal facilities while satisfying three criteria: minimizing the total costs TC, maximizing the average recycling rate of the entire network AR and maximizing the recovered material weight $RW_{kj,l}$ by each material.

The variables and parameters of the mathematical formulation are listed as follows.

i)Indices

i	:	Objective function belonged to soft classes ($i=1, ..., NSC$)
s	:	Ranges ($s=2, …, 5.$)
k	:	Status for the EOL products ($k=1, …, K.$)
g	:	Collection centers ($g=1, …, G.$)
j	:	Recycling and disposal facilities ($j=1, …, J.$)
l	:	Individual material type ($l = 1, …, L.$)

ii)Parameters

K	:	Number of statues for the EOL products
G	:	Number of collection centers
J	:	Number of recovery and disposal facilities
L	:	Recovered materials
M	:	Very large number (big M)
$\widetilde{w}_{is}^{+}, \widetilde{w}_{is}^{-}$	:	Positive/negative deviation weight of the sth range of objective i
t_{is}^{+}, t_{is}^{-}	:	Positive/negative limit to the sth range of objective i
RC_{kj}	:	Recycling/Disposal cost for EOL products with status k at facility j
LC_{gj}	:	Transportation cost from collection center g to facility j
FC_j	:	The fixed opening cost at facility j

R_{kj}	:	The possible recycling rate of status k at facility j
RW_{kjl}	:	The recovered weight of polypropylene with status k at facility j
R_{kj}	:	The recovered weight of aluminum with status k at facility j
QS_{kg}	:	Number of EOL products with status k at collection center g
B_{kj}	:	Available production capacity of status k at facility j
C_j	:	Total production capacity at facility j
NSC	:	Numbers of soft classes

iii) Variables

m_{kgj}	:	Number of products with status k transported from collection center g to facility j
u_j	:	Binary value; 1 if facility j is opened, else 0
d_{is}^+, d_{is}^-	:	Positive/negative deviation variable from the sth range limit of objective i
QD_{kj}	:	Number of processed EOL products with status k at facility j
TC	:	Total cost of reverse supply chain
AR	:	Average recycling rate of the entire network
TW_l		Total recovered material weight of material type l

In this study, LPP [3] is applied to the design method of the reverse supply network. The total costs TC means the sum of transporting and recycling EOL products and the costs associated with opening recovery facilities. Both recycling and transportation costs are dependent on the numbers of transported EOL products to each recover/disposal facility. The opening facility cost is required to open the recover or disposal facilities for processing EOL products. Therefore, total costs TC is obtained in equation (1).

$$TC = \sum_{k=1}^{K} \sum_{g=1}^{G} \sum_{j=1}^{J} (RC_{kj} + LC_{gj}) m_{kgj} + \sum_{j=1}^{J} FC_j u_j \rightarrow Min \tag{1}$$

On the other hand, the average recycling rate of the entire network AR, which is the rate of processing EOL products at the recovery facilities compared to all collected EOL products at collection centers, is set as equation (2).

$$AR = \frac{\sum_{k=1}^{K} \sum_{j=1}^{J-1} R_{kj} QD_{kj}}{\sum_{g=1}^{G} \sum_{k=1}^{K} QS_{kg}} \rightarrow Max \tag{2}$$

The total recovered weight TW_l, which is the recovered material weight of each material type l by processing EOL product at the recovery facilities, and is obtained in equation (3).

$$TW_l = \sum_{k=1}^{K} \sum_{j=1}^{J-1} RW_{kjl} \rightarrow Max \tag{3}$$

Similar to a previous study [6], other constraints are defined using integer programming [12]:

$$\sum_{j=1}^{J} m_{kgj} = QS_{kg} \qquad\qquad k = 1, \dots, K \quad g = 1, \dots, G \tag{4}$$

$$\sum_{g=1}^{G} m_{kgj} = QD_{kj} \qquad\qquad k = 1, \dots, K \quad j = 1, \dots, J \tag{5}$$

$$QD_{kj} \leq B_{kj} \qquad\qquad k = 1, \dots, K \quad j = 1, \dots, J \tag{6}$$

$$\sum_{k=1}^{K} QD_{kj} \leq C_j \qquad\qquad j = 1, \dots, J \tag{7}$$

$$\sum_{k=1}^{K} QD_{kj} \leq Mu_j \qquad\qquad j = 1, \dots, J \qquad\qquad (8)$$

$$u_j = \{0, 1\} \qquad\qquad j = 1, \dots, J \qquad\qquad (9)$$

$$m_{kgj}, QD_{kj} \geq 0 \qquad\qquad k = 1, \dots, K \; g = 1, \dots, G \; j = 1, \dots, J \qquad (10)$$

$$m_{kgj}, QD_{kj} \qquad\qquad \text{are integers.} \qquad\qquad (11)$$

Equation (4) means that the all EOL products at the collection centers should be transported. Equation (5) ensures that all transported EOL products should be processed at each recovery and/or disposal facility. Equation (6) means that the numbers of the processed EOL products with status k is equal to or less than the number of the production capacity B_{kj} with status k at facility j. Equation (7) shows that the total amount of processed EOL products at each facility j should be less than the total production capacity C_j. Equation (8) ensures that the transported EOL product is processed at only the opened facility j. Equation (9) means the binary restrictions. Equations (10) and (11) mean the non-negativity and integer restrictions.

3. SETTING TARGETS AND FORMULATION OF EACH OBJECTIVE FUNCTION

To apply LPP for integer programming, each objective function is divided into 6 preferences level. The preference level means the range based on DM's desire. As assumptions that DM consider all objective functions are improved to the same degree, the interval between the worst value and best one is divided into the same scale in this case. Table 1 and 2 show the ranges of preference level for each objective function.

Table 1 Ranges of preference level for the total cost TC and the average recycling rate AR

Preference level	Total costs TC [Yen]	Average recycling rate AR [%]
Ideal	≤3,000,000	≥60%
Desirable	(3,000,000, 5,500,000]	[47.5%, 60%)
Tolerable	(5,500,000, 8,000,000]	[35%, 47.5%)
Undesirable	(8,000,000, 10,500,000]	[22.5%, 35%)
Highly Undesirable	(10,500,000, 12,000,000]	[10%, 22.5%)
Unacceptable	>12,000,000	<10%

Table 2 Ranges of preference level for each recovered material weight TW_l

Preference level	Recoved material weight of polypropylene TW_1	Recoved material weight of aluminum TW_2	Recovered material weight of PVC TW_3	Recovered material weight of PMMA TW_4	Recovered material weight of ABS RW_4	Recovered material weight of Motor TW_5
Ideal	≥10,000,000	≥2,000,000	≥350000	≥3000000	≥350000	≥4000000
Desirable	[8,000,000, 10,000,000)	[1,600,000, 2,000,000)	[300000, 350000)	[2,500,000, 3,000,000)	[250000, 350000)	[3000000, 4000000)
Tolerable	[6,000,000, 8,000,000)	[1,200,000, 1,600,000)	[250000, 300000)	[2000000, 2500000)	[200000, 250000)	[2500000, 3000000)
Undesirable	[4,000,000, 6,000,000)	[800,000, 1,200,000)	[150000, 250000)	[1500000, 2000000)	[150000, 200000)	[2000000, 2500000)
Highly Undesirable	[2,000,000, 4,000,000)	[400,000, 800,000)	[50,000, 150000)	[1000000, 1500000)	[100000, 150000)	[1000000, 2000000)
Unacceptable	<2,000,000	<400,000	<50,000	<1,000,000	<100000	<1000000

To solve the solve the objectives obtained as equations (1), (2) and (3) using LPP, the aggregate objective function [6] is obtained using equation (12). Equation (12) indicates that the whole objective function minimizes the sum of deviation weights $\widetilde{w}_{is}^{+}/\widetilde{w}_{is}^{-}$ and deviation variables $d^{+}{}_{is}/d^{-}{}_{is}$.

$$\sum_{i=1}^{NSC} \sum_{s=2}^{5} (\widetilde{w}_{is}^{+} d_{is}^{+} + \widetilde{w}_{is}^{-} d_{is}^{-}) + \; \rightarrow min \qquad\qquad (12)$$

In this model, the first objective function is related to the total costs TC of the whole reverse supply chain. The first objective is transposed using constraints (13) and (14). By minimizing the sth deviation variable $d^{+}{}_{1,s}$ in equation (13), the total costs TC tries to reach ideal range $t^{+}{}_{1,s}$. Equation (14) means that the total costs TC is lower than the limit of the unacceptable $t^{+}{}_{1,5}$. The second objective function is related to the average recycling

rate AR of the entire reverse supply chain network. Therefore, the second objective is obtained using equations (15) and (16). Similar to equation (13), the average recycling rate AR tries to reach the ideal range by minimizing the sth variable $d^+{}_{2,5}$. Equation (15) means that the average recycling rate AR is higher than the limit of the unacceptable $t^+{}_{2,5}$. Equation (16) enforces higher than minimum value $t^-{}_{i,5}$ on the average recycling rate AR in the entire reverse supply chain network.

$$TC - d^+_{1,s} \leq t^+_{1,s-1} \qquad s = 2, ..., 5 \tag{13}$$

$$TC \leq t^+_{1,5} \tag{14}$$

$$AR + d^-_{2,s} \geq t^-_{2,s-1} \qquad s = 2, ..., 5 \tag{15}$$

$$AR \geq t^-_{2,5} \tag{16}$$

Since third to eighth objective functions are related to the recovered material weight of individual material TW_l. Therefore, they are obtained as equations (17) and (18). The recovered material weight TW_l tries to reach ideal range by minimizing sth variable $d^+{}_{is}$. Equation (17) means that the recovered material weight TW_l is higher than each limit of the unacceptable $t^+{}_{i5}$. Equation (18) enforces higher than minimum value $t^-{}_{i,5}$ on the recovered material TW_l weight in each material.

$$TW_l + d^-_{i,s} \geq t^-_{i,s-1} \quad \begin{array}{l} l = 1,2, ..., L, i = 2 + l, s = \\ 2, ..., 5 \end{array} \tag{17}$$

$$TW_l \geq t^-_{i,5} \quad l = 1,2, ..., L, i = 2 + l \tag{18}$$

4. THE RESULT OF REVERSE SUPPLY CHAIN NEWORK FOR EACH OBJECTIVE FUNCTION

Table 3 Value and preference level of each objective function

Objective function	Value	Preference level
Total cost TC	9,149,420 [Yen]	Undesirable
Average recycling rate AR	46.4%	Tolerable
Recovered material weight of Polypropylene TW_1	7,971,469 [g]	Tolerable
Recovered material weight of Aluminum TW_2	1,403,110 [g]	Tolerable
Recovered material weight of PVC TW_3	251,620 [g]	Tolerable
Recovered material weight of PMMA TW_4	2,509,820 [g]	Desirable
Recovered material weight of ABS TW_5	286,605 [g]	Desirable
Recovered material weight of Motor TW_6	3,519,230 [g]	Desirable

Table 3 shows the value and preference level of each objective function. Regarding the environmental objective functions, the average recycling rate AR and the recovered material weights such as polypropylene TW_1, aluminum TW_2, PVC TW_3, PMMA TW_4, ABS TW_5 and motor TW_6 are in the tolerable or desirable preference levels. However, the total cost TC which is the economic objective function is in undesirable preference level. In this study, only one economic objective function is set, while seven environmentally-friendly objective functions are set. Therefore, larger amount of recycling EOL products are recycled. As the above imbalance among the objective functions, harmony will be achieved by increasing new economical objective function or other types of objective functions such as social objective function.

Focusing on plastic materials, values of recovered material weight for polypropylene TW_1 and PVC TW_3 are in tolerable preference level while others such as PMMA TW_4 and TW_5 are in desirable preference level. This is because the objective function for plastic materials is in acceptable range, thus, each material weight is in effected vacuum cleaner. In a vacuum cleaner, the total weight of part made from plastic materials is 918g, and that accounts 64%. Therefore, the recycling plastic part also contributes to increasing the average recycling rate of the entire reverse supply chain network. On the other hand, the recovered materials weight for polypropylene is the most collected ones in this experiment. As one of the reasons of it, the polypropylene is used in 13 out of 25 parts and then recycled.

5. CONCLUSION AND FUTURE STUDY

This study designed reverse supply chain network with multi-objective functions economically and environmentally-friendly by using LPP. By setting the recovered material weight as the objective functions, the reverse supply chain network was designed more environmental-friendly. Future studies should set social objective functions and other environmental one such as CO_2 saving rate.

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OPTIMAL INVENTORY POLICIES IN DISRUPTED SUPPLY CHAINS DURING PANDEMICS: AN APPLICATION TO DIAGNOSTIC TEST KITS

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Abstract:

The COVID-19 pandemic has changed the normal life and business environments across the globe. Not long after starting large-scale testing, countries hit a roadblock -- the shortage of swabs used in the testing kits, which took place due to disruptions in the supply chain caused by COVID-19. This disruption translates to a variable production capacity of the swab suppliers. By considering different swab demand patterns and production capacity scenarios for swab suppliers, we develop analytical models to derive optimal policies and provide managerial insights as to how countries should optimally react to changes in the supply and demand of swabs.

Keywords: Inventory, COVID-19 testing, Supplier capacity uncertainty, stationary and stochastic demand.

1. Introduction

On December 31, 2019, the World Health Organization (WHO) office in China was informed of cases of pneumonia (now known as COVID-19) detected in Wuhan City (Zhu et. al. 2020). On January 30, 2020, the WHO declared the outbreak a Public Health Emergency of International Concern -- 7,818 cases confirmed globally, affecting 19 countries in five WHO regions (Srivastava et. al. 2020). Not long after that, in March 2020, many countries around the globe declared an emergency. Subsequently, cities and states/provinces across countries were shut down to prevent the spread of the COVID-19. For instance, in Italy, one of the first-hit and hardest-hit countries, the Italian government has commanded the most extreme curbs deployed in Europe and shut down

the entire economy to contain the virus's spread, telling Italians to stay at home except for emergencies or necessary work-related purposes.

As the result of the pandemic, a lot of the hospitals around the glob are facing surges in the number of requests for COVID-19 tests. This results in as increase in the demand for Diagnostic Test Kits (DTK). On the supply side, however, DTK suppliers are facing supply chain disruption because of COVID-19. For example, they lack raw material and workforce. This translates into an unknown capacity for the supplier over time. Therefore, in the presence of DTK supplier capacity uncertainty, it is crucial for hospitals\states\countries to adopt a proper DTK inventory management policy to facilitate and well-coordinate the DTK procurement policy. In our study, we focus on an inventory management problem, where the retailer (e.g., a country, state or a hospital) orders DTK from a supplier with stochastic capacity. Note that this temporary DTK inventory management should continue until a vaccine or a therapeutic is discovered, because that is when the supply chain disruption is resolved. Therefore, in our paper, we consider the time horizon to be finite.

Additionally, the demand for DTK could have different patterns based on the country's situation. In some cases, the country orders DTK based on the forecasts; hence, DTK demand is stationary. On the other hand, some countries plan to procure DTK according to the daily number of COVID-19 patients. In this case, DTK demand is stochastic. Therefore, in our paper, we focus on two demand patterns: (1) stationary demand, and (2) stochastic. Furthermore, note that any DTK shortage results in a shortage, because patients are still in the hospital. Therefore, in our paper, we consider a case where DTK shortages are back-ordered.

2. Model and Analysis

We study a DTK inventory management problem in a finite time horizon setting. In our model, we consider a country/state/hospital as the retailer, which orders DTK from a supplier facing supply chain disruption. Depending on the supplier's capacity constraint and the stochasticity of the demand, we study the following four models. 1) In this model, demand is stationary, and the supplier has ample capacity. This model serves us as the first benchmark. 2) In this model, demand is stationary, and the supplier has stochastic capacity. That is, the supplier cannot necessarily fulfill the DTK demand. 3) In this model, demand is stochastic, and the supplier has ample capacity. This

model serves us as the second benchmark. 4) In this model, demand is stochastic, and the supplier has stochastic capacity. That is, the supplier cannot necessarily fulfill the DTK demand.

We derive the total cost expression for the above four models. Further, for Model 1, we derive the optimal policy. For Model 2, we find sufficient conditions to obtain the optimal policy. For Model 3, we partially derive the optimal policy and devise an algorithm to find the optimal policy. For Model 4, we derive sufficient conditions to partially find the optimal policy and devise an algorithm to fully characterize the optimal policy. Then, through an extensive numerical study, we compare the optimal policies to derive insights for public health administrations regarding how to optimally react to changes in DTK supply chain disruptions and changes in daily number of COVID-19 patients.

3. Results

This study makes three major contributions to the literature. First, to our knowledge, the problem considered here has not been studied. This problem is essential in practice and has significant implications because it deals with people's lives and livelihood. Second, our results help policymakers optimally react to changes in the disruption in the DTK supply chain. For example, our results show that under stochastic demand, as the variation of the supplier's capacity increases, the optimal number of DTKs to be ordered always increases, and consequently, the optimal number of back-orders decreases. Moreover, the optimal number of orders increases regardless of the stochasticity of the demand.

Additionally, when the mean of supplier's capacity is large, as the variation of the supplier's capacity decreases, the optimal order quantity and the optimal expected total cost decrease, regardless of the stochasticity of the demand. In other words, when DTK supply chains face significantly large disruptions, it is best for countries to have a higher DTK reorder point. The reason is that as there is more disruption in supply chains, due to the uncertainty of the capacity, there is a higher chance the DTK supplier cannot fulfill the order placed by the country. The supplier, however, can only fulfill the number of DTKs being produced. Therefore, the country has to order more frequently to satisfy the total demand over the time horizon, and the country has to carry more DTKs over the time horizon to avoid stock-outs, because of which it is expected the number of DTKs on back-order decreases. However, this is possible at a higher cost for two reasons. First, because the country orders more frequently, ordering cost increases. Next, because

the country is carrying more DTK inventory, holding cost increases. Therefore, total cost faces an increase.

Lastly, our managerial insights provide decision-makers with strategies to better control the spread of COVID-19 by reducing the DTK back-orders and by optimally ordering DTKs under different demand circumstances. When the DTK supply chain is disrupted, as the supplier's average DTK capacity increases, the country should carry fewer DTKs over the time horizon. This implies that as DTK-supplier capacity constraint becomes less of an issue for the country, the country should decrease its reorder point. This results in a lower holding cost and a higher expected number of back-orders. Our numerical study suggests that the decrease in fixed ordering costs and holding costs sometimes dominates the increase in back-order cost, hence a decrease in total cost.

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PROBLEM OF REMANUFACTURING OPTION SELECTION WITH DISASSEMBLY FOR CO₂ SAVING RATE AND COST

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ABSTRACT

In recent years, there has been a significant increase in the problems pertaining to the disposal of old electronic products and waste and the CO_2 emissions generated during production, resulting in severe environmental issues. As a solution, remanufacturing, involving processes such as disassembly, re-assembly, recycling, and reuse, offers economic and environmental benefits. Given the high costs associated with disassembling and reassembling a product, the life cycle options with remanufacturing of end-of-life products through disassembly and assembly should be designed both from environmental and economic perspectives. This study considers CO_2 savings and profits achieved via remanufacturing option selection. The experiments with environmental objective functions and economic objective functions are formulated by setting 0–1 integer programs and ε constraint method. Throughout a laptop case study, it demonstrates that the proposed method of remanufacturing obtained higher CO_2 savings and profits.

Keywords: CO₂ saving , Crushing Cost, Reassembly, Reuse, Integer Programming

1. INTRODUCTION

Assembled products such as home appliances and automobiles comprise a variety of materials used in the different components. Technological and industrial advancements have enabled improvements in such assembled products, offering several advantages such as comfortable use. However, the CO_2 emissions generated during the manufacturing of these products, their handling, and their disposal result in severe environmental effects. Global warming is one such major environmental problem; increasing CO_2 emissions have increased the amount of greenhouse gases released to the atmosphere, further worsening the problem [1].

Remanufacturing refers to returning used products back to performance as much as new products [2]. Disassemble used products such that their performance is similar to that of new products. First, the used products are disassembled completely and all the components of the products are inspected. Subsequently, faulty components are replaced with new ones, while functional components are retained after testing. Lastly, the remanufactured product is reassembled [3]. Such life cycle options can involve reuse, recycling, and disposal of the components of the product through disassembly [4][5]. Life cycle options involving remanufacturing enable us to treat the reuse of components, thereby reducing CO_2 emissions.

Han et al. (2020) [6] studied recovery costs and the CO_2 emissions associated with manufacturing computer products based on the life cycle options to compare the results among three countries. However, they did not consider remanufacturing, whereby used products perform just as well as new products. Yoda et al. (2020) [2] formulated the remanufacturing option selection based on the recovery rate and profit for

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a laptop. However, they did not consider the effects of the CO_2 emission reduction afforded by remanufacturing and the additional costs such as crush cost pertaining to disposal.

This study considers CO_2 savings and profits achieved via remanufacturing option selection considering the crushing cost in disposal. The experiments with environmental objective functions and economic objective functions are formulated by setting 0–1 integer programs and ε constraint method. Throughout a laptop case study, it demonstrates that the proposed method of remanufacturing obtained higher CO_2 savings and profits.

2. METHOD

Based on Yoda et al. [2] considering recovery rate, this study proposes an approach for selecting life cycle options with remanufacturing under CO_2 saving and profit objectives as shown in Fig.1. The details of the procedures are as follows:

STEP 1) Collecting data for estimating cost and CO_2 saving rate for each component
The disassembly of a product was considered to determine the cost of the material of each component. Moreover, this cost comprises the re-assembly, disassembly, procurement, disposal, and treatment costs. The assumption is considered because most CO_2 emissions occur during material production [7].

STEP 2) Applying equation for life cycle option selection with remanufacturing
Selecting the life cycle option with remanufacturing of each component is achieved by the formulation on section 3 using a 0–1 integer program [8]. In this research, numerical experiments are performed using the GLPK model [9] and ε constraints [10] to determine the solutions.

STEP 3) Analyzing the data on CO_2 saving rate and Crush cost
Using the data from Step 2, the changes in the life option cycle for each targeted CO_2 saving rate are determined, and the differences in the results are analyzed while costs are added for remanufacturing and Crush Cost.

STEP 1. Collect data for estimating cost and CO_2 saving rate on each component
1. Extracting cost such as procurement cost, disassemble cost etc. about Laptop usage 5 years
2. Assume the CO_2 emission in this research system boundary

↓

STEP 2. Apply equation for lifecycle option selection with remanufacturing
1. Set the ε constraint method on the formulation with 0-1 integer program
2. Find optimal solutions on each target rate by STEP 2 - 1

↓

STEP 3. Analyze data on CO_2 saving rate and crush cost
1. Analysis on the results of Life cycle option with remanufacturing on Laptop
2. Comparing result about crush cost 0 and 10

Figure 1 Selection of life cycle option with remanufacturing considering CO_2 emissions and profit

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3. ASSUMPTIONS

Yoda et al. [2] proposed a remanufacturing option selection method with two objective functions of recovery rate and profit. This method is applied in the product design stage and the stage of reviewing remanufacturing or redesigning reverse logistics for already distributed products. However, in this study CO_2 saving rate is used instead of recovery rate [11]. CO_2 saving rate means a reduction in CO_2 emissions when using components through the remanufacturing option selection instead of new components made from raw materials.

J: Set of components

P_j: Set of immediately preceding components in disassembled component j

j: Index of components

I: Immediately preceding component in disassembling component j

v: Binary value (1 if product is remanufactured; otherwise, 0)

w_j: Binary value (1 if component j is procured; otherwise, 0)

x_j: Binary value (1 if component j is recycled; otherwise, 0)

ys_j: Binary value: (1 if component j is sold for spare parts or reused; otherwise, 0)

ya_j: Binary value: (1 if component j is reused for product reuse installation; otherwise, 0)

z_j: Binary value: (1 if component j is disposed; otherwise, 0)

$Crems$: Revenue from remanufactured products (price of remanufactured products)

Crs_j: Revenue of spare parts from component j (price of reused components)

$Cdis_j$: Disassembly cost of component j

$Ctre_j$: Treatment and disposal costs of component j (including profits on the sales of raw materials)

$Cpro_j$: New procurement cost of component j

$Casse_j$: Reassembly cost of component j

Zc: Crush cost from disposed products

E: Total CO_2 saving rate of parts

e_j: CO_2 saving rate for Part j

ε_e: Constraint of target CO_2 saving rate

l_j: Durability of component j

u: Usage years of a product

C: Total profit on a product

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4. FORMULATION

In this research, two objectives were used for the disassembly and remanufacturing option selection from CO_2 saving and economic perspectives similar to Yoda et al. [2] with recovery rate and profit. The first objective, expressed in Equation (1), is to maximize profits as the economic objective function through remanufacturing and life cycle options. The first member in Equation (1) is referred to as the revenue from remanufactured products. The second member is the obsolescence of components that cause reuse cost depreciation. The straight-line method is used for estimating cost depending on the usage year [4]. The third member is the disassembly cost of the component when the component is recycled, procured, reused for spare parts, and reused for product installation. The fourth member refers to the treatment and disposal costs of components when the components are recycled, including the $Ctre_j$ disposal cost, sales of recycled materials from the components, and landfill costs [4]. The fifth member is the procurement cost when the component is newly procured. The sixth member is the reassembly cost when the components are remanufactured.

The last member is the cost for crushing the component, i.e., when component is disposed. Yoda et al. [2] calculated various costs of $Ctre_j$ when a component was recycled. However, the cost of disposal for each component was not considered. Thus, this member allows as to treat a more realistic end-of-life cost.

$$C = Crems \times v + \sum_{j \in J} Crs_j \frac{l_j - u}{l_j} ys_j - \sum_{j \in J} Cdis_j(x_j + ys_j + ya_j + w_j)$$
$$- \sum_{j \in J} Ctre_j x_j - \sum_{j \in J} Cpro_j w_j - \sum_{j \in J} Casse_j(w_j + ya_j) - \sum_{j \in J} z_j \, Zc \quad (1)$$
$$\rightarrow Max$$

$$E = \sum_{j \in J} e_j(ys_j + ya_j + x_j) \rightarrow Max \quad (2)$$

$$E \geq \varepsilon_e, \qquad \forall j \in J \quad (3)$$

$$x_i + ys_i + ya_i + z_i + w_i = 1, \qquad \forall j \in J \quad (4)$$

$$w_i + ya_i = v, \qquad \forall j \in J \quad (5)$$

$$uya_i < l_i, \qquad \forall j \in J \quad (6)$$

$$uys_i < l_i, \qquad \forall j \in J \quad (7)$$

On the other hand, Equation (2) presents the total CO_2 saving rate, which increases when the component is used for spare parts and product installation or recycling. To solve this bi-objective problem, the 0–1 integer programming [8] and the ε constraint method [10] are used for life cycle option selection and remanufacturing in this research. The environmental objective function expressed in Eq. (2) is transposed to the ε constraint as shown in Eq. (3); by using the ε constraint method, two objectives can be attained

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simultaneously.

Equations (4)–(7) are constraints. Equation (4) shows that each component can only be subjected to one process from recycling, reuse for spare parts, reuse for product installation, disposal, and procurement. Equation (5) refers to the component selected for reuse in product installation or procurement only when the product is remanufactured. Equations (6) and (7) indicate that components cannot be reused for spare parts if the lifetimes of the components exceed the physical limits. For example, in this study, the recommended lifetime of the product is set as five years. If the lifetime for one of the components exceeds five years, it cannot be used due to the physical lifetime expired.

5.   CASE STUDY

This study considers a laptop case study to select life cycle options such as spare parts reuse, disposal, remanufacturing ,recycling, and new procurement over a usage period of five years. The bill of materials (BOM) presents resulted 34 components. The reassembly cost of each component is estimated using the assembly reliability evaluation method (AREM) [12], whereas the disposal cost, sales of the material, landfill cost, and disassembly cost are calculated using the recyclability evaluation method (REM) [13] software, developed by Hitachi Ltd. In this study, procurement costs are estimated using the input–output table for 2015, including the weight of each component [14]. If there is no data for the material of the components, the reuse price will be zero, as in the case of #31 Cushioning. 32 out of 34 components have a lifetime of ten years, except for components #6 HDD and #21 Fan [4]. Thus, #6 HDD and #21 Fan do not have a reuse price because their lifetime is five years in this study. The reuse price can differ depending on the lifetime of each component. In the case of the reuse cost, the obsolescence of the components causes cost depreciation. Similar to [2], the straight-line method is used to estimate the cost of each component depending on usage and lifetime.

6.   RESULTS

Table 1 shows processes of each component on notebook by the remanufacturing option selection in case that crush cost 10. First, the CO_2 saving and profit of the targeted CO_2 saving rate for each number are indicated. ε is set to achieve life cycle option each targeted CO_2 saving rates.

The different option selection were adopted for each targeted rate for each component. It is evident that the CO_2 saving rate is almost achieved by using the spare parts use, except for targeted CO_2 saving rates –97%. To achieve 100% CO_2 saving rate, all components must be recycled or reused not disposed. The components, #21 Fan, #26 Connecting cable, #27 Antenna cable, #29 WEB camera + Board and #34 Cords were only disposed to targeted CO_2 saving rate 99% because of low weight and CO_2 emissions.

Comparing the targeted CO_2 saving rate –97% with other targeted CO_2 saving rates between 97 and 100, it can be seen that the profit on targeted CO_2 saving rate –97% (¥222.22) can yield 13 times higher than the lowest profits on targeted CO_2 saving rate 100% (¥16.505) while the difference of the CO_2 saving rate is not large. Additionally, 31 components are reutilized by the remanufacturing option selection except new procurement for 3 components on the targeted CO_2 saving rate 97%. In the other targeted CO_2 saving rates between 97% and 99%, more than 5 components are always disposed except targeted CO_2 saving rate 100%. Compared to another case without the crush cost, when the crush cost is measured to zero, the use of remanufacturing still has a higher CO_2 saving rate, but it does not show much difference in profitability. Thus, when the crush cost is taken into account, it is said that to utilizing components by

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remanufacturing is useful comparing to other option selection such as spare part reuse, recycling and disposal.

Table 1 The result of Life Cycle Option Selection with Remanufacturing(Crush Cost10)

NO.	Part Name	Target Percentage				
		~97	97	98	99	100
1	Lithium Ion Battery	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
2	Key + Top Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
3	Membrane Plug Board	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
4	Back Plate	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
5	Stabilizer	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
6	HDD	New procurement	Recycle	Recycle	Recycle	Recycle
7	RAM	Production Installation reuse	disposal	disposal	spare part reuse	spare part reuse
8	Case Body	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
9	Case Body	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
10	Case Body + Board + Cord	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
11	Case Body	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
12	Pad Part	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
13	Board Component	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
14	CPU	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
15	Top Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
16	Top Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
17	Bottom Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
18	Bottom Cover	Production Installation reuse	disposal	spare part reuse	spare part reuse	spare part reuse
19	Resin Frame	Production Installation reuse	disposal	disposal	spare part reuse	spare part reuse
20	Metal Frame	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
21	Fan	New procurement	disposal	disposal	disposal	Recycle
22	Heat Sink	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
23	Liquid Crystal Module	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
24	Front Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
25	Rear Cover	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
26	Connecting Cable	Production Installation reuse	disposal	disposal	disposal	spare part reuse
27	Antenna Cable	Production Installation reuse	disposal	disposal	disposal	spare part reuse
28	Frame	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
29	WEB Camera + Board	Production Installation reuse	disposal	disposal	disposal	spare part reuse
30	Mother Board	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
31	Cushioning	New procurement	Recycle	Recycle	Recycle	Recycle
32	Speaker	Production Installation reuse	spare part reuse	spare part reuse	spare part reuse	spare part reuse
33	Wireless LAN Card	Production Installation reuse	disposal	disposal	spare part reuse	spare part reuse
34	Cords	Production Installation reuse	disposal	disposal	disposal	spare part reuse
	CO2 Saving[%]	96.38	97.16	98.01	99	100
	Profit[¥]	222.22	67.82	63.085	46.575	16.505

7. CONCLUSION

This research proposed the problem of life cycle option selection with remanufacturing using a laptop (usage of five years) with crush costs, considering CO_2 saving rate and profit. The life cycle option with remanufacturing affords profits and CO_2 savings simultaneously. As the amount of target CO_2 rate is increased, additional components are utilized. This results leads to additional expenses for achieving high CO_2 savings. Moreover, for a crash cost of ten, significant profits and CO_2 savings were noted, as compared to those provided by other options such as recycling, spare part reuse, and procurement

This research considered CO_2 emissions related to the material production of laptops in Japan. Recently, owing to globalization, components can be produced in different countries and the final product is assembled by acquiring the required components through supply chains [6]. Thus, future research should consider global supply chain with custom duty pertaining to the transport of components beyond countries

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SMALL WORLD OPTIMIZATION ALGORITHM FOR SOLVING MULTI-OBJECTIVE U-SHAPED DISASSEMBLY LINE BALANCING PROBLEM

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Environment waste is one of the most crucial problems to all of the countries and individuals. Increasing number of manufacturing factories and shorten lifespan of daily products together make waste problem worse. One way to deal with waste problem is remanufacturing. Remanufacturing obtains rapid development in the last 20 years. Remanufacturing has different processes and through several steps, remanufacturing aims to transfer End-of-life products to reusable products. Disassembly is the first and one of the most important steps of remanufacturing. Disassembly aims to turn End-of-life (EOL) products to different subassemblies/parts. Cost and profit are two non-negligible elements in disassembly processes and factors that related to the disassembly line are raising more attentions recently. Therefore, disassembly line balancing should be better done in real world. The operation of disassembly line balancing is through adjustment of disassembly sequence of parts to get optimal or near-optimal task sequences. Task sequences should obey principles and task relationships. Straight disassembly line is commonly used operation line in disassembly line balancing problem (DLBP). In this paper, U-shaped disassembly line is proposed to operate multi-objective disassembly task. The most distinguish difference between U-shaped line and straight line is workers can disassembly parts on both sides of the U-shaped line, therefore this feature may improve productivity and increase line efficiency. Since DLBP is proven to an NP-hard problem, this paper proposed small world optimization algorithm (SWOA) to help avoid long computation time. SWOA belongs to meta-heuristic algorithm and it has the ability to global

search and the convergence speed is high. SWOA was inspired by a theory of "all people are six or less than six, social connections away from each other". Two kinds of concepts: short-distance neighbor and long-distance neighbor are used in SWOA to avoid local optimal solutions and ultimately find optimal or near-optimal solutions. In this paper, one previous instance is used to examine the superiority of SWOA among other meta-heuristics and results show SWOA is superior to several meta-heuristic algorithm on many aspects. What is more, results show several advantages of U-shaped line compared with straight line.

Keywords: *Remanufacturing, Disassembly Line Balancing, U-Shaped Disassembly line, Small world optimization (SWO).*

1. Introduction

Rapid development of economic and increasing utilization of resources create huge number of new products. With the diversity of demand of people increases, products have shortened lifespan than ever before. Therefore, many out styled products and stopping used products turn into 'waste' products. One of the hardness problems of all the countries is how to deal with increasing number of wastes. Product recovery is seen as one of the best ways to figure out this difficult problem. Recycling, remanufacturing and refurbishing are several available ways of product recovery. Gungor and Gupta [1] studied several issues in environmentally conscious manufacturing and product recovery. In 2010, Ilgin and Gupta [2] deeply researched the relationship between environmentally conscious manufacturing and product recovery. Among all of these concepts, disassembly is the first step and one of the most important processes since disassembly outputs valuable parts/subassemblies [3]. A set of workstations are linked together via a transportation system to operate disassembly tasks and to output components. In order to achieve preset objectives, attentions should be made during operation processes especially setting suitable strategics for the disassembly line. Therefore, a high efficiency disassembly line becomes much more essential in real world disassembly factories especially Covid-19 causes market instability. Gungor and Gupta [4] first proposed the concept of disassembly line balancing problem (DLBP) in 1999 and later this area attends much more attention in the last two decades. A high efficiency

disassembly line should maintain several predetermined principles and better attain objectives. DLBP is much more complicated than assembly line balancing since its special characteristics have high degree of uncertainties. These characteristics make researchers focus on balancing phase and find more efficient algorithms to deal with challenging.

The rest of the paper is structured as follows: Section 2 is the literature review. In Section 3, problem definition and mathematic formulation will be clarified. Section 4 includes detailed real case and computational results. Conclusions and future opportunities will be discussed in Section 5.

2.   Literature review

Disassembly lines can be classified as straight, U-shaped, parallel and two-sided disassembly lines. According to the published data in [5] the majority of the previously published studies use straight disassembly line. In 2008, Agrawal and Tiwari [6] first utilized U-shaped line to operate mixed-model DLBP. Later, Avikal and Mishra [7] and Avikal, Jain, and Mishra [8] proposed different heuristic methods on U-shaped layout. By using a modified NEH heuristic method, Li, Kucukkoc, and Zhang [9] solved sequence dependent DLBP on U-shaped disassembly line and results showed that their modified NEH heuristic algorithm with a novel local search method can obtain high quality initial solutions. Recently, Wang, Gao, and Li [10] proposed a novel discrete flower pollination algorithm to solve multi-objective DLBP on U-shaped layout. One creative thing in their study is they consider partial destructive mode of end-of-life (EOL) products. Several studies listed advantages of U-shaped disassembly line compared with straight line. In this study, the comparison of two kinds of lines will be presented.

Many more methods and solution approaches are proposed in DLBP area since 1999. Gungor and Gupta [11] later proposed a solution procedure using the shortest path formulation to minimize the affection of defective parts on disassembly line. After the NP-completeness proof of the decision version of DLBP by McGovern and Gupta [12] and unary NP-completeness proof of DLBP by McGovern and Gupta [13], a great number of meta-heuristic algorithms are used on DLBP. Genetic algorithm, artificial bee colony algorithm, ant colony optimization, simulated annealing, tabu search, particle swarm optimization and immune algorithm are all proposed to solve DLBP. In this paper, small world optimization algorithm (SWOA) is proposed to help find near-optimal solutions

since there will be four different objectives. SWOA belongs to meta-heuristic algorithm and two great advantages of SWOA are global searching and high convergence speed. SWOA was inspired by a theory of "all people are six or less than six, social connections away from each other". Two kinds of concepts: short-distance neighbor and long-distance neighbor are used in SWOA to avoid local optimal solutions and ultimately find optimal or near-optimal solutions.

Different objectives will lead to quite different optimal solutions. Based on the statistic of [5], nearly 53% of papers prefer the objective of minimizing idle times and approximately 40% of papers consider removing hazardous and high demand parts as early as possible. In this paper, total of four different objectives are considered which are minimization of number of workstations, minimization of idle time, removal of hazardous parts early and removal of high demand parts early.

The main contributions of this paper lie in three aspects. As the best knowledge of the author, small world optimization algorithm (SWOA) is the first time utilized on DLBP and results show that the performance of SWOA is superior to some meta-heuristic algorithms like Genetic algorithm and artificial bee colony optimization. Multiple objectives are considered in this paper, which contains minimization of number of workstations, minimization of idle time, removal of hazardous parts early and removal of high demand parts early. And in the meanwhile, this paper will introduce the concept of Pareto front to help find non-dominated optimal solutions. Also, this paper will examine the superiority of U-shaped line compared with straight line on the same case.

3. Problem definition

Disassembly line balancing aims to adjust task sequences to achieve related objectives and tasks should follow related constraints. Tasks mean disassembling related parts. In this paper, four objectives are minimizing of number of workstations, minimizing of idle time, removal of hazardous parts early and removal of high demand parts early. Tasks should obey two constraints: cycle time constraint and precedence constraint. Cycle time is predetermined, and total processing times of each workstation should be less than or equal to the cycle time. Precedence constraint is disassembly order of tasks. Adjustment of task sequence should not violate this constraint. In this paper, AND/OR graph will be used to present relationships among tasks.

3.1 Notation

Indices

i, j index of tasks

m index of workstations

Parameters

M set of workstations, $M = \{1, 2, \ldots, M\}$

N set of tasks, $N = \{1, 2, \ldots, N\}$

CT cycle time

t_i processing time of task i

h_i binary variable, 1, if task i is hazardous; 0, otherwise

d_j demand value of task j

T_m Total task processing times of workstation m

Z objective functions

Decision variable

x_{im} 1, if task i is assigned to the front side of workstation m; 0, otherwise

y_{jm} 1, if task j is assigned to the back side of workstation m; 0, otherwise

s_i position number of task i in disassembly sequence

r_{ij} 1, if task i is the immediate predecessor of task j; 0, otherwise

WS_m 1, if workstation m is opened; 0, otherwise

3.2 Assumption

(1) Only one model of EOL products

(2) Each task should be assigned to only one workstation

(3) Total task processing times of each workstation should not large than cycle time

(4) Precedence relationship should be strictly followed

3.3 Mathematical formulation

$$\text{Min } Z_1 = \sum_{m=1}^{M} ws_m \tag{1}$$

$$\text{Min } Z_2 = \sum_{m=1}^{M} (CT - T_m)^2 \tag{2}$$

$$\text{Min } Z_3 = \sum_{i=1}^{N} (s_i * h_i) \tag{3}$$

$$\text{Min } Z_4 = \sum_{i=1}^{N} (s_i * d_i) \tag{4}$$

The objective function (1) is to minimize total number of workstations. (2) represents the total idle times of all the workstations. (3) minimizes total value of hazardous parts and (4) aims to minimize total value of demand.

3.4 Constraints

$$\sum_{m=1}^{M} (x_{im} + y_{im}) = 1 \tag{5}$$

$$\sum_{i=1}^{N} (x_{im} + y_{im}) \geq 1 \tag{6}$$

$$CT \geq T_m \tag{7}$$

Constraint (5) ensures one task can only be assigned to front or back side of one workstation. Constraint (6) represents one workstation can disassembly one or more tasks. Constraint (7) is the cycle time constraint.

4. Numerical result

The proposed SWOA was coded in MATLAB and tested on Apple M1. The disassembly product information and related precedence relationship were modified from McGovern and Gupta [14]. Table 1 presents basic values of all the tasks. Based on 10-time runs of U-shaped line and straight line. The solutions show that U-shaped line does have advantages compared with straight line since average values of each objective found on U-shaped line are lower than that on straight line. Part of performance of U-shaped line and straight line of this scenario is shown in Table 2. Proposed SWOA was compared with genetic algorithm (GA), ant colony optimization (ACO), improved ACO (IACO), improved ABC (IABC) and hybrid group neighborhood search algorithm (HGNS). Related data of algorithm performance on this scenario can be found from McGovern and Gupta

[14], Zhang et al. [15], Zhu et al. [16] and Zhu, Zhang, and Guan [17]. From Table 3, SWOA performs the best on minimization of idle time and on other objectives SWOA has lower average values. Therefore, SWOA is available to help find near-optimal solutions and also, on some aspects, it is superior to other compared meta-heuristic algorithms.

Table 1

Basic data of scenario

Task	Part removal time	Hazardous	Demand
1	14	0	0
2	10	0	500
3	12	0	0
4	17	0	0
5	23	0	0
6	14	0	750
7	19	1	295
8	36	0	0
9	14	0	360
10	10	0	0

Table 2

Performance of straight line and U-shaped line

Disassembly line	Z_1	Z_2	Z_3	Z_4	Task sequence
Straight line	**5**	273	5	11135	5,4,1,6,7,9,8,10,2,3
	5	369	6	10350	10,1,9,6,5,7,4,8,2,3
	5	241	5	9605	6,1,10,5,7,4,8,9,2,3
	5	249	**3**	**8685**	5,6,7,4,9,1,8,10,2,3
U-shaped line	**5**	211	4	9480	5,6,10,7,9,1,4,8,2,3
	5	337	5	10385	4,5,6,10,7,9,8,1,2,3
	5	**207**	4	8980	5,6,10,7,9,1,4,8,2,3
	5	249	**3**	**8685**	5,6,7,4,9,1,10,8,2,3

Table 3

Performance of compared algorithms

Objective	GA	ACO	IACO	HGNS	IABC	SWOA(S)	SWOA(U)
Z_1	5	5	5	5	5	5	5
Z_2	211	211	211	219	211	211	**207**
Z_3	4	4	4	4	4	4	4
Z_4	9730	10090	9730	7510	9730	9480	8980

5. Conclusion

Disassembly line balancing problem (DLBP) gains more attention in recent years. This paper proposed small world optimization algorithm to solve multi-objective U-shaped DLBP. Previous studies focused more on straight disassembly line. Therefore, research on U-shaped disassembly line can be more attractable in the future since U-shaped line is more efficiency than straight line. What's more, two-sided and parallel disassembly layouts should gain more attentions. In the meanwhile, more optimization algorithms and mathematical approaches can be applied to solve DLBP.

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Supply Chain Sourcing Plan to Achieve Sustainability and Cost Efficiency

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Supply Chain Sourcing Plan to Achieve Sustainability and Cost Efficiency

Abstract

We develop a supply chain sourcing plan model that incorporates both sustainability and cost efficiency. The model selects suppliers and determines sustainability investments and order allocations among the selected suppliers. High sustainability performance as well as cost efficiency are achieved while a high service level is maintained. We formulate the problem as a nonlinear bi-objective integer-programming model, discover the model's special features, and propose an effective and computationally efficient algorithm to solve it. Numerical tests verify that our algorithm outperforms an existing sourcing algorithm. A simulation of Apple's sourcing decisions demonstrates the effectiveness of the model in business practice.

Key words: supply chain management, sustainability, nonlinear bi-objective model, sourcing plan, Pareto optimal

TACKLING PRODUCT REFUND WARRANTY FRAUD FOR REMANUFACTURED PRODUCTS IN REVERSE SUPPLY CHAIN

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Abstract −The issue of warranty fraud in remanufactured products has been addressed in recent literature. This paper addresses the issue of warranty fraud arising from the customer. The study aims to examine problems in product refund and replacement in the consumer electronics remanufacturing sector, and examines strategies available to the warranty provider to tackle said fraud. Discreet event simulation is utilized to contrast how the use of sensors may mitigate product refund fraud by comparing relevant fraud statistics with the previously existing system. The study showed that the sensor embedded scenario was able to preemptively stop more frauds.

Keywords − End-of-life, Fraud, Remanufacturing, Warranty, Reverse logistics

1. INTRODUCTION

Remanufactured products are required to perform as well or at least at a comparable level to its conventionally manufactured counterpart. The intention of the remanufacturer is to provide a market substitute at a reasonable cost; however the consumer may not perceive that as being the case. This manifests itself as a level of uncertainty in the mind of the consumer regarding the apparent quality of the remanufactured product, and might lead to a decision to subconsciously opt out of buying it. Therefore most remanufacturers feel the need to provide additional assurances to the products consumer through the use of incentives such as generous product warranties. Warranty servicing involves multiple parties working together with interests that do not always align; and as such it is inevitable that one party might sacrifice the systems collective

interest over personal profit. There are many types of frauds that can exist, some that are quite blatant in their execution (Pandit & Gupta, 2019), whereas some others which could be seen as perfectly legal. One example of a fraud that toes the line of legality is fraud involved during product refund and or replacement. Dealing with these types of frauds puts a strain on the warranty reverse supply chain (Kurvinen et al., 2016), coupled with the absence of an effective means for controlling the fraud, imposes substantial costs on the manufacturers and consumers of such parts and the products in which they are used (Hayes, 2005). This type of fraud can be seen in many areas (and many scales) from clothing and handicraft products and all the way to products such as consumer electronics. This paper attempts to improve upon existing methods of fraud prevention/detection by considering the implementation of sensors.

2. LITERATURE REVIEW

Over the past few decades there has been an interest in environmentally conscious manufacturing which arose partly due to the implementation of government legislation and the dwindling of natural resources. The field of Environmentally Conscious Manufacturing and Product Recovery (ECMPRO) has produced many research papers that are of interest in setting up this study. Gungor & Gupta (1999) presented a state of the art survey paper covering most papers published through 1998 in the field of ECMPRO. A later paper by Ilgin & Gupta (2010) presented another updated survey in the same area, noting how the level of uncertainty in the remanufacturing system hinders any analysis of it. These reviews served to show the building interest in this area, and while at the present time certain issues may not be prevalent (due to a lack of product volume), steps should be taken preemptively to deal with problems that will acerbate with time, such as fraud.

A number of studies have been conducted to understand the factors that influence the decision making of customers in choosing one product over another (Guide & Li , 2010; Vadde, Kamarthi & Gupta, 2006). Warranty has in the past been used as a tool for competitive marketing. Many manufacturers and researchers have explored a host of ways to make a product more appealing by experimenting with warranty policies by doing things such as adding additional services, extending the periods, offering favorable terms etc. (Podolyakina, 2017). The review noted that there are two takeaways with regard to how warranty marketing affects the consumers decision making a) There is evidence that more expensive complex products involve more extended

decision making, thereby enhancing the probability that the warranty could play a significant role (Wilkes & Wilcox, 1981) and b) The consumer relies more often upon the manufacturer than they do upon the retailer as to the nature and quality of the goods; and this fact has strongly influenced courts in warranty cases (Southwick, 1963). The majority of the extant literature was focused on warranties with respect to the new product industry. Many of the same issues have been tackled more recently in the remanufacturing sector as well. (Alqahtani & Gupta ,2017 ;Dulman & Gupta, 2018).

Warranty fraud is a significant problem affecting motor vehicles and other consumer products having multiple components that are the subject of a warranty. These frauds are typically between the manufacturer, warranty service agent and the custome. The study of such frauds has been a topic of interest among researchers in recent years (Murthy & Jack, 2016, Kurvinen, Töyrylä & Murthy, 2016). There are methods and systems for obtaining and analyzing data using embedded sensors in electronic products for warranty management. A data collection unit in an electronic product collects and reports data about environmental factors that is relevant about a warranty agreement and transmits the data over a communications link to a data interpretation unit. The use of such sensors to address issues in consumer electronics products has been suggested in the past to address issues both at EOL (Ilgin and Gupta, 2011, for washing machines) and even during a products life (Dulman and Gupta, 2018 for laptops) thus suggesting that sensor embedded products (SEP) could be an effective way of catching fraud.

Based on the literature review we can see that fraud is still a prevalent issue in the consumer product industry. However the majority of extant literature focuses on new products, little research is focused on frauds pertaining to remanufactured products. While a number of techniques (such as game theory) have been used in the past, many models consider frauds to be one of events and do not incorporate factors such as prior history and party motivation. Additionally the trend of sensor implementation has proven to be useful in solving other problems and literature shows a few instances that show it has potential in dealing with this particular fraud scenario. These points influenced the direction and methodology followed in this study.

3. FRAUD OVERVIEW

Customer fraud typically relates to cases where a customer tries to have a repair or replacement done although there is no warranty coverage. This can be the case when the warranty has expired, the customer has damaged the product, or the service action is not covered by a warranty. Usually, the fraud done by a customer is limited to one or few cases per purchased product, although large-scale fraud also exists (Kurvinen, Töyrylä and Murthy, 2016)

Pandit and Gupta (2021) explored a fraud scenario where an out of warranty part/products were being repaired through a fraudulent scheme. The study examined an instance of product part substitution fraud, wherein failed out of warranty parts were being serviced, by incorporating them into functioning in warranty products. In this paper we attempt to examine a closely related customer warranty fraud that shares some parallels to that study (the case of refund fraud and the closely related replacement fraud). Return of purchased products for any reason is acceptable when it happens within the time period defined by retailer policy or consumer rights legislation. During this period, the return period has expired; the customer is entitled to a full refund. Customers may also return products they have bought at discounted prices and get undiscounted price as a refund if purchase prices are not tracked. After the return period has expired, the customer may claim a fictitious problem in order to be entitled for a refund. No fault is found in large proportion of products returned by customers. Consumer electronics in particular is prone to this behavior. Also, online sales have high return rates when compared to purchases done in traditional brick-and-mortar shops. (Kurvinen, Töyrylä and Murthy, 2016). Alternatively, the customer may report a fictitious issue to get a replacement unit. Instead of having the customer product repaired, warranty providers may replace the faulty products. Replacement units may be substitute products or new products of the same model as the original one. If the customer's original product has been worn out or is a fake, even a substitute may be of more value than the original one. In this paper we attempt to model a refund type warranty fraud for a consumer electronic product (and by extension replacement fraud).

4. DESCRIPTION OF THE SYSTEM

Product refund fraud mainly involves the primary parties of the service chain, in that the consumer is the fraud's perpetrator and the service agents (and by extension the remanufacturer)

are the victims. In a typical warranty service system, when a product is rendered nonfunctional, it is inspected to determine the cause of failure. The information about any such failure is transmitted to the service personnel who conducts the required service operations; for example, replacing the failed component or components. After this process, failed products are transferred to the service facility. After the maintenance process takes place, the products are brought back to working condition. Once the maintenance service operations are complete, the products are returned to the customers. The generalized activity flow chart for all types of warranty maintenance is shown in figure 1 below.
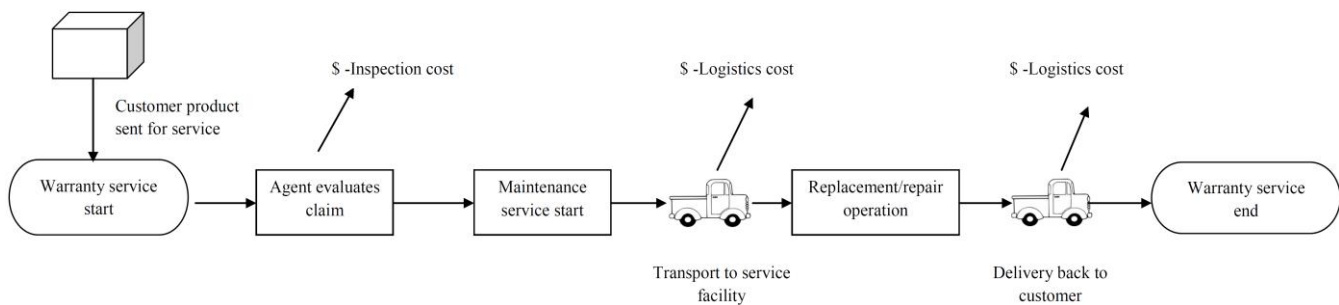
Figure 1 –Warranty service operation for products

The above case presented assumes that the claim is true and that the customer is acting in good faith. However, when introducing the concept of fraud into the scenario, it is assumed that for certain cases, the product being serviced (in this case "returned") is being done so outside of the time period outlined by the retailer's policy. Accepting service of such a product would violate the warranty agreement between the customer and remanufacturer. In addition to the extra service cost incurred, there would also be additional inspection and logistics costs to account for. The next section describes two simulation scenarios that were considered to model the problem further.

5. SIMULATION SCENARIOS

The study makes use of discrete event simulation to model customer driven fraud for cellphone's. The model was simulated using Rockwell arena software, the input to the simulation model are customer claims, which arrive at a rate governed by a Poisson distribution function. The logistics costs were assumed at a fixed rate per trip (to and from repair center), while the

inspection cost was assumed on an hourly basis. We consider the following two cases for our research.

Case 1 –Regular systems

In a regular system, when a warranty claim is made by the customer, it is the service agent's responsibility to first verify that the claim is true and conduct any services to fulfill the warranty contract. There exist built in systems to catch refund and replacement frauds. For instance in electronic products, the vendor keeps a log of sales data (and in case of online orders, a log of shipping data) that helps determine the approximate start point of the "return period". This helps catch these frauds fairly early on in the process, however it cannot catch all types of fraud (Example: To determine if a product was damaged before it reached the customer or if it was damaged after the customer received it). In cases of fraud we consider multiple forms of cost to the remanufacturer. Productivity loss occurs when service agents are trying to rectify claims that are fraudulent while putting true claims on hold. In the system, productivity loss time is calculated by determining the time between receiving the faulty claim and the service completion time. Maintenance costs include the costs that are incurred as a result of inspecting the product failure. We assume that issues (problems) that result in a maintenance/refund claim being submitted to service provider fall into one of two broad categories.

1) Superficial problems

   These encompass issues the customer has with the product that are purely "surface level" and do not affect a products functionality. These problems can be real but are most often subjective. (Example: Scuff marks on a phone casing, "warping" of display screen etc.).

2) Functionality problems

   These issues encompass those issues that affect product functionality. (Example: A dead phone battery, nonfunctional touch screen etc.). Based on the level of repair required, the service agent may judge that a replacement be the less expensive option.

If a corrective maintenance strategy is chosen and the failed components are replaced, the material cost associated with the replacement of the components is added to the overall maintenance cost. Finally, logistics costs are also taken into consideration within maintenance costs.

Case 2 - With sensors

In sensor embedded scenarios we assume that sensors can make up for some of the short falls that exist in regular systems. To further highlight this effect we consider the existence of human error in the model and as such consider claims to be reviewed by multiple inspectors, each with slightly different process times and fraud detection capabilities. The model assumes that the customers past fraud history will have an effect on the decision to commit frauds in the future. For instance, the model assumes that if a customer has been previously successfully in committing fraud, the truthfulness of the next claim will be different from if they were previously caught. We assume that sensors provide us with both position data as well certain environmental data (temperature data for example would indicate if certain damages occurred due to inappropriate storage or misuse of the product). It is assumed that this will weed out instances where damages occur due to mishandling of the product by the consumer (and not any other party in the warranty service chain), as well as establish the exact time that the customer receives the purchased product (and is therefore liable for any issues thereafter) that gives us the start of the refund period and thus eliminates a number of fraudulent claims. In addition to costs that are incurred in the regular scenario, we also assume the cost of sensor implementation. This will allow us to make the determination if the cost of sensor implementation is worth any potential fraud catching benefits.

6. RESULTS & CONCLUSIONS

This paper described the literature surrounding the issues of fraud and warranties. This review served to show the importance in tacking the issue of fraud in the remanufacturing service industry. The modes in which customer driven fraud affects the warranty service industry were elaborated on. Lastly the problem was modeled using discrete event simulation to better understand and combat warranty fraud. Results show that the sensor embedded scenario outperformed the regular system in terms of its ability to catch and deter frauds. There was a 32 % decrease in the number fraudulent claims that escaped, a 12 % decrease on the average time it takes to process claims and an 18% decrease in total logistics costs. Based on these results, it was judged that the cost savings from fraud and maintenance justified the price of sensor implementation.

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THE IMPACT OF COVID-19 DISRUPTION ON DESIGNING A GLOBAL SUPPLY CHAIN NETWORK ACROSS THE TRANS-PACIFIC PARTNERSHIP AGREEMENT

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ABSTRACT

The global supply chain network consists cross-border trades. Then custom duty is imposed because of to protecting domestic industry. However, there is a trend of eliminating custom duties through free trade agreements such as the Trans-Pacific Partnership Agreement. On the other hand, the COVID-19 had a serious impact on a global supply chain. In this study, it is analyzed that the impact on a global supply chain network considering custom duties and disruptions in costs and the selection of suppliers and factories. In the result, total cost is increased maximum 1.7% and TPP cannot be effect to the selection for suppliers under a small scale of domestic disruption and 10% of custom duty rate.

Keywords: Bill of Materials (BOM), Custom duty, 0-1 Integer Programming, Free trade agreement, TPP

1. INTRODUCTION

A global supply chain is a series of connections between procurement, production, storage, transportation, and sales that crosses national borders [1]. These cross-border transactions also impose custom duties, which are taxes imposed on imported goods [2]. From 2020, the Trans-Pacific Partnership Agreement (TPP), a free trade agreement among 11 countries including Japan and Malaysia, has been effective, where the custom duty of parts and products between TPP participants will be free [3]. Regarding the effect on TPP, a global supply chain network considering TPP and Brexit was modeled by Nakamura et al. [4]. Hayashi et al. [5] designed and analyzed a global supply chain network that included TPP and a carbon tax based on the maund-based emissions from product manufacturing in addition to the TPP. However, their models did not consider the risk of disruptions of a supply chain.

On the other hand, COVID-19, which is the disease caused by a new coronavirus called SARS-CoV-2 [6], has had a serious impact on the production capacity drop-off [7][8] and disruption, which means cutting of the supply capacity, by the vulnerability in the global supply chain network [9]. The disruption on supply chain means that a seldom occurring and high-impact non-stationary risk [10]. Jabbarzadeh et al. [11] presented a stochastic robust optimization model which had resilience under the disruption. Ivanov et al. [12] introduced a new point of view that was Interconnected Supply Chain (ISC) in a study of supply chain resilience if the viability was needed to be considered under the extraordinary disruption. Min et al. [13] gathered the data through telephone survey and analyzed the impacts of the COVID-19 pandemic on the food supply chain in Wuhan. However, they did not consider the both impact on disruption and custom duties in a global supply chain network simultaneously.

This study addresses a global supply chain network considering custom duties and supply disruption scenarios simultaneously. Firstly, a global supply chain with custom duties is modeled and formulated. Secondly, dataset based on BOM is prepared and the disruption is considered scenarios. Next, the impact of disruption in China on costs is analyzed through a numerical experiment considering the disruption as scenarios. Finally, the effect of TPP is validated through a numerical experiment considering the disruption in Malaysia.

Notation used in this study is as followed.

Sets:

G : Set of suppliers that are part of the Trans-Pacific Partnership Agreement

O : Set of suppliers, $o \in O$

$City$: Set of disruption suppliers, $d \in City$, $City \subseteq O$

J : Set of parts, $j \in J$

P : Set of factories, $p \in P$

Q : Set of demand locations, $q \in Q$

Decision variables:

v_{opj} : The number of parts j transported from supplier o to factory p

v_{pq} : The number of products transported from factory p to demand location q

k_p : The number of products manufactured in factory p

z_{pq} : 1, if the route between factory p and demand area q is opened
, 0, otherwise

u_p : 1, if the fixed opening cost at factory p is opened
, 0, otherwise

Cost parameter:

LC_{op} : Cost of transporting a part between supplier o and factory p

LC_{pq} : Cost of transporting a product between factory p and the place of demand location q

PC_{oj} : Cost of procuring a part j by supplier o

$DUTY_{op}$: Customs duty cost per unit on transportation from supplier o to factory p

$DUTY_{pq}$: Customs duty cost per unit on transportation from factory p to demand location q

MC_p : Manufacturing cost per product at factory p

OC_{pq} : The fixed opening route cost between factory p and demand location q

FC_p : The fixed factory opening cost of factory p

Production parameter:

N_j : The number of a part j that make up a product

$N_{product,q}$: The amount of demand for a product at the demand location q

M : Very large number (Big M)

C_p : Production capacity at factory p

2. MODEL WITH DISRUPTION

This study designs TPP and a global supply chain model with disruption based on the model used by Hayashi et al. [5]. Fig.1 shows a global supply chain network considering supply disruptions and economic partnership agreements in the TPP. For example, a part j is produced by supplier o and transported from supplier o to factory p. Then, a finished product consisting of N_j parts is assembled in factory p. Finally, finished products are transported to the demand location q.
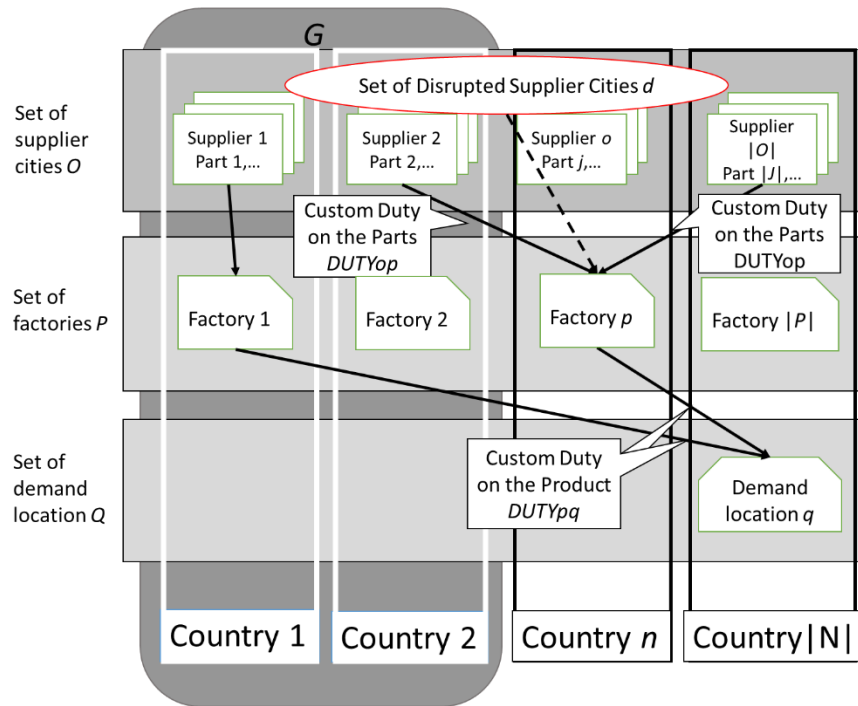
Figure 1 model of global supply chain network considering disruption and TPP

The global supply chain network considering disruption and TPP in this study is modeled as follows. It is considered that supplier cities have possibility of disruption, and if a supplier city is disrupted, it is unable to supply parts to a factory. In this model, the suppliers on set of disrupted supplier cities cannot supply all parts to any factories. Suppliers, factories and demand locations are belonging to a set of country. In this model, group G is meaning a set of supplier cities in countries belonging to TPP, and custom duties are imposed when parts and products are imported across countries.

3. FORMULATION

Based on the model in Fig.1, the objective function of this study is minimizing the total cost including transportation, procurement, custom duty cost, route opening and factory opening costs in Equation (1). Equations (2)-(4) are constraints on the amount for transportation of parts and products, respectively. Equation (5) defines a constraint on supplier supply disruptions, where supplier cities belonging to the disrupted city cannot supply parts to the factory. Equation (6) is production capacity of factories and Equation (7) is transportation capacity from factories to demand locations. Equations (8) and (9) set the binary restrictions and non-negativity

Objective function:

$$\sum_{o \in O} \sum_{p \in P} \sum_{j \in J} (LC_{op} + PC_{oj} + PC_{oj}DUTYop)v_{opj} + \sum_{p \in P} \sum_{q \in Q} (LC_{pq} + MC_p + MC_pDUTY_{pq})v_{pq}$$
$$+ \sum_{p \in P} \sum_{q \in Q} OC_{pq}z_{pq} + \sum_{p \in P} FC_p u_p \rightarrow min \tag{1}$$

Constrations :

$$\sum_{o \in O} v_{opj} = N_j k_p, \forall p \in P \ \forall j \in J \tag{2}$$

$$\sum_{q \in Q} v_{pq} = k_p, \forall p \in P \tag{3}$$

$$\sum_{p \in P} v_{pq} = N_{product,q} , \forall q \in Q \tag{4}$$

$$\sum_{j \in J} \sum_{p \in P} v_{dpj} = 0, \forall d \in City \tag{5}$$

$$\sum_{q \in Q} v_{pq} \le C_p u_p, \forall p \in P \tag{6}$$

$$v_{pq} \le M z_{pq}, \forall p \in P, \forall q \in Q \tag{7}$$

$$z_{pq}, u_p = \{1,0\}, \forall p \in P, \forall q \in Q \tag{8}$$

$$v_{opj}, v_{pq} \ge 0, \forall o \in O, \forall p \in P, \forall j \in J, \forall q \in Q \tag{9}$$

4. DISRUPTION SCENARIOS

To analyze the effect of supply disruption inside and outside TPP in a global supply chain, an example is prepared for a global supply chain with a vacuum cleaner which has a 23-part the same as Hayashi et al. [5]. The details of an example problem in this study are given below.

- 13 cities are selected as suppliers from China, Malaysia, the United States and Japan, respectively, a total of 52 cities.
- Four cities, Shanghai, Kuala Lumpur, Seattle, and Tokyo, are selected as candidate location for factories. The production capacity in each factory is 3,000 units. The market demand is set at Seattle in the United States, with a demand of 6,000 units.
- The custom duty between the United States and China is 25%.The custom duty between a participation in TPP and a country out of TPP is 10%. For instance, Malaysia and China, Japan and the United States. The custom duty between participations in TPP is free. For instance, Malaysia and Japan.
- In the situation of a supplier disruption, the supply of parts from the supplier to factories is cut off.

In this study, two disruption scenarios for China and Malaysia, respectively, where China is outside of TPP and Malaysia is inside of TPP are prepared to evaluate the impact. The disrupted areas by COVID-19 are increase the scale and finally it is worth the whole of the country. The government decides whether a city is disrupted.
- Baseline: No disruption
- Scenario A: Three-city disruptions (Xi'an, Chengdu, and Chongqing) in China out of TPP.
- Scenario B: Three-city disruptions (Miri, Kota Kinabalu, and Sandakan) in Malaysia in TPP.

To optimize the supply chain network, the optimization solver Numerical Optimizer (NTT Data Mathematical Systems Corporation, 2020) [14] on an Intel® Core™ i5-4300U CPU @ 1.90 GHz PC with Windows 10 Pro is used.

5. ANALYSIS OF THE IMPACT OF DISRUPTION

In this section, a numerical experiment is conducted for the cost minimization formulated in section 3, the difference of the impact by disruptions between China and Malaysia is analyzed. Table 1 shows the result of the selection for suppliers and factories. In all of the cases, the factories in Shanghai and Kuala Lumpur are maintained as well as the baseline. However, there is difference of the resulted selection for suppliers. In scenario A, with 3 Chinese suppliers disrupted, 3 suppliers in Malaysia and 4 ones in Japan are switched instead of disrupted 3 suppliers in China as the suppliers for the Shanghai as shown in Fig.2. One of the reasons is that the procurement cost of Malaysian suppliers is the lowest among 4 countries in this experiment. However, it is noted that 4 suppliers in Japan are also selected because the transportation

4

cost from Japan to Shanghai is lower than one from Malaysia by shorter travel distances, even though the procurement cost of Japanese suppliers is higher than one of Malaysian suppliers.

On the other hand, in scenario B, instead of disrupted 3 suppliers in Malaysia, 4 suppliers in China are selected. However, suppliers in Japan and the United States are not selected because of the higher procurement cost.

Table 1 The result of the selection for suppliers and factories.

	Baseline		Disruption Scenarios			
			Scenario A in China out of TPP		Scenario B in Malaysia in TPP	
Factory	Shanghai	Kuala Lumpur	Shanghai	Kuala Lumpur	Shanghai	Kuala Lumpur
Supplier	12 in China 2 in Japan	13 in Malaysia	9 in China 3 in Malaysia 4 in Japan	13 in Malaysia	12 in China 2 in Japan	4 in China 9 in Malaysia

Fig.2 indicates the result of total cost in baseline and scenario A, B. As can be seen in Fig 2, the difference of total cost from baseline between scenarios is about 1% only. Thus, when the disruption scale is as small as three cities in China or Malaysia, it is recommended that the factory should not be changed but the suppliers should be switched from disrupted to the other suppliers.

Regarding the breakdown of cost, total custom duty cost in scenario A is increased by 1456.33% from the baseline. On the other hand, one in scenario B is increased by 3439.35% from the baseline regardless of TPP. This is because suppliers for Kuala Lumpur factory in Malaysia are selected form China while Japanese suppliers are not chosen due to the high procurement cost. Thus, under this scale and areas of disruption, cost suppression by a low procurement cost of China is more effective than one of TPP saving custom duty cost in the experiments.
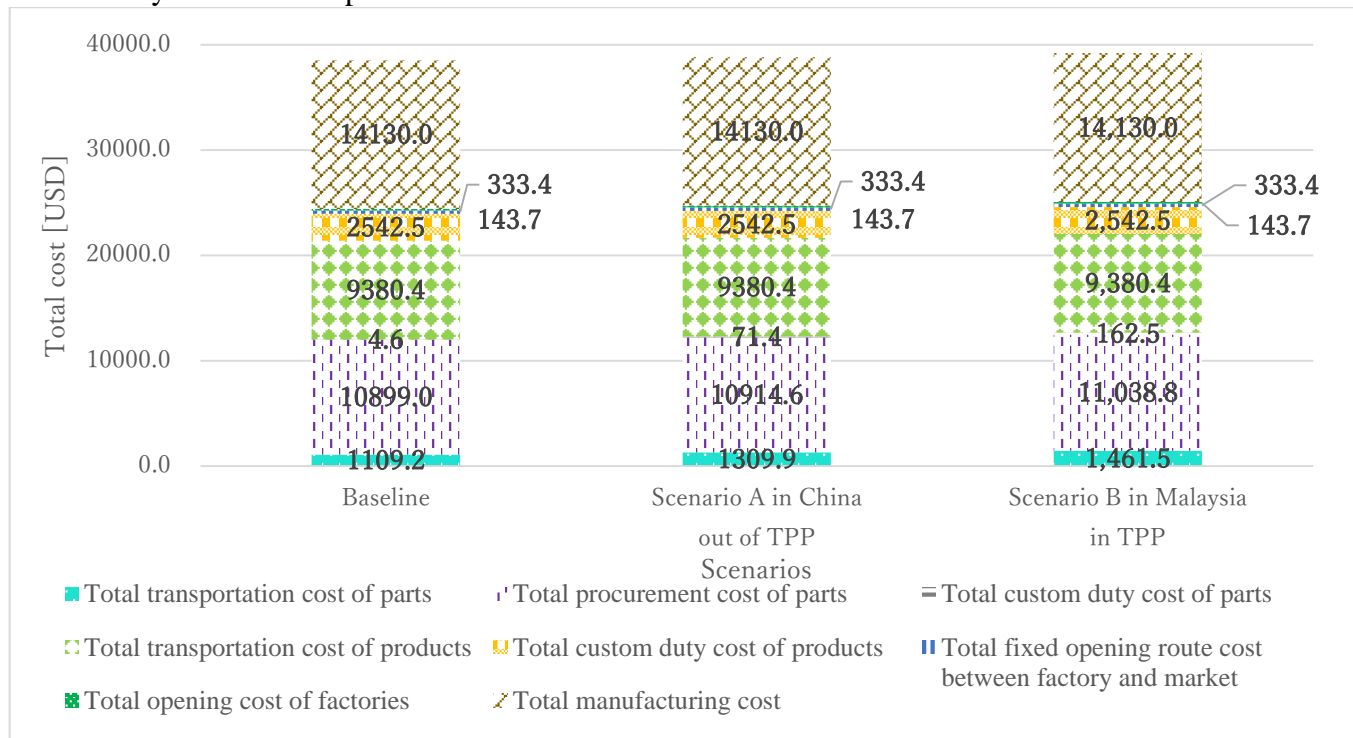
Figure 2 The result of total cost in the baseline and scenario A, B

SUMMARY AND FUTURE STUDIES

This study analyzed the impact of disruption for a global supply chain. In the small disruption, the suppliers are required to be switched to available suppliers though the factory is not changed from the

baseline. However, the influence of TPP is not seen in the model that the custom duty rate is 10% under the small domestic cities disruption in this experiment.

Further researches should address the large scale disruption and the various area of disruption, and apply other factors such as consideration of factory disruptions, TPP and carbon taxes.

ACKNOWLEDGMENTS

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Sustainability Management

CORPORATE - NONPROFITS PARTNERSHIPS TO IMPROVE SOCIAL INNOVATION AND CORPORATE SOCIAL RESPONSIBILITY

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Abstract

Corporations are under increasing pressure to serve social purposes beyond maximizing shareholder value. One of the best resources for businesses seeking to affect social change meaningfully is through working with, learning from, and partnering with nonprofits. Different approaches have been emerging for nonprofits to inform and support the interests of for-profit businesses in the area of corporate social responsibility (CSR). In particular, collective impact (CI) and its implications for corporate partners; increasing positive community engagement through progressive hiring practices instituted by non-profit organizations (NPOs); fostering innovation within an organizational setting through NPO collaboration; and exploring a hybrid model of non-profit/for-profit business, with an examination of the advantages and disadvantages thereof. In this paper, we review these unique approaches to show how for-profits can learn from nonprofits and *vice versa* when it comes to social innovation and corporate social responsibility.

Keywords: Corporate Social Responsibility, Social Innovation, Nonprofits, Collective Impact, Triple Bottom-Line

Introduction

For-profits can learn from non-profits, especially with regard to addressing the social and environmental needs of their communities, employees, and society at large. Corporate Social Responsibility (CSR) refers to activities undertaken by businesses to enhance their value in the community and society and benefit their reputation and brand. "Corporate Social Responsibility is a management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders." UNIDO (2011). For-profits can address their CSR through emerging methods of interaction with nonprofits. To create progressively more robust collaboration, for-profits can build partnerships with nonprofits through an exchange that cultivates innovation, deepens community engagement in organizational business practices, explores organizational hybrid models, and creates Collective Impact. According to a report produced in 2009 by Sabeti there is, " increasing use of business methods by nonprofits and the growing responsiveness of business to social concerns, and sees "a new class of organizations with the potential for generating immense economic, social, and environmental benefits … emerging" (Sabeti as cited in Worth, 2019). For-profits can reap the benefits of learning from nonprofits while simultaneously providing them with much-needed expertise. These exchanges are promising, yet expectations, alignment, and integrity must be present from the beginning to accomplish mutual benefits.

Setting the Context Partnership with the private sector has long been used by private foundations (Peterson, Yawson, Sherman, & Johnson Kanda, 2018). The Ford Foundation, the W.K. Kellogg Foundation (WKKF), the Charles Stewart Mott Foundation (Mott), and others have invested several billion dollars in poverty alleviation strategies, many of them tapping business partnerships through Community Development Financial Institutions (CDFIs) and corporate engagement (Peterson et al., 2018).

With growing investments coupled with the more business-oriented mindset of new global philanthropists, it is essential to unleashing the power of business schools to educate future and existing leaders. Many new philanthropists are turning to business schools for help, and many business schools are unprepared to address critical issues involving community partnership, social change, and performance measures that include numbers and nuance required in achieving long-term, sustainable social change (Headwaters Group Philanthropic Services, 2011).

However, even with a growing interest in markets and social change, there are impediments to the perspective that business can be an important partner in addressing the needs of families in deep poverty. There can be a cultural disconnect between corporate decision-makers and the poor. Although business practices based on the triple bottom line (social, environmental, and financial success) that serve the bottom-of-pyramid market abound, many companies are unaware of effective practices or have difficulty maneuvering the needs of low-income people (Headwaters Group Philanthropic Services, 2011). There can be confusion between charity and social programs conducted by business and integrating social concerns into core business practice and making it the responsibility of all managers, not just the province of marketing or community relations departments. Companies' ambitions in addressing poverty may be set too low, and, conversely, their expectations may be too optimistic. Self-regulation, transparency, and sustainability in this work are paramount values.

A review as to why it might be desirable for a nonprofit to join in a venture with a corporate sponsor with a triple bottom line can offer insight. Nonprofits operate in a competitive environment; they compete for gifts from corporations, foundations, and individuals, and government grants. By cultivating an exclusive relationship with a corporate sponsor who has an outstanding reputation for its products or services as well as a willingness to support the nonprofit's vision and mission, a nonprofit organization can establish a robust and advantageous partnership. For instance, the nonprofit does not have to compete for gifts from the corporate sponsor and the need for federal and state grants may be reduced. At times, federal and state grant requirements may pressure nonprofits to target specific communities. This could minimize services, which in turn can widen the poverty gap and collapse the social ladder into the middle class.

The potential benefits for a nonprofit to partner with a for-profit company are significant. Why, then, should a for-profit business develop a partnership with a nonprofit organization and build a triple bottom line of profitability and social return? A for-profit's financial bottom line does not mandate social or environmental returns. A for-profit organization that seeks to become a corporate sponsor must think in terms of business interest and social goals when identifying potential nonprofit partners. It must also consider social goals' sustainability and profitability. For example, the for-profit corporation, Home Depot formed a partnership with the nonprofit KaBOOM!. KaBOOM! builds children's playgrounds. Home Depot sells

building materials, and the business has strong ties with the community. This relationship, therefore, is a good fit. As Worth (2019) states, "it would not be logical for a company that manufactures entertainment products to be a partner with a nonprofit concerned with homelessness." (p.308).

Another example is Timberland and City Year's relationship. City Year had a captured audience of people in need. City Year brought Timberland high visibility in communities because volunteers wore the Timberland logo. It was a positive sign of excellent products that supported low-income communities' education and social advancement. This means low-income children are cultivated with the Timberland's logo as a symbol of high status. These children, through education, then climb the social ladder and teach their children to value and purchase Timberland products. This is a win-win for City Year and Timberland (Austin et al., 2004).

While nonprofit organizations have routinely implemented alternative strategies to build net assets, in recent years, more are using direct business principles in their programs. Many more have identified the need to use innovative financial planning to diversify their unrestricted income sources – particularly those with a reliance on government – and they are all asking for help in doing so (Illinois Facilities Fund, 2013). For example, in the new world of nonprofit accountability, government and financial donors demand more fiscal responsibility when managing nonprofits with 501(c)(3) IRS status. At the same time, they ask: Are we receiving a return on investment as measured by positive social impact on individuals, families, and communities (Ebrahim and Rangan, 2014, p. 118)? For instance, nonprofits must demonstrate their ability to measure positive social impact before they can receive a grant from United Way. United Way and its partners evaluate the effectiveness of impact strategies, so they can continuously improve. They identify appropriate measures, collect and analyze results, and assess progress toward desired outcomes. Positive social impact can be measured at multiple levels, programs, systems, and communities and may cause United Way and its partners to rethink, change, or adjust strategies, actions, and investments (United Way, 2005, slide 57). A nonprofit organization that is effectively using the triple bottom line has a distinct advantage in procuring funds from sponsors such as the United Way.

Effective measurement of social impact also means that every leader and manager in the nonprofit industry should understand the triple bottom line in order to match the mission statement and vision with social responsibility. Donors' contributions should be measured to

determine if the funding is actually achieving its intended goals through positive social impact. Additionally, sustainable nonprofits should tie impact goals to financial goals. This effective management of hybrid revenue strategies requires a well-outlined nonprofit business model that links the impact strategy directly with the revenue strategy (Nonprofit Answer Guide, 2014). Long term financial planning begins with an organic and flexible approach that involves trial and error. Even some of the best-made plans can be susceptible to daunting economic downturns.

Nonprofit organizations are searching for alternative ways to mitigate poor revenue streams and funding cuts, which perpetuate competition in their market. A successful mitigation strategy can include collaborations, which are more common due to these financial constraints. Collaborations focus on the beneficial trade-off of a hybrid entity that can diversify its revenue stream and thrive in the competitive nonprofit marketplace. "Management of hybrid strategies can be a challenge. For this reason, different financial goals must be set for different revenue streams" (Nonprofit Answer Guide, 2014). It takes a good leader and manager to make the necessary decisions that can pull resources together in a timely manner for the sake of the organization's longevity.

For example, there are those opting for a Low-Profit Limited Liability Company (L3C) structure. "The L3C is structured to be able to receive Program Related Investments (PRIs) from foundations, which are grants that enable the foundation to generate a return from the nonprofit entity. Another difference is that while L3Cs are organized as LLCs - they are designated as 'low-profit organizations' with specific charitable or educational goals - L3Cs are for-profit in the sense that they can distribute profits, and are nonprofit in the sense that they are organized for charitable purposes" (Sertial, 2012). Ultimately, adequate management of the triple bottom line has leaders and managers rethinking their strategies and organizational structures, developing new decision making and financial models to follow the fiscal health of their organizations, and searching for ways to maximize their potential for social impact and longevity.

Finally, nonprofit organizations often focus on making ends meet today; they must also look to long-term financial sustainability. Effective measurement of the triple bottom line can assist organizations in their analysis of strengths and weaknesses in financial and social aspects. Nonprofits must focus on the long term goals of organizational programs and quality of service to be better equipped to manage this challenge of positive social impact.

Research Questions and Inquiry

We shaped our inquiry around the following questions:

1. How could nonprofits be given a voice and decision-making power within collaborative projects involving business?

2. What can business (For-Profit) learn from nonprofits and *vice versa* to improve social innovation and CSR?

In addressing these questions, we integrate the existing concepts of Innovation through Collaboration, Community Engagement, Hybrid Organization Model, and Collective Impact to highlight examples of for-profits, hybrid social enterprises, and not-for-profits whose goals and outcomes include poverty alleviation.

Innovation through Collaboration

As corporations are pushed to be ever more socially innovative and competitive, it is becoming increasingly expensive to develop social innovation from inside a corporation. There are several reasons why a corporation needs to remain socially innovative, including "for competitive advantage, social legitimacy, or firm survival" (Holmes & Moir, 2007). However, "the locus of innovation lies outside a firm's boundaries and access to a diverse range of external partners within an organization's network is important for driving innovative ideas" (Holmes & Moir, 2007). Partnering with nonprofit organizations has proven to be a useful and socially-responsible answer to innovation creation, regardless of whether the motivation is internally-driven by the corporation or externally-driven by a nonprofit engaging with a corporation to primarily meet the needs of the nonprofit (Holmes & Moir, 2007).

Several vital indicators can lead to a higher probability of collaborative success for both the corporation and the nonprofit. "The willingness of the organization to experiment" is an indicator showing that managers are open to interpreting data as an opportunity and not a threat (Holmes & Moir, 2007). A second indicator is the "innovation orientation of its managers" (Holmes & Moir, 2007), essentially stating that managers must believe that partnering with a nonprofit will benefit both the corporation and the nonprofit; that this partnership is not just an opportunity to give back to the community (Holmes & Moir, 2007). The final indicator is a corporation's "communicative capacity" (Holmes & Moir, 2007) and "openness to new ideas is widely identified as a critical component of innovation and firms need to have the processes in

place to bridge the boundaries with other organizations" (Holmes & Moir, 2007). As in every collaboration, excellent communication is essential.

Once a collaboration has been established, and the indicators above are showing favorable direction, "research demonstrates the value of an open innovation approach driven by the need to address societal and social issues (rather than those purely economic)" (Holmes & Smart, 2009). This is where the scope is particularly important, as research indicates that outcomes can be drastically different when the scope is defined by the corporation versus the nonprofit approaching a corporation for collaboration. Where the engagement remit had been narrowly defined by the corporate partner at the outset, the opportunity for scope development was limited: the corporate actors appeared to have a clear understanding of why they were engaging with the nonprofit and did not deviate very much from this (Holmes & Smart, 2009). Alternatively,

> "where the firm had agreed a broader engagement remit with the NPO at the outset, or indeed, had no agenda for the relationship as the nonprofit had approached the firm, the range of activities was expanded or extended further (often to the surprise of the corporate actors involved), and firm innovations in these cases emerged during the course of the engagement" (Holmes & Smart, 2009).

In conclusion,

> "firms with a narrow engagement scope were looking to exploit the skills and resources of the NPO through the collaboration. By contrast, those firms with a broad or an undefined engagement scope were more exploratory in their approach, using the collaboration to search for new innovation opportunities" (Holmes and Smart, 2009).

Collaboration can be an excellent approach to innovation for both corporations and nonprofits alike. Research shows that innovation can occur regardless of which partner initiates the partnership, however, the degree of innovation achieved can be influenced. An example of a successful collaboration includes

> "The World Wildlife Fund helping Coca-Cola develop models and create a framework to evaluate tradeoffs between conserving biodiversity and minimizing costs. The partnership has resulted in improved ecological health of seven of the

world's most important freshwater basins while improving Coca-Cola's water efficiency by more than 20%" (Mahmud, 2014).

Once the collaboration is established, alignment of critical indicators, including the willingness of managers to engage, to see the broader purpose, and to create strong communications channels (Holmes and Moir, 2007), can ensure the collaboration is off to a good start. And as the collaboration formalizes, keeping a broad agreement and allowing for an exploratory approach (Holmes and Smart, 2009) can improve the chances of success.

Increasing Community Engagement

Community-engagement is the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar situations to address issues affecting the well-being of those people (Osafo & Yawson, 2019). For-profit organizations today have the unique opportunity to increase community engagement efforts in ways that can help target specific community challenges and provide scale to impact society positively. The depth of issues facing communities requires organizations to go beyond their charitable giving and invest in non-traditional ways to improve and strengthen the lives of communities around the world. Expanding a business' community involvement to include efforts to help reduce recidivism through progressive hiring practices is one example of how organizations can go about increasing their social impact. The Salvation Army even in the 1980's had great success with this kind of a program boasting rehabilitation of 80% previously incarcerated people through a strict work program run largely by volunteers (Drucker, 1989). Historically this space has been dominated by non-profits, but there's significant evidence that suggests that for-profits can benefit from and help play a role in reducing recidivism. According to Schnepel (2018) there is a strong correlation between the availability of good jobs in certain sectors and a decrease in recidivism. Schnepel (2018) also found that the existence of low-skill manufacturing and construction employment opportunities at the time of labor market entry is associated with significant reductions in the number of released offenders who return to prison.

Prisons in the United States are built as revolving doors with more than two-thirds of individuals released from prison in California, for example, returning to prison within three years (Schnepel, 2018). The scale of incarceration in the United States is largely driven by the failure of former inmates to reenter society successfully. Released offenders face a number of social, housing, and financial challenges upon leaving prison and an inability to obtain employment are

often cited as one of the most important factors that contribute to recidivism. The National Employment Law Project has reported that approximately 70 million people have some type of arrest or conviction record that prevents them from obtaining jobs, despite relevant knowledge and skillset. Once a potential employer learns of an applicant's criminal history, the chances of that job seeker receiving a call back decreases by 50 percent. The effect is even greater for Black men, where only one in three receives a callback. Although this research showed that employers were hesitant to hire Black people even without criminal records, they became more reluctant to make job offers when they were aware of known criminal history. Conviction records for Black people, then, have significant impacts on one's ability to engage in the labor market (Marek, 2018).

For-profit organizations can look for insights from NPOs in reducing recidivism and apply those lessons learned in meaningful ways in order to solve complex problems facing society. For-profit organizations can institute fair hiring practices like "banning the box," as more states are starting to do. As of 2016, over one hundred municipalities and twenty-four states have recently adopted a growing fair chance hiring policy called "ban the box," which refers to the commonly used checkbox on job applications inquiring into an applicant's prior criminal record. Ban the box laws mandate that employers remove the question from employment applications asking, "have you ever been convicted for violation of the law other than minor traffic offenses?" Ban the box policies offer fair chances for job opportunities to those with prior criminal records, which encourages rehabilitation, promotes community development, and reduces the recidivism rate (Reed, 2016). One of those states, Hawaii, implemented ban the box law in 1998 and the ban resulted in a substantial decline in repeat offending among criminal defendants being prosecuted for felony crimes in Honolulu County (D'Alessio, Stolzenberg, & Flexon, 2015). The ban the box policies reduce barriers to employment so that people with past criminal involvement - after they have been held accountable and paid their dues - can compete for appropriate work opportunities to support themselves and their families, pay their taxes, and contribute to the economy.

Beyond the hiring opportunities, for-profit organizations must be willing to invest resources in training offenders. California's Last Mile program offers a program called Code 7370, where students are taught computer coding. In 2015, the inmates were provided actual entry-level front-end coding positions from companies outside the prison walls. Programs like

the ones San Quentin prison leads have as low as a 7.1 percent recidivism rate in comparison a 54 percent rate for the rest of the state (Alfaro, 2019). Other nonprofits like The Prison Entrepreneurship Program is a nonprofit organization that connects released felons with executives and entrepreneurs. This re-entry program focuses on teaching leadership and innovation skills. Since the program began in 2004, there have been over 1,300 graduates who began careers with starting wages 60 percent higher than the minimum wage and almost 100 percent are still employed 12 months after their release. Most importantly, the recidivism rate for graduates is below 7 percent, which is far below the national average (Prison Entrepreneurship Program, 2019). Through the examples of non-profits who are committed to hiring and training those who have been incarcerated corporations can contribute to society while not perpetuating the cycles of unemployment and incarceration that exist today.

Figure 1: **A model for participation in local economic development**
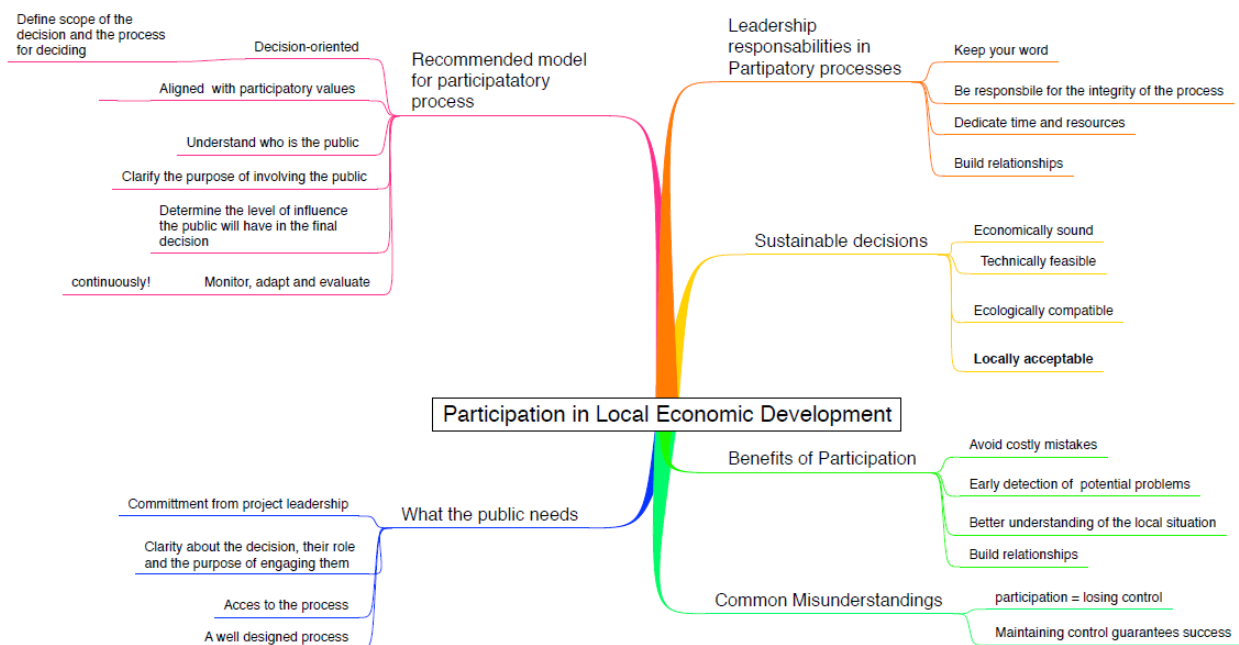
Copyright ©2011 pfc Social Impact Advisors (Formerly Headwaters Group)

The challenge of the principles of community engagement, outlined above using recidivism, as an illustration, is putting them into practice (Headwaters, 2011). Some corporate and corporate-nonprofits partnerships have demonstrated the value of successful engagement with the surrounding community. Business and nonprofits can work effectively to engage and give voice to the community whether as targets of charity, the customers or neighbors of a

corporation, or other stakeholders who may be affected by programs and policies. Figure 1 offers an illustration of a model for participation in local economic development. There are many other community-based processes used to engage the community (Osafo & Yawson, 2019).

Hybrid Organization Model

In response to the market demand from the public to focus on corporate social responsibility, hybrid organizations are becoming common. Hybrid organizations are enterprises that design their business models based on the alleviation of a particular social or environmental issue (Haigh, Walker, Bacq, Kickul, 2015). The case for the hybrid model is that it blurs the boundaries of traditional nonprofits and for-profits by incorporating social missions like nonprofits and generating income to accomplish the mission like for-profits. (Haigh & Hoffman 2012).

Committed to doing good business, but also doing good by society, the main objective of hybrid organizations is to increase profitability while concurrently pursuing a social mission. With a two-part bottom line, hybrid organizations have changed the conversation about for-profit and mission-based work. Through careful attention to financial planning and the effective use of technology, nonprofit and hybrid organizations alike can ensure they are prepared to meet the challenges of tomorrow, while continuously building and expanding a base of donors, stewards and volunteers. Thus, a dual-pronged approach serves as the foundation of sustainable organizational operations.

Hybrid organizations can be either for-profit or non-profit. Two examples of this are; Ten Thousand Villages, which is a nonprofit that uses a for-profit retail model to sell goods and provide income to artisans; Seventh Generation, a for-profit, that strives to be the most environmentally responsible cleaning product in the world (Haigh & Hoffman 2012). In defining a legal structure, hybrids can be broken down into three different segments; a for-profit structure that links a strong social mission; a nonprofit structure that earns some or all of its revenue; and a "mixed-entity" structure that associates a for-profit with a nonprofit through ownership, contracts, and donations (Haigh, Kennedy, Walker, 2015).

In addition to these three legal structures, for-profit organizations have begun to see a growing number of business registration categories. These categories have been created to highlight the dual social-economic purposes of the organization. Some of the categories are also valuable to those organizations initially looking to register as a nonprofit. The list of some of

these categories is (dependent on state) Low-Profit Limited Liability Company (L3C) and Benefits LLC, and variations of the corporation, Benefit Corporation, Flexible Purpose Corporation, and Social Purpose Corporation (Haigh et al., 2015).

Notably, the blurring of for and nonprofit sectors has led to more organizations generating more revenue from charitable gifts and business ventures while utilizing business methods in pursuit of their social mission (Worth, 2019). Traditional organizations can leverage hybrid models and strategies not only to extend their responsibility to social and environmental goals or in the policy of their fiscal sustainability practices but also to pioneer their business model. With this being said, organizations may learn how to launch their business models in ways that go above current norms, making their mission profitable, rather than making profit their only mission. Hybrids, as opposed to traditional, consider the integrity of nature a rewarding pursuit and its preservation value that benefits society (Alberti, Garrido, 2017). "Partnerships have become attractive to corporations, some of whom eagerly seek relationships with nonprofits that provide a good fit with their strategic goals. Some engage for-profit marketing firms to identify organizations and negotiate the partnership agreement." (Worth, 2019, p. 309). Nonprofit and hybrid organizations alike can greatly benefit from establishing, tracking, and reporting on the triple bottom line.

Collective Impact

One of the most sweeping ways for-profits can engage in affecting social change is to partake in coalitions of organizations across sectors in a coordinated effort, capitalizing on the concept of collective impact. The originators of this idea define collective impact as "the commitment of a group of important actors from different sectors to a common agenda for solving a specific social problem" (Kania, Kramer, 2011). "The main thesis underlying the collective impact framework is that while each organization faces a unique set of challenges because of differing levels of operations, differing visions and missions, variances in corporate culture, and the different corporate stories of impacts, there are also crucial commonalities" (Yawson, Peterson & Johnson-Kanda, 2019, p.3).

For-profits engage in philanthropy through charitable donations, but also have many additional resources that can be utilized for social purposes outside the organization. For example, data collection and analysis are something that a large for-profit company may excel at, but it is incredibly challenging for smaller nonprofits to gain competency. By lending their

expertise and some of their employees' time, for-profits can provide other actors with support in critical spaces that would otherwise be impossible to access. In this way, for-profits can use their resources and knowledge to support communities through collective impact to partner across for-profit, nonprofits, government and community organizations to effectively and efficiently promote social good (Kania, Kramer, 2011).

Additionally, corporations are well-positioned to support the creation of coordinating entities within a coalition or community called backbone organizations to maximize collective impact (Easterling, 2013). Backbone organizations are instrumental in building and supporting effective alliances. As Kania and Kramer note,

> The expectation that collaboration can occur without a supporting infrastructure is one of the most frequent reasons why it fails. The backbone organization requires a dedicated staff separate from the participating organizations who can plan, manage, and support the initiative through ongoing facilitation, technology, and communications support, data collection and reporting, and handling the myriad logistical and administrative details needed for the initiative to function smoothly"
> (Kania, Kramer 2011).

Traditionally, corporate philanthropy consists of writing a check or donating some time towards the work of external organizations, often non-profit or public sector. This is top-down philanthropy, in which corporations can support the existing work of others, but are somewhat limited in their ability to impact the way that work is being done. Collective impact is a type of "networked" philanthropy, where individual players with unique skill sets and perspectives come together around a common goal, pooling different kinds of resources as needed to address the more significant cause. For the network to communicate across silos, a backbone organization is required. Backbone organizations can take the form of funder-based, developing a new nonprofit, other existing non-profits, and government (FSG, 2019). An example of a backbone organization is National Fund for Workforce Solutions, which works across sectors and has regional collaboratives to "individuals develop new skills and access a good job, businesses find trained employees, and communities generate prosperity for all" (National Fund for Workforce Solutions, 2019). Successful, profitable corporations know how to communicate and coordinate internally across complex organizational hierarchies. In many ways, the schema used to keep the for-profit corporation working towards the collective mission can be applied externally, to

outside teams, groups, and institutions working towards social causes. While a corporation should not function as a backbone organization itself (backbones need to be independent to function properly), it can work closely with the community in informing and the process of building an effective one.

Conclusion

The demand from consumers that for-profit organizations operate with corporate social responsibility has forced a shift to develop new ways of balancing financial, social, and environmental priorities. For-profits are looking to nonprofits to inform gaps of knowledge and drive innovation through partnership to ensure competitive advantage. They could also learn and internalize community-focused business practices that seek to end injustices such as the cyclical nature of incarceration and unemployment that the Salvation Army has addressed in their hiring practices for over thirty years. Furthermore, hybrid organizations offer a different stake in how businesses can create positivity with NPO's and corporate partners by working together to create a sustainable infusion of social impact principles into modern capitalism. Finally, there has been widespread momentum around collective impact as it establishes a vital shift in addressing significant system issues that require collaboration among all sectors to make real change. It is not prudent or effective for entities to take on collective impact without utilizing backbone organizations to support coalitions.

Through collaboration with nonprofits at varying degrees, for-profits strengthen public perception of their corporate social responsibility and can implement practices that can even aid in profit growth. Ultimately for-profits are confronted with the reality that they must learn from nonprofits who have always had the challenge of balancing financial, social, and environmental responsibilities in their business practices. Some of society's most significant issues will require solutions that require collaboration across sectors and the understanding that financial gain cannot always be a top priority in the pursuit of the greater good.

Private-sector businesses have a unique role to play in solving social challenges—they have the tools, a stake in improving these markets, and collectively access to global capital that significantly exceeds the available pool of foreign aid. Nonprofits can seize this moment and leverage these resources to achieve its goals of improving the situation of the very poor. This paper has identified opportunities for businesses and nonprofits to embrace the notion that business has a stake in improving quality of life among and providing goods and services to the

poor both in developing economies and in the United States. We have also identified ways to learn these lessons together and to scale up and disseminate successful models quickly through multi-sector networks of practice.

Acknowledgment

We wish to acknowledge the following individuals who contributed in so many ways to the original research from which this paper was prepared: Michael Calonita, Cooper Davis, Mistral Etienne, Ariana Massery, and Javier Ramirez.

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Undergraduate Student Poster Competition

Brain Tumor Classification Based On Graph neural networks

Daniel Babalola   Faculty Advisor: Dr. Hien Nguyen

Abstract

The increased availability of medical images has led to recent advancements in medical image processing as well as diagnosis. However, due to the high variation present in these data, classification has remained a fairly challenging task. Common classification methods involve the use of powerful Convolutional Neural Networks (CNNs) as well as Support Vector Machines (SVMs). However, these models fail to generalize well and often overfit. In this work, we are interested in seeing how the accuracy of medical image classification can be improved using graph-based modeling techniques. We present a modification of the Graph Convolutional Network (GCN) to help classify brain medical scans, detecting whether a tumor is present or not. The flexibility that graph structures offer allow us model these brain images in such a way that more information regarding the features present within the images are better preserved. After training with an augmented dataset consisting of 253 original images, our results show that these graph networks tend to generalize better than traditional models and yield higher accuracy as well.

Introduction

Medical imaging is a field that has gained the attention of machine learning experts in recent years. Unlike classic image recognition tasks, these datasets hold unique challenges that prevent traditional approaches from being as successful.

First, it is usually more difficult to gather a large enough sample size to sufficiently train most sophisticated models. Second, medical images are typically marked with high variability. Even with machine learning models that are best suited for image recognition tasks such as convolutional neural networks (CNNs), this problem may prove difficult to overcome.

And lastly, because of how delicate the medical practice is, it isn't sufficient to simply build a model with high accuracy. More care must be taken to ensure high sensitivity as failure to correctly detect an abnormality could result in death.

Our research proposes a graph-based learning model to help overcome this challenge.

Background

Graphs have already become widely used in the field of technology. They are used to model information in ways that can be understood both visually and computationally. One key property of graph-based learning models is their ability to understand nodes within the context of the graph. Because information is repeatedly passed between nodes, each node learns from the information contained in its adjacent nodes (neighbors). This makes graph-based learning models particularly suited for tasks where feature co-dependency is desirable, as is the case with medical imaging.

In 2016, Chen et al. highlights a strength inherent in graph-based models in their work on multi-label image recognition. They were able to prove how GNNs measure the dependency between labels even within the same image. Their work provides a lot of optimism about the performance of GNNs with tricky images such as medical images since objects such as tumors would be easily identified within the context of the entire organ in the image being fed into the model.

In 2016 and 2017, Kipf et al. and Defferrard et al. respectively also both show how existing CNNs could be extended. In their papers, through a process called *spectral filtering*, they show that graph-based networks result in a significant improvement in node classification.

We hypothesize that adopting a graph-based learning model would perform better than existing traditional machine learning models, including CNNs.

Methodology

Our approach can be summarized in the following four steps:

1. **Data augmentation:** By applying a rotation range of 15, a shear range of 0.05 as well as slightly manipulating brightness, width and height, we were able to successfully augment our dataset from 253 original images to 5120.

2. **Image preprocessing:** Our preprocessing step employed a technique called *contouring* to help crop the brain images. Using contours, we were able to find extreme points in each image and then crop out the image.

3. **Graph transformation:** To transform each image to its respective graph representation, first, we segmented the image into sets of pixels to help locate objects and boundaries present. Next, we generated the adjacency matrix from this segmentation as well as its feature and label matrix representation.

Processed Image → SLIC Segmentation → Adjacency Matrix → Graph Representation (Label: 1 (contains tumor))
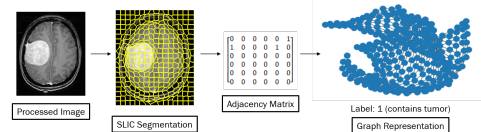
4. **Building the Graph Network Learning Model:** Our model was built by combining GCNs with several convolution and pooling layers. It takes as input the graph represented by its adjacency and node features matrices and outputs a corresponding label.

Results

To evaluate the performance of our learning model, we considered the following four metrics: **accuracy**, **sensitivity**, **specificity** and **comparison to other models**.

Our results show little or no overfitting. With an Accuracy of **95%**, a sensitivity of **95%** and a specificity of **95%** as well. These are very impressive results especially when compared to other learning models.
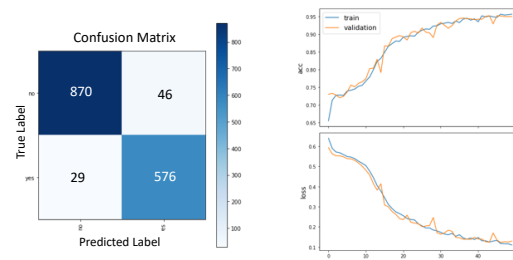
MODEL NAME	ACCURACY (%)	SENSITIVITY (%)	SPECIFICITY (%)
Graph network	95	95	95
GCN	Mean: 86; Mode: 96	-	-
CNN	82 (98)	77	88
K-NN	88	92	83
SVM	92	95	87

Conclusions and Future Work

Based on the results, it can be said that graph-based models tend to yield higher accuracy on complex classification tasks.

More so, graph-based models though using convolutions aren't prone to overfitting. This can be attributed to the nature of the representation of data as a graph which preserves feature dependency.

While the graph-based network seems to combine the strengths of both the GCN and the CNN e.g., prevention of overfitting, it does inherit some weakness, including the fluctuating results present in the GCN.

As regards **future work**,

- More comparisons with traditional models would need to be carried out to better understand the strengths and trade-offs associated with these models.
- More research also needs to be done to ensure that these models can produce consistent results across various training sessions.

PENN STATE · Penn State Harrisburg · Computer Science & Mathematical Sciences

Deptford, NJ Starbucks Process Analysis
Tyler N. Bell

The Deptford, NJ Starbucks follows the outlined process to prepare orders. The drive thru is visibly congested at almost all times of day, but moves slowest in the evening. How and where can the process be improved?

Actual

Forecasting Transaction Quantity

Exponential Smoothing

Note: ESM used an initial forecast of 15

······ Actual ——ESM .2 ——ESM .9

Proposed
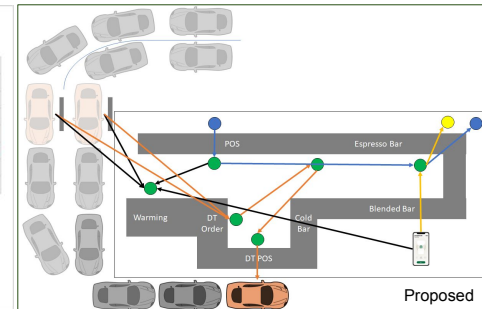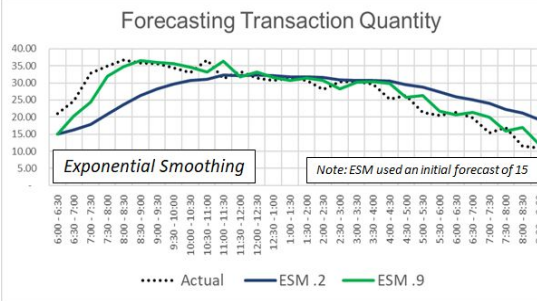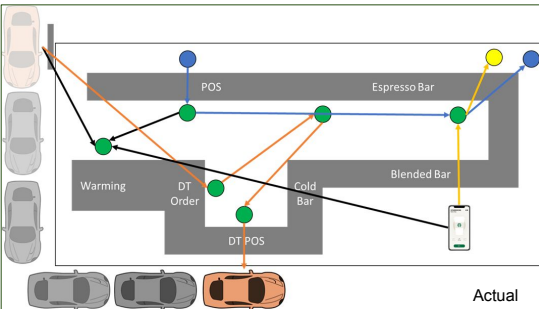
6-9 Cpk: 0.23, 7-3:30 Cpk: 0.35, 3:30-9 Cpk: 0.25, The process is *not* capable, but is more capable during higher volume.

5:00 am - 9:30 pm

6:00 am - 9:00 pm
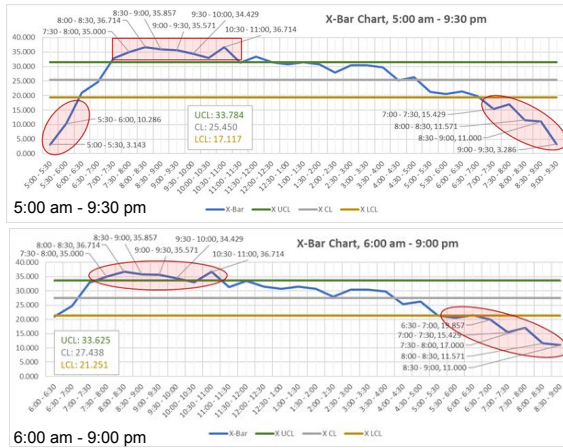
- SPC analysis shows three out of control periods. Narrowing the scope to 6am - 9pm shows only two out of control periods.
- Forecast is higher than actual mostly in the evening.
- These points suggest a bottleneck issue.
- The process is most capable in the morning, but still not capable overall.
- Recommend a second lane or modularized order fulfillment.
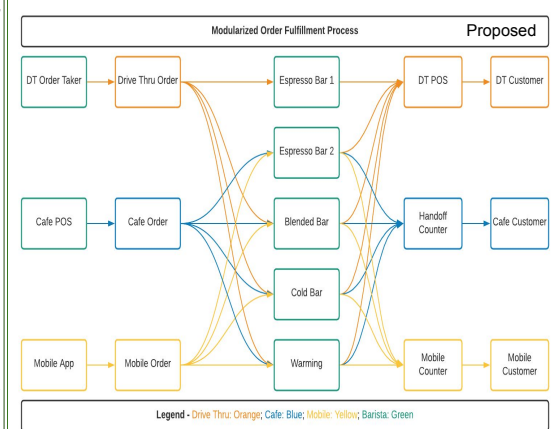
Modularized Order Fulfillment Process — Proposed

Legend - Drive Thru: Orange; Cafe: Blue; Mobile: Yellow; Barista: Green

Explainable Artificial Intelligence (AI) and Benefits for Business Applications

Chasity Nadeau – Masters of Business Intelligence and Analytics – Class of 2022
Jeannine Shantz, MSIT – Certificate in Cyber Analytics - 2022

INTRODUCTION

Abstract

The National Institute of Standards and Technology (NIST) recognized the many challenges in designing, constructing and assuring a Cyber Physical System (CPS), and in response developed the CPS Framework, designed to break down the process of completing a CPS into three separate facets and to aid in the processes associated with the realization of a CPS. We augment the Framework with AI and Explainable AI (XAI), through which we provide the tools promoting cross-functional collaboration and offer three high-level approaches to understand and explain the decisions made by AI that will be explored throughout the poster.

BACKGROUND RESEARCH

NIST & CPS

While traditionally the CPS Framework is favored by researchers and engineers, we believe the methodology of this framework can be useful for business processes relying on AI and not requiring physical systems.

The structure of the CPS Framework provides a foundation for making business decisions by providing tools to standardize vocabulary, develop a common structure, and analysis methodology that promotes overall acceptance by stakeholders.

The CPS Framework is formed by the interdependencies of three facets and multiple Aspects. Each Facet (**Figure 1**) has its own unique set of characteristics and outputs.
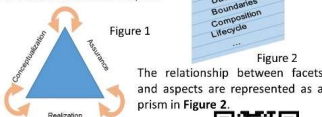
Figure 1

Figure 2
The relationship between facets and aspects are represented as a prism in **Figure 2**.

References

Scan QR code for References

USE CASE

Apple Credit Card

With AI, data goes in, decisions come out, but the processes between input and output are opaque. This type of AI is called "black box" and is problematic for businesses. Research shows there may be biases fed into machine learning (ML) models, which, as in the Apple card case shared below, lead to undesirable results.

The Apple credit card release sparked controversy when David Heinemeier Hansson, Ruby on Rails tech entrepreneur, tweeted alleged gender discrimination in the algorithms used to determine credit limits for the Apple Card. Hansson received a credit limit twenty times that of his wife. Ironically, his wife has a better credit score. Apple responded by raising Hansson's wife's credit limit. This resolution is a one-off response as Hansson was informed that Apple cannot change the algorithm's decision.

Hansson was not the only tech leader to claim discriminatory practices with the Apple credit card. Apple co-founder, Steve Wozniak, was given ten times the credit limit offered to his wife. Wozniak called on the government to investigate the operation of black box algorithms, which experts say are often biased.

As we can see in the Apple card case, the law requires ML behavior to satisfy certain criteria. Unintentional bias is not an excuse for non-compliance. This accountability is crucial for business processes utilizing AI.
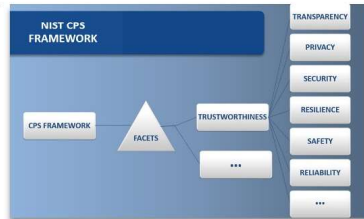
Figure 3

With the example of the Apple credit card, we can utilize the CPS Framework to understand AI. While this is not an exclusive list, one aspect and a few of its respective concerns we can look at are Trustworthiness: transparency, privacy, security, resilience, safety, reliability. Figure 3 takes a closer look at what this application may look like.

THREE HIGH LEVEL APPROACHES OF XAI

Explainable Model & Explanation Interface
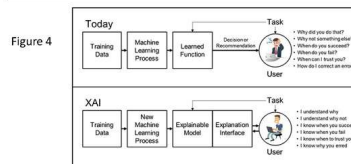
Figure 4

Above, Figure 4, is a diagram that depicts the key difference in artificial intelligence and explainable artificial intelligence. Where the top line highlights the lack of clarity to users with artificial intelligence, the bottom line shows the users work with XAI. With life without XAI, the user is unsure about why the decision or recommendation was made; on the other hand, life with XAI, an explainable model and explanation interface, the users are provided with details as to why a specific decision or recommendation was made. This is undoubtably crucial regarding physical systems, but also with business processes that truly rely on AI and those not necessarily utilizing a physical system.

Upon successful implementation of the explainable model and explanation interface, users will understand the decision. Having this sort of accountability allows businesses to showcase their compliance with the many AI risks that are outlined through Key Performance Indicators (KPIs).

KPI'S & OKR'S

We do not necessarily know why certain kinds of AI does what it does, nor can we predict what it will do under new circumstances. However, in using KPIs, we can mitigate AI risks.

Figure 5
AI risks may include the following components: bias, compliance, comprehensiveness, data privacy, explainability, trustworthiness and fairness. Since most companies use KPIs, this is a widely accepted strategy. Adopting KPIs and its components may help us in solving some of the challenges we currently face with the CPS Framework.

Objectives and Key Results (OKRs) require a human element. OKR implementation requires that everyone understands the company's goals, and has a clear vision of others' work, past performance and how they will achieve goals.

OKRs differ from KPIs in the sense that objectives are memorable descriptions of what you want to achieve, are short, inspirational and engaging, and key results measure progress towards the objective. OKRs take KPIs to the next level. Where one is quantitatively based, OKRs are qualitatively based. See Figure 5.

With the incorporation of KPIs and OKRs, explainable artificial intelligence may look different for each business. That is the great thing about these two metrics. They are customizable and adaptable, while also widely known.

CONCLUSION

Use of the CPS Framework

In the development of the CPS Framework, it is evident that Cyber-Physical Systems have become a bigger part of our everyday lives. However, to those relying simply on AI, not just physical systems, we propose that there is opportunity to use the CPS Framework outside of its original scope. Through the implementation of explainable artificial intelligence, decisions made by artificial intelligence are now apparent which, in the end, helps users understand.

We recognize that the original NIST CPS Framework might not be useful in providing explanations for the behavior of AI-driven systems used by businesses; however, we embed this capability in a prospective extended addition. This addition can function to bridge gaps by simplifying major aspects and concerns of systems into easily understandable components. XAI can be used to link observed behavior to the requirements imposed on AI via the framework. We believe that the Framework aids companies with achieving AI explainability, and in addition, demonstrates how the Framework can shed light in the decision-making process involving business components controlled by AI.

ACKNOWLEDGEMENTS

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We augment the Framework with AI and Explainable AI (XAI), through which we provide the tools promoting cross-functional collaboration and offer three high-level approaches to understand and explain the decisions made by AI that will be explored throughout the poster.

Figure 1

The CPS Framework

Facets (Figure 1)
- **Conceptualization**
- **Realization**
- **Assurance**

Background Research

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The structure of the CPS Framework provides a foundation for making business decisions by providing tools to standardize vocabulary, develop a common structure, and analysis methodology that promotes overall acceptance by stakeholders.

The CPS Framework

Aspects (Figure 2)
- **Broad appeal**
- **System specific**
- **Divided into concerns**
- **Apply to all Facets**

Figure 2

Explainable Artificial Intelligence (AI) and Benefits for Business Applications

Chasity Nadeau – Masters of Business Intelligence and Analytics – Class of 2022
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USE CASE

Apple Credit Card

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Data In
Data Out

problem Bias race
ethical
non-ethical
gender unfair
sensitive perception
protected
uncertain

755

Explainable Artificial Intelligence (AI) and Benefits for Business Applications

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Explainable Artificial Intelligence (AI) and Benefits for Business Applications

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Explainable Model & Explanation Interface

Figure 3

Explainable Artificial Intelligence (AI) and Benefits for Business Applications

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KPI'S & OKR'S
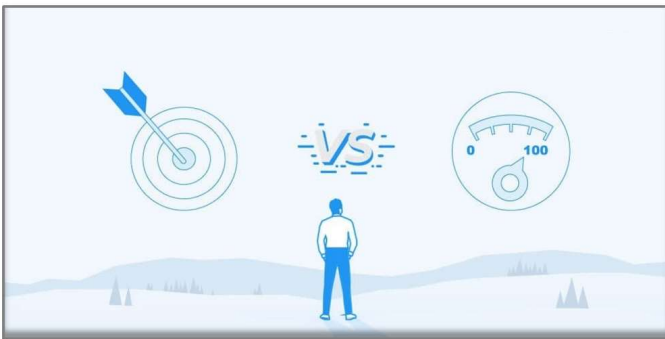
We do not necessarily know why certain kinds of AI does what it does, nor can we predict what it will do under new circumstances. However, in using Key Performance Indicators (KPIs), we can mitigate AI risks.

AI risks may include the following components: bias, compliance, comprehensiveness, data privacy, explainability, and fairness. Since most companies use KPIs, this is a widely accepted strategy. Adopting KPIs and its components may help us in solving some of the challenges we currently face with the CPS Framework.

Objectives and Key Results (OKRs) require a human element. OKR implementation requires that everyone understands the company's goals, and has a clear vision of others' work, past performance and how they will achieve goals. OKRs differ from KPIs in the sense that objectives are memorable descriptions of what you want to achieve, are short, inspirational and engaging, and key results measure progress towards the objective. OKRs take KPIs to the next level. Where one is quantitatively based, OKRs are qualitatively based. See the image to the left.

With the incorporation of KPIs and OKRs, explainable artificial intelligence may look different for each business. That is the great thing about the two metrics. They are customizable and adaptable, while also widely known.

**Explainable Artificial Intelligence (AI) and
Benefits for Business Applications**

Chasity Nadeau – Masters of Business Intelligence and Analytics – Class of 2022
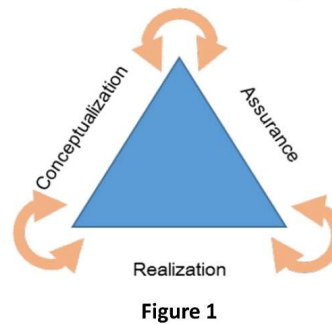Jeannine Shantz, MSIT – Certificate in Cyber Analytics - 2022

CONCLUSION

Use of CPS

In the development of the CPS Framework, it is evident that Cyber-Physical Systems have become a bigger part of our everyday lives. However, to those relying simply on AI, not just physical systems, we propose that there is opportunity to use the CPS Framework outside of its original scope. Through the implementation of explainable artificial intelligence, decisions made by artificial intelligence are now apparent which, in the end, helps users understand.

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Outline

- Investigate and analyze the factors that make it difficult for the elderly to go out, based on existing data.

- Identify areas where elderly people tend to have difficulty going out, and suggest measures to support them.
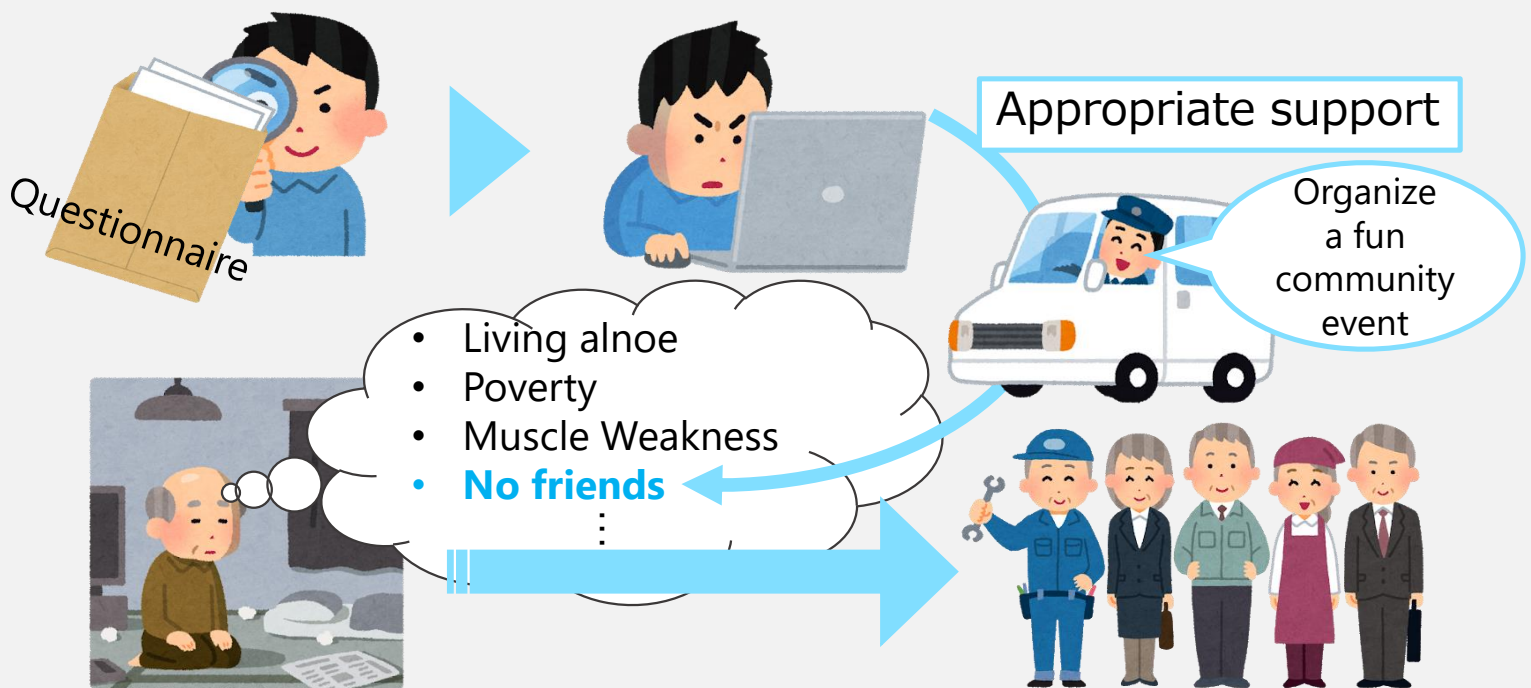
Abstracts

Accounting, Finance, Economics

Comparison of VAR &VECM Models for ASEAN Countries' Stock Price Indices

Oral

Mrs. Rahmet USLU YUVACI [1]

**1.** Hofstra University

While ASEAN can not implement one market in the economy, it would be very interesting if there is evidence whether the capital market in the ASEAN region.

This study attempts to partially fill the gap in the literature and to provide empirical evidence for degree of stock market integration among the ASEAN-5. For modelling, for multivariate time series approach is more appropriately used if the observed variable as well as the predicted one is more than one. Both VAR and VEC models are used if the observed data of the pattern tends to have no high fluctuations or no outliers.

Connecticut Real Estate Market: The 2020 COVID -19 Pandemic and the Prior Period, 1996 to 2020

Oral

Dr. Chiaku Chukwuogor [1], Dr. Ikechukwu Ndu [2], Dr. Emmanuel Anoruo [3]
1. Eastern Connecticut State University-CT, 2. University of Southern Maine, 3. Coppin State University

This study examines the state of Connecticut's Real Estate market with particular focus on the impact of the 2020 COVID -19 Pandemic. Data was sourced from Federal Housing Financing Agency, Quarterly Data: Purchase-Only Indexes, Federal Reserve Bank of St. Louis: Homeownership Rate for the United States and Connecticut, Zillow Home Value Index, Core Logic and S&P/Case-Shiller U.S. National *Home Price Index and.* Connecticut Department of Labor, Labor Information

The empirical analysis combines trend analysis, correlation, and regression analysis of such variables as averages home prices, volume of home sales, gross domestic product growth rates, unemployment rates, and mortgage interest rates.

Corporate Growth and the ROIC/WACC Spread: An Examination of the Russell 2000

Dr. Robert Goch [1]

1. _Molloy College_

This paper examines the relationship between company growth, its return on invested capital (ROIC) and its weighted average cost of capital (WACC). Finance theory dictates that if a company's return on capital is greater than its cost of capital it can increase shareholder value by expanding its operations. This paper analyzes public companies within the Russell 2000 to see if this relationship holds and will examine whether company industry/sector (high growth vs slow/no growth) impacts this relationship. Data relating to company growth, ROIC, WACC and industry sector will be obtained via the Bloomberg Professional Terminal.

Determinants of the Profitability of U.S., Banks Return on Assets (ROA)- An Empirical Analysis 1996 to 2020

Oral

Dr. Chiaku Chukwuogor [1], **Dr. Emmanuel Anoruo** [2], **Dr. Ikechukwu Ndu** [3]

1. *Eastern Connecticut State University-CT,* **2.** *Coppin State University,* **3.** *University of Southern Maine*

This study examines the determinants of the profitability of the U.S. banks during the period 1996-2020. Data was sourced from Reports of Condition and Income for All Insured U.S. Commercial Banks, Federal Reserve Bank of St. Louis and World Bank and several banks financial institutions' websites.

The empirical analysis combines bank specific dependent variables such as the Net Profit Margin (NIM), Non-Interest Profit Margin (NIPM), Loan Loss Provision ratios, etc. and macroeconomic variables, such as Gross Domestic Product (GDP) Growth Rates, unemployment rates, Interest Rates, Inflation Rates and through the Generalized Method of Moments (GMM) system estimator.

Disclosures Of Critical Accounting Estimates (CAEs) And Critical Audit Matters (CAMs): A Pilot Study Of The Dow 30 Companies S

Oral

Dr. Nathan Slavin [1], **Dr. Jianing Fang** [2]

1. Hofstra University, **2.** Kean University

Since 2003, management has been disclosing critical accounting estimates (CAEs) within the Management Discussion and Analysis section of their annual reports under SEC regulations. On June 1, 2017, the PCAOB adopted standard, AS 3101 where auditors are now required to disclose critical audit matters (CAMs). This paper will review these disclosure requirements in a pilot study for the DOW 30 companies for the fiscal 2019 year in determining the following:

- How many CAEs are also reported by the auditors as CAMs?
- Which are the most common CAEs and Cams?
- What are the average number of CAEs and CAMs disclosures?

Drivers of FDIs: New evidence in West African regions

Oral

Mr. Emmanuel Korsah [1], Mrs. Richmell Baaba Amanamah [1], Mr. Prince Gyimah [1]

1. *Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development*

This paper examines the factors that attract Foreign Direct Investments (FDIs) in 16 West Africa regions from the period 1989 - 2018. The fixed and random effects models show that demand for the sourced countries' products (import size) is the major driver of FDI inflows in WAC. Other drivers revealed by the study are natural resources, how a country is open to trade, and the strength of the exchange rate. The study has given a different dimension on the factors that influence FDIs and has contributed to theory and practice in emerging countries perspective.

Elasticity Estimates of US Household Saving, with Special Emphasis on the Impact of the Covid-19 Pandemic

Oral

Dr. Lillian Kamal [1] **_, Dr. Kolluri Bharat_** [1]

1. _University of Hartford_

This paper highlights determinants of US household saving, and the impact of the Covid-19 pandemic on US savings behavior. Using quarterly date from 1960 – 2020, we investigate factors susceptible to government policy, such as interest rates, government surplus or deficits, social security contributions, personal debt and household wealth, and the effects of these variables on personal saving in the US. Cointegration and error correction techniques are utilized to distinguish between short run and long run equilibrium relationships, and derive long-run elasticity estimates. The paper concludes with public policy recommendations in light of the impact of the Covid-19 pandemic.

Examine the Relationship between the Stock and the Real Estate Markets after COVID-19 Pandemic

Oral

Dr. Kuo-Hao Lee [1]

1. _Bloomsburg University of Pennsylvania_

The main purpose of this research is to investigate the causal relationships between the stock market and two variables of the real estate market, which includes the sales of homes and the prices of homes since COVID-19 pandemic hit the United States in March 2020. The data results showed that the stock market caused significant movement of the real estate stock market. It was also suggested that the stock market is affected by the sale of the homes. Our findings significantly differ from the conclusions of previous research, and provide prospect investors with another consideration when building an investment portfolio.

Expanding Data Analysis In Accounting: Variation In Critical Audit Matter Mandated Reporting

Oral

Dr. J L Souza [1], Dr. Sina Shokoohyar [1]

1. Saint Joseph's University

More sophisticated and lower-cost methods of tracking business activities have led to expanded use of data analytics in business reporting and decision-making. What began with trend analysis and correlations has now expanded into textual analysis of business communications, requiring more sophisticated data extraction, cleaning and analysis tools. Many accounting researchers lack the expertise in using such tools, requiring instead collaborative work with technology experts to investigate and answer emerging questions in accounting and other business fields. We present, as an example of such collaborations, the use of data tools to evaluate the usefulness of auditors' reports about critical audit matters.

FUTURES FOR WATER H20, A SIGN OF ENVIRONMENTAL AND FINANCIAL RISKS

Oral

Dr. Carmen Quirvan [1]

1. *The University of Rhode Island*

ABSTRACT

In the U.S. the opening of the Index Veles Water in 2020 is calling our attention of the importance of environmental risk in this nation and around the world. Wall Street is selling Futures of Water, as a commodity like gold. This fact recognizes the urgent action for protecting the environment. However, some companies do not report data regarding their environmental and financial impact. Pressure made by investors to companies to disclose financial information regarding environmental and financial risk such as water is a red light for all.

Key words: Futures for water, environmental and financial risks, data.

Gender equality in Businesses and Financial Inclusion

Oral

Dr. Nihal Bayraktar [1]

1. *Pennsylvania State University*

This paper investigates the empirical link between gender equality in businesses and financial inclusion of women. The research question is whether gender equality in access to financial instruments and the share of women in businesses move together. The paper includes tabular and graphical analysis as well as probit and panel regressions. The findings show that improvements in financial inclusion of females are related to higher shares of female involvement in businesses. The findings of the paper have useful policy implications, such as increasing the presence of women in the business world may require gender equality in financial inclusiveness.

Labor Market Outcomes and Sexual Orientation: An Exploration of Differences in Earnings

Oral

Dr. Jorge Medina [1]

1. *New Jersey City University*

This study uses General Social Survey (GSS) data to explore the difference in earnings between heterosexual and non-heterosexual workers. The most recent GSS surveys have data on self-identified sexual orientation, providing an opportunity to explore its role as a determinant of earnings with greater accuracy than previous estimations in the literature. Results show a significant difference in earnings in favor of heterosexual workers, implying discrimination against non-heterosexuals in the form of lower earnings. However, these results are sensitive to alternative model specifications. These findings provide new empirical evidence to further advance the understating of possible discrimination in the labor market.

Measuring Earnings Management

Oral

Prof. Yao Tian [1]

1. *San Jose State University*

Over the last 30 years, researchers have developed different approaches to measure earnings management. This study builds on prior research and combines the total accrual approach and the earnings distribution after management approach to develop a more accurate measure of earnings management. Empirical results show that this refined measure developed in this study is more accurate in identifying firms that manipulated earnings (manipulators) and firms that did not manipulate earnings (non-manipulators). This contributes to the earnings management literature a more accurate measure of earnings management to meet or beat a specific earnings benchmark.

Measuring Housing Services in the Time of COVID

Oral

Dr. Peter D'Antonio [1]

**1.** Molloy College

The 2020 COVID-19 pandemic has brought to light a flaw in the accounting and pricing of housing services in consumer spending (PCE) and the consumer price index (CPI). The dramatic shifts in housing usage caused by the pandemic have not registered at all in PCE. This paper takes a fresh look at the use of opportunity costs to measure housing services. It shows how the current gauge can miss real changes in services flows. The paper proposes that housing services be measured instead by hedonic methods, using new survey questions added to the Consumer Expenditure Survey (CES) and the CPI.

MNC Operating Foreign Exchange Exposure: Evidence by Practitioners

Oral

Dr. Augustine Arize [1], Prof. John Malindretos [2], Dr. Ikechukwu Ndu [3], Prof. demetri Tsanacas [2], Prof. Alex Panayides [2]

1. *Texas AM,* **2.** *William Paterson,* **3.** *University of Southern Maine*

.Operating foreign exchange exposure exposure measures the change in expected cash flows as a result of an unexpected alteration in foreign exchange rates. An important duty of the financial manager is to measure the effect of foreign exchange exposure and manage it in such a way as to maximize the profitability, net cash flow and market value of the firm. When foreign exchange rates change, the effects on a firm can be measured in several ways.

Modelling earnings management, corporate governance, capital management and risk using Dynamic Panel Data estimation – The case of listed commercial banks in the United States

Oral

Dr. Ikechukwu Ndu [1] , _Dr. Chiaku Chukwuogor_ [2] , _Dr. Augustine Arize_ [3] , _Dr. John Malindretos_ [4]

1. _University of Southern Maine,_ **2.** _Eastern Connecticut State University,_ **3.** _Texas A&M University-Commerce,_ **4.** _William Paterson University_

This study examines the relationship between earnings management, capital management, risk and corporate governance for listed United States commercial banks. Earnings management in the form of Loan Loss Provisioning (LLP) is a well-known problem that has an adverse impact on the users of the financial statements of banks in the form of accounting violations and bank failures.Secondary financial statement and corporate governance data are sourced from the Bloomberg database and published financial statements of listed United States commercial banks for the period 2010 to 2020. This study will help academics to achieve a clearer understanding of this research problem.

Multinational Company Accounting Foreign Exchange Exposure: An Application

Oral

Dr. Augustine Arize [1], *Prof. John Malindretos* [2], *Dr. Ikechukwu Ndu* [3], *Prof. demetri Tsanacas* [4], *Prof. Alex Panayides* [4]

1. *Texas AM,* **2.** *economics finance and global business,* **3.** *University of Southern Maine,* **4.** *William Paterson*

Translation Exposure, otherwise known as Accounting Exposure, stems from the need to redo consolidated worldwide operations according to the predetermined rules. The translation follows rules set up by an accounting association such as GAAP, the parent firm's government, or by the board of the fi1m itself. The revenues, expenses, assets and liabilities that have already been calculated in a foreign currency, must now be restated in terms of the home currency in order to be consolidated with home currency accounts.

In this study, we examine the actual protection , which finance decision makers take toward it.

Pass through effect of Oil on Latin American Emerging Stocks in a Pre and Post Covid- 19: An Evidence through Wavelets and VAR Approach

Oral

Dr. Jesus Tellez [1] *, Dr. Aqila Rafiuddin* [2] *, Dr. Gyanendra Sisodia* [3]

1. *Tecnologico de Monterrey, Business School,* **2.** *University of Science and Technology, Fujairah,* **3.** *Ajman University, College of Business Administration*

Evidence of possible connections between oil price and LATAM stock markets is analyzed through Coherent Wavelet analysis which can best be applied to the identification of patterns in a time series. A mixture of time varying parameter VAR model is used to study the impact of oil prices shocks on the LATAM stock returns. The standard deviations of the demand side structural shocks during the pandemic have remained high. The contribution of oil market specific demand price has shown fundamental linkages rather than pure contagion. The effect of oil prices innovations on stock markets returns depends on timing.

Retirement benefit evaluation based on impaired mortality and tax considerations

Oral

__Dr. Gao Niu__ [1] *, Dr. James Bishop* [1] *, Dr. John Quinn* [1]

__1.__ Bryant University

We present retirement benefit evaluation and comparison based on impaired mortality and tax impact. Adjusted mortality tables are calculated based on impaired life expectancy and standard US pension mortality. Lump sum, single life and joint life annuitization options are calculated. State and federal level tax consequences are evaluated and compared. Lump sum rollover is also considered as part of the evaluation and comparison.

The Use of Earnings and Non-Earnings Forecasts in Generating Analysts' Stock Recommendations

Oral

**Dr. Tao Li** [1]_**, Dr. Wenxiu Nan**_ [2]_**, Dr. Sultan Jahangir**_ [3]

1. _SUNY New Paltz,_ **2.** _Salisbury University,_ **3.** _Bentley University_

We utilize the decision tree models to extract analysts' weight of forecasts assigned in their stock recommendation decisions.

We find that compared to earnings forecasts, analysts' non-earning forecasts also play an important role in analysts' stock recommendations. We find that analysts' weights of forecasts are positively associated with the recommendation effectiveness.

We use Euclidean distance to measure the differences in assigning the weight of forecasts among analysts and attribute the homogeneity of the weight of forecasts as analysts' learning. We find that analysts who learn from those hired by top-tier brokerage firms have a higher chance to get career promotions.

Big Data, Analytics, and Knowledge Management

A Bayesian Approach to Forecasting Spare Parts Demands Subject to Intermittency and Irregularity

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Oral

Dr. Tim Lu [1]

1. _University of Maine_

This study develops a Bayesian approach to forecasting the demand for spare parts that is often intermittent and has irregular distribution. Our approach accounts for not only the interdependence between zero-demand and positive-demand states but also full uncertainty about the state transition probabilities. The approach also predicts demand size from a Bayesian bootstrapping procedure that better fits data and improves prediction performance. In addition, rather than a simple point prediction of customer demand, our prediction simulates fully defined posterior demand distribution and thus provides substantially more information about customer demand.

A Knowledge Management Approach to Integration of Educational Analytics

Oral

Dr. Shouhong Wang [1], Dr. Laura Forker [1]

1. *University of Massachusetts Dartmouth*

Educational analytics encompasses a variety of computational techniques to process educational big data for improving teaching, learning, research, service, and administrative decision-making. Educational analytics includes three categories: learning analytics, administrative analytics and faculty analytics. This paper discusses a knowledge management approach to integration of the three categories of educational analytics and proposes a semantic network model for implementation of integrated educational analysis.

A NEW RANKING METHOD IN THE DATA ENVELOPMENT ANALYSIS CONTEXT FOR A TWO-STAGE NETWORK MODEL

Oral

Prof. Hong Jae-Dong [1]

1. *South Carolina State University*

This paper proposes an innovative procedure for transforming the two-stage network (TSN) data envelopment analysis (DEA) model into a single-stage DEA model. The TSN-DEA models' critical issue is that the efficiency score depends on the reference set of the decision-making units (DMUs) to be rated. As a result, the TSN-DEA ranking methods for the two-stage process are so limited. For the single-stage DEA model, several popular DEA-based ranking methods may be applied. Through a numerical example, the procedure for the proposed method is shown to demonstrate its outstanding performance.

AI-Enabled Knowledge Management: Redesigning Knowledge Workers' Roles and Processes

Oral

Dr. Shankar Sundaresan [1] **_, Dr. Zuopeng Zhang_** [2]

1. *Rutgers University-Camden,* **2.** *University of North Florida*

The recent growth in the use of artificial intelligence (AI) by organizations has increasingly demanded the redesign of knowledge workers' roles and processes to facilitate better use of AI. Our research develops a framework for analyzing AI's role in different knowledge management activities, explores the impact of AI in transforming knowledge workers' roles and processes in knowledge sharing and learning, and derives managerial insights.

ANALYTICAL MODELS AND BITCOIN PRICE AT TIMES OF UNCERTAINTY

Oral

Dr. Ahmad Vakil [1]

1. _St. John's University_

The non-centralized nature of Bitcoin makes it an appealing choice in times of uncertainty. The COVID 19 pandemic has been instrumental in causing a huge uncertainty in financial markets. In this study, we examine the recent changes in the price of Bitcoin and explore the relationship between various financial factors and the price of Bitcoin. Furthermore, we explore the relationship between the Bitcoin price and different market indexes and commodities before and after the COVID 19 pandemic. We also examine the relationship between the S&P 500 index measure of volatility (VIX) and Bitcoin price before and after the pandemic.

Comparing National and State Economic Indicators

Oral

Dr. Mary Lois White [1]

1. *LSU Shreveport*

Conventional economic indicators are published weeks, even months, after surveys are conducted. Economists have begun to focus on creating real-time economic indicators as an alternative. This research evaluates how well local, state, and national indicators compare. Strong positive correlations show the indicators follow the same pattern, however, to the extent the indicators differ, the size of the effects indicate a difference in severity of impacts at different geographies. As decision-makers at all levels grapple with the policies to mitigate the economic effects of the pandemic, these results emphasize the importance of having timely data relevant to geographic area of interest.

Data Analytics for Entrepreneurial Ventures: A proposed framework for optimal utilization of data and potential techniques

Oral

Mr. Praneet Tiwari [1]*, Dr. Vallari Chandna* [1]

1. *University of Wisconsin-Green Bay*

While large business enterprises and corporations begin to reap the benefits of using data analytics, smaller firms and nascent start-ups are still limited in the way they use these tools. The three major challenges experienced by these firms are discussed in detail in our work: namely, (1) what data to collect, (2) how and when to collect data, (3) when collected, how best to analyze and strategically utilize data. We develop a prescriptive typology related to data analytics mechanisms and tools entrepreneurial ventures by starting with a classification system based on type of venture and existing digital presence.

Data Preparation using Self-service Data Prep Tools

Oral

Dr. Mohan Rao [1] , **_Ms. Navya Velverthi_** [2]

_1._ _Texas A&M University-Corpus Christi,_ **_2._** _University of North Texas_

One of the six steps in a data mining process is data preparation. It is an extremely important step requiring special attention. Research findings on data mining projects report that as much as 80% of the time is spent on data preparation and only 20% on actual data analysis. The Self-service data prep tools can come to the rescue. We will review select data prep tools and present an application using Tableau Prep Builder. Integrating an application like this in a data analytics course can lead to many class projects with open source databases such as the World Bank databases.

Efficient forecasting model for food supply chain demand planning

Oral

__Mr. Scott Miau__ [1] , Prof. Wei-Hsi Hung [1]

__1.__ Department of Management Information Systems, National Chengchi University

The sustainability of the food supply chain depends on accurate predictions of future demand. Sales forecasts are the basis for decisions on when to replenish goods from the distribution center and suppliers. This study explored future demand prediction methods using restaurant reservation data. We proposed a model that combines the classic autoregressive integrated moving average (ARIMA) artificial neural network and a long short-term memory (LSTM) model to improve the accuracy of forecasts while adding more relevant independent variables. The final workflow used reservation data from an international restaurant, indicating prediction accuracy of the proposed model better than some other models.

HOW INFORMATION TECHNOLOGY – IT – CONTRIBUTES TO THE PERFORMANCE OF BUSINESS PROCESSES: A STUDY CASE IN A BRAZILIAN CONTACT CENTER INDUSTRY UNDER THE INFLUENCE OF ENVIRONMENTAL TURBULENCE

Oral

Mr. Renan Herculin Lavrador [1] **_, Dr. Adilson Carlos Yoshikuni_** [1] **_, Dr. Alberto Luiz Albertin_** [1] **_, Dr. Napoleao Galegale_** [2]

1. *Fundação Getulio Vargas (FGV-EAESP),* **2.** *Pontifícia Universidade Católica de São Paulo*

The Coronavirus / Sars-CoV-2 Pandemic changed the world from night to day bringing with it lots of impacts for all economies and jobs around the world. In a scenario which is much more virtual every day, IT units update their system of resources to deal with the exchange in business processes and daily technological releases. Based on the dynamic capabilities found on literature, this study investigates how IT capabilities (DITCS), gathering with organizational memory and improvisational capabilities, contributes for the performance of business processes (BPER) under the influence of environmental turbulence.

Presidential Candidate Influence on Sentiment Towards Covid-19 Protocols

Oral

Ms. Kai-Jia Yue [1], Mr. Mitchell Leahy [1], Dr. Suhong Li [2]

1. Bryant University, 2. Bryant

The purpose of this paper is to discuss general public's sentiment towards presidential candidates (Trump and Biden) and Covid-19 Protocols (Mask Wearing, Vaccines and Social Distancing), and how a user's political learning impact his/her sentiment on Covid-19 protocols. The result of a correlation analysis revealed that users with higher sentiment towards Donald Trump have lower sentiment on both social distancing and masks. Users that have higher sentiment towards Joe Biden have higher sentiment on both masks and social distancing. These results infer that democrats are more likely than republicans to have positive sentiment towards Covid-19 protocols.

Regulations Impact on Collaborative Consumption Pricing: An Econometrics Model Approach of Airbnb.

Oral

Mrs. Funda Sarican [1]

_1._ _Bentley University_

The sharing economy provides new opportunities across different industries, but it is also raising several regulatory issues as more incidents arise concerning bypassing laws. To deal with these issues, cities have begun to practice regulations. Driven by the different regulation approaches, this paper aims to determine the effect of these regulations on Airbnb listing prices. A Difference-in-Difference model is applied to estimate heterogeneous treatment effects. This paper attempts to conduct a comprehensive regulatory evaluation by synthesizing different regulatory practices which could lead research in the right direction to answer the challenging question of how to regulate this new phenomenon.

Textual Analytics & Natural Language Processing: Value and Workforce Training for Business Domains

Oral

Dr. Jim Samuel [1], **Dr. Rick Ferris** [1], **Dr. Scott Bellamy** [1], **Ms. Yana Samuel** [2], **Dr. Suvayan De** [1], **Dr. Alex Pelaez** [3]

1. *University of Charleston,* **2.** *Northeastern University,* **3.** *Hofstra University*

Amidst the din of ubiquitous artificial intelligence and big data technologies, it is important to identify streams of value creation associated with domain specific applications of technological advancements. The two objectives of this research article are, 1) to provide insights into the potential for artificial intelligence technologies for NLP applications in finance, marketing, business management and economics, and 2) consider conceptual approaches for training the textual analytics (TAn) and NLP workforce for application, interpretation and innovation with TAn and NLP associated methods, tools and technologies. The article concludes with comments on limitations and potential for economic value creation.

The Influence of Intellectual Capital in Enterprise System Deployments

Oral

__Prof. Anjana Arunkumar__ [1] , Dr. Arun Madapusi [2]

__1.__ Arizona State University, __2.__ Northeastern State University

In this research study we investigate the influence of intellectual capital on firm performance in enterprise system deployments. A research model was developed, and data were gathered through a field study from production firms to test the hypothesized relationships. The model relationships were tested using factor analysis and multiple linear regression analysis. The results indicate that intellectual capital moderates the relationship between enterprise system deployments and firm performance. The findings suggest that firms need to leverage their intellectual capital in tandem with the technical deployment of their enterprise systems to maximize performance benefits.

Understanding Covid-19 Pandemic: Insights from Social Media Discussion

Oral

Dr. Suhong Li [1]

1. *Bryant University*

The purpose of this study is to understand the Covid-19 pandemic through discussion on social media platforms. The results showed that tweets with the prevention measure hashtags such as #socialdistancing, #stayhome, #wearamask and #vaccine received overall positive rating, while all hashtags in the news media category (#foxnews, #smartnews #fakenews, #breaking, and #news) received negative rating, reflecting people's pessimistic reaction to Covid-19 news. In addition, the findings of this study show that the months or countries with more cases/deaths are associated with a higher number of tweets and a more negative sentiment.

Using Artificial Intelligence To Guide SME Social Media Marketing Strategy

Oral

Mr. olumide Adebayo [1], *Dr. Elif Kongar* [1]

1. *University of Bridgeport*

Big Data and Artificial Intelligence (AI) provide unique innovation opportunities for Small- and Medium-sized Enterprises (SMEs) via incremental changes that could potentially ensure their competitiveness in the ever-changing landscape of modern commerce. SMEs, however, are generally characterized by their limited resources which limit their abilities to implement rather cost-intensive AI solutions. This research presents a framework depicting how SMEs can leverage Artificial Intelligence to sustain their businesses using social media data.

Cyber Security, IT, and Emerging Technologies

A Framework for Anonymizing and Acquiring Customer Data with Customized Privacy Protection

Oral

Dr. Hasan B. Kartal [1]

1. _University of Illinois at Springfield_

Privacy mechanisms are designed to protect customer data, however, the trade-off between the utility of data and privacy remains a key challenge. Organizations complying with privacy regulations typically apply strict measures on the collection and use of data or acquire customer data for analysis with privacy consent. While the former limits the utility of the data, the latter comes with self-selection bias and high acquisition cost. To overcome these limitations, this study proposes a new mechanism of anonymizing and acquiring personal data with customized privacy protection by aligning the privacy expectations of customers with the utility needs of organizations.

Artificial Intelligence Techniques Strengthen Cybersecurity Protection

Oral

**Mr. Frank Bucco** [1] _, **Dr. Carolyn Lammachia**_ [1]

1. _Bloomsburg University of Pennsylvania_

Cybersecurity management infrastructure includes authentication processes, access control, virus protection, intrusion detection, firewalls, vulnerability scanning, procedures, and training. Despite diligent effort and financial investment, breaches still occur. Artificial intelligence (AI) applications recognize patterns in data, interpret language, and distinguish images. By capitalizing on AI's strengths, new processing techniques are being integrated with cybersecurity tools to improve protection and detection processes. This research paper will report the results of scholarly literature and industry white paper review along with the examination of various cybersecurity application specifications of AI techniques that have been incorporated into cybersecurity management tools.

Augmented Reality or Price Cut: What Matters and to Whom? A Case of Peer-to-Peer Accommodation

Oral

Dr. Mehdi Darban [1] , **_Dr. Minsun Kim_** [1]

1. _Louisiana State University - Shreveport_

One important technological development expected to impact the hospitality industry is augmented reality (AR). Despite the increasing popularity of AR-enabled applications, academic investigations on consumer response to AR technology in the peer-to-peer accommodation context remain rare. To fill this research gap, we conduct a series of two studies. The first study focusing on the booking stage examines whether consumers value an AR-enabled service more than a price discount. The second study focusing on the post-check-in stage investigates the interactive impact of technology characteristics (information enhancement, vividness, and interactivity) and information overload of user on consumers' responses drawing from affordance theory.

Blockchain Implementation Challenges

Oral

Dr. Carolyn Lammachia [1]

1. *Bloomsburg University of Pennsylvania*

Blockchain, an emerging technology underpinning cryptocurrencies, is also the foundation of many innovative ideas to provide an immutable ledger to control the validity and flow of information. Successful implementations draw upon cybersecurity, management, data management, and analytics principles. Multiple industries are implementing blockchain solutions to increase transparency and streamline operations. There is active research in discovering and improving both the scalability and number of blockchain use cases. The purpose of this research is to collect best practices for implementing blockchain solutions to contribute to the body of knowledge that supports the expansion of this important tool.

Comparison of Business and Healthcare Analytic Approaches for Qualitative Data: Thematic vs. Content Analysis

Oral

Dr. Loreen M. Powell [1] **_, Dr. Daniel Powell_** [2]

_1._ _Bloomsburg University of Pennsylvania,_ **_2._** _Nort Pocono Shool Distict_

Continuum research findings often demonstrate the degree of data transformation from description to interpretation. The value of a qualitative description is the knowledge that can initiate from meaningful findings. Thus, it is essential to utilize the correct qualitative analytic method to provide the best findings within the business and healthcare sectors. However, many traditional qualitative business data analytic approaches often lack a high level of interpretive complexity needed within the healthcare sector. This research compares the thematic analysis and content analysis. It also provides a justification as to the need for separate healthcare and business analytic courses.

Cyber Security Risk Assessment in Nonprofit and Nongovernmental Organizations Under the COVID-19 Crisis

Oral

Dr. Claire Yun [1], **Dr. Bok Gyo Jeong** [1], **Mr. Stanley Mierzwa** [1], **Ms. Maureen Lawshe** [1], **Mr. Bruno Lima** [1]

1. *Kean University*

Under this unprecedently global health pandemic, the enormous demand for health services with limited staff and resources, the cybersecurity may become more significant but more vulnerable. Different from government agencies that are strictly regulated, nonprofits do not have clear guidelines or regulations on the ways to design and develop security solutions for the safety and resiliency of systems. Using an online survey, this study will evaluate the awareness and preparedness of cybersecurity of nonprofit global health service organizations under this COVID-19 pandemic.

Global Ethical and Societal Issues and Considerations with Cybersecurity in Digital Health: A rapid review

Oral

Mr. Stanley Mierzwa [1] *, Dr. Saumya RamaRao* [2] *, Ms. Toni Jackson* [1]

1. Kean University, 2. Population Council

Cybersecurity ethics can be defined differently and from different lenses depending on a perspective and topical focus. The realm of ethics is introduced into many different disciplines. This is with warrant because without this constraint, there is the potential to do something inside the respective fields that can be inferred as illegal and wrong compared with our normal activities, and this includes utilizing cyberspace.

This cybersecurity research note rapid review paper will draw attention to the background on ethics and societal issues surrounding the global public health sphere, in light of COVID-19.

Is Grid & Volunteer Computing Taught Within the Classroom?

Oral

Mr. Adam Karafinski [1] *, Dr. Loreen M. Powell* [2]

1. Blombur University of Pennsylvania, 2. Bloomsburg University of Pennsylvania

Grid and volunteer computing are some of the most important resource sharing innovations of the 21st century. The number of super computing projects is increasing daily. As such organizational grid and volunteer computing usage is also actively
growing. Additionally, the global health pandemic has temporary closed organizations and their on-site computing resources are now idle and available to assist in volunteer computing on the grid. Thus, teaching grid & volunteer computing within the IT curriculum is important. Using a content analysis, the study actively examines IT texts for grid and volunteer computing content. Methods and preliminary results will be explained.

Leadership in the Implementation of ERP Systems: A Case Study of a Global Pharmaceutical Organization ERP migration to the Cloud

Oral

Ms. Elizabeth Famodimu [1] **_, Dr. Elif Kongar_** [1]

1. *University of Bridgeport*

Many organizations have implemented ERP systems to adapt to their ongoing business changes. Unfortunately, not all of these organization have had a successful implementation. Senior management support is one of the critical factors in the success of an ERP implementation. This study introduces a real life case study focusing on the SAP ERP migration to the cloud in a pharmaceutical organization. The transfer project was conducted using the integration of system development lifecycle (SDLC) and Lean Six Sigma toll-gate review approach. Different leadership styles needed in each phase of the SDLC for successful ERP implementation are detailed in the study.

SENTIMENT ANALYSIS CHALLENGES DURING A PANDEMIC

Oral

Ms. Anna Dempsey [1] , **Dr. Loreen M. Powell** [2]

1. *Bloomsburg University,* *2.* *Bloomsburg University of Pennsylvania*

The unprecedented, global, health pandemic radically altered how people socially communicate. The United States (US) Center for Disease Control's (CDC) social isolation and distancing guidelines to combat the pandemic has resulted in many organizations shifting towards the use of public social media applications to communicate and understand customers. These alternate routes of communication may be challenging for retailers to rely on the accuracy of the data and sentiment analysis results throughout this health pandemic. This paper explores the sentiment analysis challenge regarding the subjective nature and emotional toxicity of COVID-19 data.

Strategy-Enterprise System Alignment and Firm Performance

Oral

Prof. Anjana Arunkumar [1], Dr. Arun Madapusi [2]
1. *Arizona State University,* **2.** *Northeastern State University*

In this research study we investigate the changes in firm performance that result from different strategy-enterprise system alignments. A research model was developed, and data were gathered through a field study from production firms to test the hypothesized relationships. The model relationships were tested using factor analysis and multiple linear regression analysis. The results indicate that different strategy-enterprise system alignments impact firm performance differently. The findings suggest that firms need to ensure that their strategies and enterprise systems are aligned to maximize performance benefits.

The information security influenced by the leadership styles: a study in the context of Brazilian multiple banks

Oral

**Mr. Murilo Catussi Almeida** [1] , _**Dr. Adilson Carlos Yoshikuni**_ [1]

**1.** FGV

Employees are still considered the weakest link in IS and managers play an important role in encouraging the desired behavior. This is relevant in the context of Brazilian banks, but there is no academic research in this context. To address this gap, this study analyzed the influence of leadership styles (based on Full-range leadership theory) on employees' IS compliance and participation intentions, through PLS-SEM. The results showed that transformational leadership has a positive influence on employees' IS intentions and passive leadership has negative influence. In addition, the results showed moderation by the control variables age, education level and work experience.

User Acceptance Of Biometric Identification Systems For Digital Commerce

Oral

Mr. Miguel Alfau Aleman [1], Dr. Mysore Ramaswamy [2]

1. University of Turabo, Puerto Rico, **2.** Southern University and A&M College

Nowadays, digital commerce is a necessity for all types of business enterprises. Customers are the main asset for all business organizations and how to retain them is a big challenge. Enterprises are introducing more advanced business processes that can provide a balance between security and customer experience at the same time. Biometric technologies are designed to create an easy interface while ensuring security, compliance and global acceptance. The purpose of this paper is to study user acceptance of biometric identification systems for digital commerce and how to achieve global acceptance of these technologies.

Decision Making: Public Administration and Policy

An asymmetric approach to the urbanization-economic growth nexus: Evidence from China

Oral

Dr. Youqin Pan [1]

1. Salem State University

This paper investigates the impact of urbanization on economic growth for China over the period 1960-2019 in a multivariate framework including gross capital formation. Urbanization has been reported to boost economic growth, however, the asymmetric effect of urbanization on economic growth is under-studied. This study utilized mixed methods of Autoregressive Distributed Lag(ARDL) and Nonlinear Autoregressive Distributed Lag(NARDL) to estimate the long- run and short-run effect of urbanization on Chines economy. The study demonstrates that urbanization and economic growth have causal relationship. However, the relationship between urbanization and economic growth is non-linear.

Breaking Down the Stigma of Mental Wellness with Law Enforcement

Oral

Mr. Wallace Fraser [1]

1. *University of Southern Maine*

One area often overlooked when considering law enforcement is the aspect of officer wellness. Recent events have brought attention to use of force by police officers and have begun to push the idea of organizational change within law enforcement. With a desire for change, this paper considers one area that can have an impact on officer conduct while also helping to improve the lives of police officers. By helping law enforcement leaders break down the stigma of asking for help and focusing on ways to better support police officers around operational stress, change can begin to happen.

Changes in Police Organizations

Oral

Ms. Amanda Giampetro [1]

1. *University of Sout*

This paper looks at the history of law enforcement in the United States. It has been suggested that police departments have not changed since the establishment of modern policing. There have been three eras identified in modern policing. This would indicate that changes were made, but that does not mean they were substantial. To identify what changed within law enforcement that sparked each new era required an in-depth analysis of history. This paper took looked at the available literature pertaining to the different eras and the lessons that can be used to address the current call for police reforms.

Data Authenticity: When Metadata Conflict

Oral

Dr. Edward C. Keller [1]
1. *Bloomsburg University of Pennsylvania*

Businesses and governments make decisions based on data. Literally, lives can been lost when incorrect, mislabeled, misappropriated or even a misunderstanding of the purpose of a data set is present. Governments have altered citizens' lives based on data and modeling which was later proven unreliable. The lack of appropriate data dictionaries with regulated metadata, and missing data governance structures are often at fault. There are no specific laws that provide for uniform metadata and data governance policies which cause the lack of data authenticity. With this poor accountability, data sets have multiple definitions for the same data sets.

Lives Saved vs. Lives Lost in Survey Research: Investigating Methodological Consistency

Oral

Prof. Candice Huynh [1], **Prof. Jeffery Guyse** [2], **Prof. Robin Keller** [3]

1. 1California State Polytechnic University-Pomon, **2.** California State Polytechnic University-Pomona, **3.** University of California, Irvine

Seven different elicitation procedures are employed in a between-subjects experiment over hypothetical scenarios involving lives either being saved or lost over time. Inspired by a study by Frederick (2003) which included lives being saved in 6 of the 7 procedures (choice, matching, total, sequence, equity, & context) and lives lost in just one of the cases (rating), we incorporate a completely balanced and symmetrical design with both lives saved and lives lost for all 7 methodologies. The effect on saved and lost asymmetry along with the contextual effect of the questionnaire design itself are analyzed.

Monte Carlo Simulation to Estimate Probability Distributions of Party Representation in Political Redistricting

Oral

Dr. Brian Adams [1], *Mr. Nathaniel Netznik* [1]

1. Pennsylvania State University Harrisburg

Each ten years states create legislative districts for representation in their federal and state legislatures. In this paper we present a Monte Carlo technique that can be used to determine the probability that a set of districts have been drawn without partisan bias – not gerrymandered. From this it will be possible to test the hypothesis that a particular redistricting plan does not unfairly disenfranchise voters of that state.

Re-examining the Philosophical Underpinnings of the Melting Pot vs. Multiculturalism in the Current Immigration Debate

Oral

Prof. Daniel Woldeab [1] *,* ***Prof. Robert Yawson*** [2] *,* ***Ms. Irina Woldeab*** [3]

1. *College of Individualized Studies, Metropolitan State University,* **2.** *School of Business, Quinnipiac University,* **3.** *Department of Natural Resources, Minnesota*

Immigration to the United States is not a new phenomenon, and it is natural for immigration, culture, and identity to be given due attention by the public and policymakers. However, the current discussion of immigration, legal and illegal, and the philosophical underpinnings is 'lost in translation', not necessarily on ideological lines, but on political orientation. We reexamine the philosophical underpinnings of the melting pot versus multiculturalism as antecedents and precedents of the current immigration debate and how the core issues are lost in translation. We take a brief look at immigrants and the economy to situate the current immigration debate.

The Effect of Alternative Income Measures on Housing Affordability Metrics

Oral

Mr. Douglas White [1] *, Dr. Mary Lois White* [1]

1. LSU Shreveport

The Department of Housing and Urban Development's methodology for evaluating housing affordability is based on family income rather than other income measures. This paper evaluates how changing this methodology affects the profile of housing affordability in local communities by providing a regional snapshot of housing affordability, and the availability of affordable rental housing units, at several scales for Louisiana, using data from the 2019 American Community Survey. We include figures for Louisiana and eleven study areas. Metrics evaluate how the deficit or surplus in rental units that are both available and affordable to households are affected using alternative income measures.

DSS, Machine Learning, and Artificial Intelligence

A Case Study of using AI tool for the Defect Detection: NAFCO, a Leading Aeronautic and Aerospace Manufactory

Oral

Mr. Tien-Yu Chang [1], **_Mr. Scott Miau_** [1], **_Prof. Rua-Huan Tsaih_** [1]

1. _Department of Management Information Systems, National Chengchi University_

Traditionally, automatic optical inspection (AOI) is usually used to detect anomaly products. However, AOI is hard to detect the inner structure of the product. With manufacturing equipment limitation and sensor cost in consideration, one of the leading manufactories – NAFCO (National Aerospace Fasteners Corporation), which made high precision parts in Asia, explores the autoencoder to produce labeled normal patterns and define defect parts threshold. Thus, the autoencoder helps find the defective parts on time. The experiment result shows a positive sign in improving the product quality and identifying defective products on time.

David and Goliath Revisited: How small investors are changing the landscape of financial markets.

Oral

Dr. Alex Pelaez [1] , **_Dr. Elaine Winston_** [1] , **_Dr. Jim Samuel_** [2]

1. _Hofstra University,_ **2.** _University of Charleston_

On January 12, 2021, a group of small investors coordinated a series of trades over the course of a few weeks in an effort to affect the positions of large hedge funds that short stocks. These large hedge funds were unaware of the tsunami that would overtake their short positions causing losses in the billions of dollars. A number of economic theories can provide insight into the activities of these buyers; however, the retaliatory aspect of these small investors is new. The aim of this paper is to explore these actions using classical economics, behavioral economics, and social coordination.

Digital Transformation - How to Beat the 90% Failure Rate?

Oral

Dr. Nagesh Ramesh [1]

1. *TE Connectivity*

Firms every year spend $1.3 trillion on digital transformation programs to improve efficiency because digital leaders outperform their peers in nearly every industry. Based on Diffusion of Innovation theory and data from three digital transformation programs within a firm that achieved vastly different results, I posit five factors as key influencers of digital transformation success. I also use machine learning (ML) techniques such as leave-one-out-cross-validation (LOOCV) to show the superiority of ML over regression to determine feature importance. In addition to contributing to theory, this research will help practitioners increase the success rate of future digital transformations.

Fetal Health Machine Learning

Oral

Ms. Sandra Nachfoerg [1]

1. Baruch College

Obstetricians have one of the most important jobs in this world, to help bring babies into the world. However, working in the health industry has many downsides, especially when a health care specialist has to deliver bad news, for example to expecting parents. It may occur that a baby is diseased before it is even born. Experts found ways to identify the health of a fetus based on cardiography. The heart rate of a baby can reveal the health of a fetus.

Machine Learning: Update Functions and Learning Rates

Oral

Dr. Robert Kissell [1]

**1.** Molloy College

Machine learning is defined as the process of teaching computers how to learn without being explicitly programmed to do so (Samuel, 1959). Machine learning is being used in industry to solve a vast array of business problem. For example, from simple regression to advanced natural language processing. Regardless of the complexity of the problem, machine learning algorithms require i) an initial guess (starting point), ii) a calculation function, and iii) an update function. We examine different machine learning update algorithms and how the starting point and learning rate influences the speed of convergence.

OPTIMIZED SUPPORT VECTOR MACHINE IN MULTI-CLASS TEXT CLASSIFICATION

Oral

Dr. Gazi Duman [1] **_, Dr. Elif Kongar_** [1] **_, Dr. Surendra M. Gupta_** [2]

1. _University of Bridgeport,_ **2.** _Northeastern University_

Text classification can be defined as an automated process of classification of text into predefined categories. It has been a prominent research area due to the recent technological advances in machine learning algorithms in the Natural Language Processing (NLP) domain. Thus, researchers seek to develop new classification systems or improve the existing ones via integrating new methods to obtain higher computational efficiency and accuracy. The purpose of this study to investigate Support Vector Machine (SVM) algorithm improved by Particle Swarm Optimization (PSO) in the classification accuracy and computational efficiency using Yelp Academic Data set.

Predicting Online Review Helpfulness through Extracting Text-Based Features

Oral

Mr. Mohsen Ahmadian [1], **_Dr. Josephine Namayanja_** [1]

1. _University of Massachusetts Boston_

Helpfulness of online reviews and its determinants have been widely studied in the literature; however, the study of review content and context in the understanding of review helpfulness is still rare and thus an open research problem. Using Natural Language Processing techniques, we extract new text-based features from the review text that can help us in predicting review helpfulness. We develop our model using these text-based features in addition to other features from the reviews, reviewers, and customers and use data from Amazon.com to test our model empirically. We present our results and discuss the significance of our findings.

Prediction of Hospital Closure – An Empirical analysis

Oral

Dr. Dinesh Pai [1], ***Dr. Usha Ananthkumar*** [2], ***Mr. Srijan Karn*** [2]

1. *The Pennsylvania State University at Harrisburg,* **2.** *Indian Institute of Technology, Bombay*

Closure of hospitals in rural as well as in urban areas has important implications for access to health care and also has an adverse effect on the local economy. Prediction of closure can help in effective planning and thus mitigate its damaging effects. In this study, we analyze the data pertaining to hospitals from different regions of Pennsylvania using various machine learning techniques. An additional challenge is the imbalance nature of the data owing to infrequent number of closed hospitals. This challenge is also being addressed and the study presents appropriate techniques for prediction of hospital closure.

Predictive Analytics Approach to Exploring Key Drivers for Soccer Player Valuation

Oral

__Mr. Yisheng Li__ [1]

1. *Brock University*

My research is focused on soccer player valuation, aiming to measure professional soccer players' market value using relevant theories. The overarching research question is: *What are the key drivers of player valuation in the soccer transfer market?* Predictive analytics is the primary methodology in conjunction with the harnessing of open-source soccer data and exploratory analysis. Several machine learning algorithms will be evaluated based on the trade-offs on predictive accuracy and model interpretability. In summary, my research is expected to have implications for the management of soccer clubs in terms of resource allocation, decision-making efficiency, and profitability.

Simple Interaction Finding Technique (SIFT) – A Simple Methodology to Generate Novel Hypotheses from Complex Datasets

Oral

Mr. Murtaza Nasir [1] , Dr. Nichalin Summerfield [1] , Dr. Serhat Simsek [2] , Dr. Asil Oztekin [1]

1. University of Massachusetts Lowell, **2.** Montclair State University

Machine Learning (ML) models have become ubiquitous in all spheres of research and decision-making. Understanding ML models as well as the data-generation-process (DGP) for the dataset under examination are important. Most highly accurate ML models are blackboxes that aren't interpretable. In this work, we propose a methodology that can help elicit important information from any ML models. Our methodology allows the use of any highly-accurate ML model to find interactions between variables in the dataset. This can allow for a better understanding of the underlying DGP by using a data-and-model agnostic process to synthesize new knowledge about the underlying phenomenon.

Using AI for Disability-Aware Healthcare Facility Design: From Classroom to Clinic

Oral

Prof. Hengameh Hosseini [1]

1. University of Scranton

Fifty million Americans struggle with a physical disabilities ranging from low vision to impaired mobility, yet the design of healthcare facilities of all types in the US fall woefully and consistently short of optimally accommodating them. In this work, we present models and studies of how to employ artificial intelligence technologies ranging from computer vision to machine learning to solve this problem. We discuss their utility in training healthcare management students to empathize with the needs of differently-abled patients, and demonstrate how they can be used by current healthcare facility leadership to improve facility design and patient accommodations.

Education, Curriculum, and Cases

A Case Study in Developing an Online Project Management Course

Oral

Dr. Dan Ball [1]

1. *Molloy College*

Project Management education requires that students learn the knowledge, hard and soft skills, and disposition necessary to successfully lead projects. Despite the advancements in learning management systems (LMS) and video capture programs, online education offers challenges to both faculty and students when courses include quantitative tools or team projects. This presentation covers the process used to build and deliver an online course in Project Management for both undergraduate and graduate students. A framework will be presented that includes proposed best practices pertaining to LMS course site design, the delivery of quantitative and analytical content, and the facilitation of team collaborations.

A Sigmoid Model of Correlation to Identify Bias in Students' Evaluation of Teaching

Oral

Dr. Brian Adams [1]

1. *Pennsylvania State University Harrisburg*

A common issue raised in evaluating faculty is that students do not fairly evaluate the professor's teaching effectiveness. The argument is that students are instead evaluating the difficulty or the rigor of the course.
In this paper an alternative theory is proposed; the statistical relationship between a professor's student evaluation is not determined by rigor but is instead a reaction to grade inflation.

This analysis investigates the correlation between student evaluations and grades in two ways; the common Pearson linear correlation, and since the range of evaluative scores and grade percentages are both constrained, a nonlinear sigmoid regression model.

An Exploratory Study Of Graduate Student Performance In A Hybrid Class

Oral

Dr. Lynn Fish [1]

1. *Canisius College*

Prior research on student performance with different content delivery formats shows mixed results and often occur across semesters, students and instructors. This study compares graduate business student performance in an operations management course for content delivered in a hybrid course where content delivery is both face-to-face and online to the same students by the same instructor in the same semester. Results demonstrate a significant difference in student performance and favor face-to-face content delivery.

An Exploratory Study Of Undergraduate Student Performance In Multi-Modal Format

Oral

Dr. Lynn Fish [1]

1. Canisius College

This study explores undergraduate student performance in a multi-modal environment where students could self-select their educational method. Average student performance for students who attended at least one class was better on graded assignments – particularly quizzes – than online students. However, online students were not significantly different than other students on overall performance, homework and exams. Students who attended more than 75% of in-class opportunities performed significantly better on graded assignments than other students. The number of times that a student attended the FTF sessions appears to have an impact upon performance. Results have implications for education following the pandemic.

Collaborative Undergraduate Business Experiences (CUBE)

Oral

Dr. Stephanie Jacobsen [1], **Dr. Xiangrong Liu** [1], **Dr. Yihong Xiao** [1], **Mr. John Paganelli** [1]

1. *Bridgewater State University*

Funded by a BSU innovation grant, the Collaborative Undergraduate Business Experiences (CUBE) initiative focuses on establishing embedded course projects to enhance students' career development through curriculum. Course projects are developed that provide strategic solutions to local businesses, while also providing real-world hands-on work experience to students. This presentation will discuss the development of CUBE and its first implementation in Marketing Research (MGMT 420) in the Fall 2020. Through the CUBE, we intend to continue to utilize this high impact practice, both online and in person in order to engage students and connect them with the local community.

Creative Destruction in Education? Curriculum Redevelopment in a Marketing Department

Oral

Dr. Elizabeth Elam [1]

**1.** Western New England University

Curriculum revision is one of those necessary, if unpleasant, tasks for faculty in higher education. Educators address the task in different ways, often making only marginal changes in what becomes an increasingly outdated and bloated program, resulting in frustrating educational experiences for students and faculty alike. Rather than begin a cycle of curriculum revision "the way it's always been done," five faculty in the Marketing Department of a small private university embraced the advice of Stephen Covey, "begin with the end in mind" and of Joseph Schumpeter, "the gale of creative destruction." The results have been both surprising and successful.

Designing a Lab Using the Open-Source iDempiere ERP Systems to Demonstrate the Integration of Business Functions for Value Creation

Oral

Dr. Zhengzhong Shi [1]

1. *University of M*

This paper is to describe a course innovation regarding the use of an open-source ERP system to integrate accounting, warehousing, and purchasing functions in the fundamentals of information systems class in a business school. First, relevant business activities and associated accounts are discussed. Second, how business activities and accounting are integrated is presented. Third, the detailed lab design and implementation are discussed. This lab may help faculty to effectively teach 1) the concept of the ERP system, 2) the integration of business functions using the ERP system, 3) the fit between business processes and ERP system functions.

Does Practical Experience Enhance Active Learning? An Empirical And Longitude Case Study Through A Joint University-Organization Event

Oral

Dr. Shirley Law [1]

1. *Hong Kong Shue Yan University*

This paper will introduce a new teaching method and a longitudinal case study spanning two years to determine the effectiveness of the method through a university's departmental event. It aims to let students explore the market potential and the application of the latest business issues locally and globally.

A case study approach was applied. Tertiary education students were selected and are required to go through the management process, including planning, organizing, staffing, leading and controlling of the whole program.

This study is an eastern-based study. It contributes as a foundation study by providing new insights to inform other cross-cultural studies.

EXPLORING THE RELATIONSHIP BETWEEN STUDENT ENGAGEMENT AND PERFORMANCE

Oral

Dr. John Weber [1] *, Dr. Bhupinder Sran* [2]

1. *DeVry University,* **2.** *DeVr*

Student engagement and performance are often related. Engagement includes attendance, participation in class discussion, and on-time submission of work. For classes that have online components, it could include participation in online discussions and time spent interacting with course materials.

Courses taught using online platforms gather large quantities of data about a student's engagement. It is possible to identify how much time the student spent in a course, and on which activities.This presentation will explore which engagement behaviors are most closely related to performance. The study will examine data from online and hybrid courses taught at a university with multiple locations.

Increasing Student Engagement using Virtual Reality in Marketing Classes

Oral

Dr. Ronda Mariani [1], **Dr. Monica Favia** [1], **. Thomas Tanner** [1]

1. *Bloomsburg University of Pennsylvania*

As universities continue searching ways to enhance student learning, technology has impacted the methods of delivering content to students. This study focuses on the use of virtual reality (VR) in university classrooms to increase participation and enhance student engagement. While the academic use of VR has been primarily used in engineering and medicine, this research focuses on the use of VR in the marketing classroom. The purpose of this study is to examine the impact of using VR in both asynchronous and synchronous online classes to measure the level of student engagement over the course of the semester.

Increasing the Perceptions by Engineering and Information Systems Students as to the Potential of Students with Disabilities through a Disability Fim Festival Forum

Oral

Dr. James Lawler [1] **, Dr. Anthony Joseph** [2]

1. Pace University Seidenberg School of Computer Science and Information Systems, **2.** Pace

The authors re-assess an annual extra-curricular film festival forum that is expanding the perceptions by engineering and information systems students as to the potential of higher-functioning people with developmental and intellectual disabilities (IDD).

Inventors Collaborate with Higher Education through 3D Printing Project

Oral

Dr. Carolyn Lammachia [1]

1. Bloomsburg University of Pennsylvania

Higher education institutions are challenged with developing a wide variety of skills that indicate career-ready graduates. Education research supports experiential teaching techniques, like those found in 3D printing design and fabrication laboratories, lead to successful learning that targets multiple skills including creativity, innovation, social responsibility, project management, teamwork, and interdisciplinary business acumen. Industry connections, often through alumni networking, is a prolific source of experiential learning opportunities. This presentation reports the collaboration of industry inventors partnering with an academic 3D printing laboratory to demonstrate the power of 3D printing to bring ideas to life.

Lessons Learned: Designing Business Analytics Courses and Programs

Oral

Dr. Peter Tarasewich [1] **_, Dr. Yang Lee_** [1]

_1._ _Northeastern University_

Reviews our experiences in creating graduate and undergraduate courses and programs in business analytics, and offers suggestions based on what worked well (and not so well).

MANAGING IN THE FUTURE: A STUDENT PROJECT

Oral

Dr. Kellyann Kowalski [1] , *Dr. Jennifer Swanson* [2]

1. *University of Massachusetts Dartmouth,* **2.** *Stonehill College*

We will present a student project that we use in our management classes. It is a two-part assignment that requires students to analyze and critically think about how management needs to change in order to adapt to the virtual workplace of today and the future. Part I is an individual assignment where students are required to research how and why the workplace has become more virtual and write a paper based on their findings. Part II is a group assignment in which students work in teams to develop and present new management theories that are applicable to the virtual workplace.

Mapping One University's Path to Sustainability in Higher Education: Aligning AACSB Accreditation with UN PRME Sustainability Development Goals

Oral

Dr. Mary Meixell [1] *, Dr. Margaret Goralski* [1]

1. Quinnipiac University

The U.N. Principles of Responsible Management Education (UN PRME) provides a global network to advance academic and social responsibility. Academics form relationships with colleagues from business schools worldwide to create this network incorporating these universal values. The U.N. Sustainability Development Goals (UN SDGs) provide a structure for action for people, planet and prosperity. Business schools with AACSB accreditation are challenged to demonstrate positive impact for the betterment of society. This paper explores how a business school can deploy its PRME membership to develop an AACSB impact framework to support faculty and students in "doing good" in the world of business.

Online Higher Education Module Under Emergent Situations And In Remote Areas

Oral

Dr. Seung Hoon Jang [1]

1. *Bloomsburg University of Pennsylvania*

This study aims to examine the role of asynchronous online module on the higher-education courses under emergent situations like the pandemic and in remote areas like different celestial bodies. For this purpose, the author reviews the related articles and discusses proper pedagogical techniques and practices. Students, faculty members, and practitioners are expected to gain implications on how to manage flexible online education modules for those dealing with unexpected changes and issues. It is also expected that higher-education can be provided to future expatriates in other planets or satellites like Mars or Titan via asynchronous methods.

Online learning during the COVID-19 Pandemic. What we know and what is next?

Oral

Dr. Chin-Yen Alice Liu [1]

1. *Texas A&M University - San Antonio*

The COVID-19 pandemic has elicited a variety of stresses around the world. The whole school system has been forced to switch to a virtual learning environment regardless the readiness of teaching, learning, and technology support. The lack of preparedness has interrupted students' learning opportunities. What is the ultimate impact to our next generation and what to do next in order to make this transition seamlessly? This paper applied systems thinking to demonstrate an online learning experience and a contingency planning to prepare and respond to this crisis since conflict mitigation will be the most important task for the current era.

Peer Assessment of IS Case Study Presentations by Students: A Comparison of American and Chinese Students

Oral

Dr. Sung Shim [1]

1. Seton Hall University

Information systems (IS) courses often require students to study IS cases and present their findings to the class as an important part of the coursework. However, it is difficult to assess IS case study presentations by students. As an effort to complement the instructor's assessment, we attempted to have American and Chinese students assess the in-class presentation of IS case studies by peer students. The results of this study will make a contribution to extending the line of empirical research on the use of student peer assessment in IS courses in a comparative perspective of American and Chinese students.

Supply Chain Employee Skills and Competencies for Industry 4.0

Oral

Dr. Pedro Reyes [1] , ***Dr. Michael Gravier*** [2] , ***Dr. Christopher Roethlein*** [2] , ***Dr. John K. Visich*** [2]

1. *Baylor University,* **2.** *Bryant University*

Industry 4.0 is changing the landscape of how manufacturing firms and global supply chains are being managed and how they compete. To better prepare supply chain students for the transition to Industry 4.0, we surveyed supply chain professionals on their views on the importance of current and emerging skills and competencies that supply chain employees should have. Based on an extensive review of the supply chain education literature we focused on the following clusters of skills and competencies: Maintain Competitiveness; Seize Opportunities and Mitigate Threats; Sense and Shape Opportunities and Threats; Technology; Sustainability; Technical Skills; and Soft Managerial Skills.

Teaching Online in the Business Disciplines: Faculty Tips for Success

Oral

Prof. Eda Sanchez-Persampieri [1] , *Dr. Marie Segares* [2] , *Dr. Esther Klein* [2] , *Prof. Danielle DiMeglio* [2]

1. *St. Francis,* **2.** *St. Francis College*

Faculty at higher education institutions find that online instruction is no longer optional. In midst of the spring 2020 COVID-19 pandemic all face-to-face classes were forced online. The abrupt switch from face-to-face to online learning required instructors to adjust their pedagogical approaches. Faculty need to deliver high-quality instruction in various disciplines through online synchronous and/or asynchronous modes. Using the multi case method, we share our experiences within the online environment of classes that moved unexpectedly mid-semester from face-to-face to online modality due to COVID-19.These case studies offer examples from which faculty may draw upon to improve their teaching practice.

TEAMS AS A LEARNING MANAGEMENT SYSTEM IN ONLINE INSTRUCTION

Oral

Prof. Nanda Ganesan [1]

1. Cali

Traditional LMSs, such as Canvas, now play a significant role in online instruction. They excel in managing courses in many ways but fall short of providing a persistent communication platform for students and instructors. With its unique template for classrooms and proven deployment in the industry, Microsoft Teams came across as a possible LMS that my overcome this drawback. It was implemented successfully to teach three different courses at a business school. This presentation discusses the LMS and communication features supported in Teams, the advantages and shortcomings of its use as an LMS, and the students' perception of Teams.

The Concerns of E-Learning on Corporate Training Programs

Oral

Dr. Edward Chen [1]

1. *University of Massachusetts Lowell*

The purpose of this paper is to explore the effects of e-learning on corporate training programs. The research was conducted on published articles focused on e-learning and its applications in corporate training programs for organizations. E-learning influences what technology is chosen to deliver effective training programs. The security and privacy implications differ between e-learning and traditional training. A company must think about success factors in implementing e-learning into a training program. From the design, development, and implementation of applying e-learning in corporate training programs, this paper analyzes the strengths, weaknesses, limitations, and implications for the future of e-learning.

The Healthcare Hackathon: An Undergraduate Experiential Immersion In Entrepreneurship & Healthcare

Oral

**Dr. Michele Montecalvo** [1] _, **Prof. Eda Sanchez-Persampieri**_ [2] _, **Dr. Marie Segares**_ [2]

**1.** Rutgers University, **2.** St. Francis College

There is a deficit of comprehensive, evidence-based health and entrepreneurship undergraduate interdisciplinary curricula to empower students to resolve or "hack" complex health issues and create radical new solution-driven products. This article explores the Healthcare Hackathon, a curricular, co-curricular, and extra-curricular learning innovation designed to develop entrepreneurial thinking and mindset in healthcare management undergraduate students.

The concept, evolving from IT hackathon theory and based in Bloom's Taxonomy teaching pedagogy, has been demonstrated for five consecutive semesters with over 120 student-created companies and healthcare products. Students report increased self-understanding, deeper respect for experiential learning, and higher articulation of objectives and business deliverables.

The Impact of COVID-19 on the Working Environment of Professional Employees: Implications for Educators

Oral

Prof. David Weidman [1], Ms. Yuanfei Zang [1], Prof. John Maleyeff [1], Prof. Canan Corlu [1], Ms. Yiwei Song [1]

1. *Boston University*

The impacts that COVID-19 has had on the working environments of professional employees were evaluated to determine what educators can learn to prepare students for the workplace of the future. We used a survey administered to 156 respondents during the first six months of the pandemic. Participants represented a range of jobs and years of experience. Results were analyzed using qualitative and text mining approaches, including affinity, word frequency analysis, and sentiment analysis. Interestingly, positive impacts were identified more often than negative impacts. Educators should prepare students for the competitive job market by simulating the remote workplace in their courses.

Thoughts about the Cloud Computing in Business Master's Program

Oral

Dr. Zhengzhong Shi [1]

1. _University of M_

This paper is to develop a curriculum for a master's program in cloud computing from the perspective of a business school. It intends to stimulate discussions about how a cloud computing master's program may be developed in a business school with more emphasis given to business and management.

Human-Technology Interface

Enhancing Virtual Communication via Emotion Recognition Technologies

Oral

Dr. Serap Zel [1] *, Dr. Elif Kongar* [1]

1. *University of Bridgeport*

Virtual social and work-related interactions became a more viable option compared to face-to-face meetings. The efficiency of virtual interactions also increased significantly due to the advancements in video conferencing technologies. However, they still have gaps to provide a similar personal connection as in-person meetings while constantly upgrading algorithms to capture emotions. Difficulties in processing non-verbal cues and decreased comfort level due to being in front of a camera are some of many concerns that hinder virtual communication. This study explores the factors that affect users' emotions and the ways they express themselves virtually.

Keywords: Virtual communication, Emotion recognition, Facial expressions

Exploring the use of Chatbots for the Education and Self-care Management of Patients with Alcoholic Liver Disease

Oral

Mrs. Taya Mounkam [1] *, Dr. Pamella Howell* [1]

1. California State University Los Angeles

Alcoholic liver disease (ALD) is caused by excessive alcohol consumption over an extended period. Education can help patients with ALD. To assistant patients with education and self-care for the disease, we developed a low code chatbot using Microsoft PowerApps. The chatbot, was created to provide information on the ALD condition, treatment, and available resources. The chatbot serves as a supplement to in-person care and is not intended to replace any treatment methods. Our results indicate that the bot can address existing inequitable access to information and lessen communication difficulties between provider and patient.

Online consumer purchase decisions in the age of automation and artificial intelligence

Poster

Mr. Jas Gaurav Singh [1] *, Dr. Elif Kongar* [1]

1. *University of Bridgeport*

Purchase decisions are complex and require numerous factors to be taken into account prior to the final decision. Both consumers and companies can benefit from a better understanding of the decision dynamics as it will create a better buying experience for consumers while reducing expenses and increasing conversion performance for companies. This research highlights the most important factors that influence purchase decisions and investigates the impact of automation and artificial intelligence on the decisions. The findings can assist companies in developing the appropriate level of automation and artificial intelligence.

Reduction of Social Isolation Using ICT

Oral

Mr. Heath Harllee [1]

1. *University of North Texas*

The aging population in the United States is reaching record highs annually. By the year 2030 more than 1 out of every 6 persons in the United States will be over 55. This proposed study will look at how technology such as tablets, smartphones, and computers that foster internet access, can reduce social isolation and increase physical activity while at the same time decreasing multiple morbidities. Simple consumer technology can reduce social isolation and increase overall activity and well-being.

Robotic Anthropomorphism, Human Personality Traits, and Robot Likeability in Human-Robot Interaction

Oral

Dr. Anshu Arora [1] **_, Ms. Mayumi Fleming_** [1] **_, Dr. Amit Arora_** [1] **_, Dr. Vasyl Taras_** [2]

_1._ _University of the District of Columbia,_ **_2._** _University of North Carolina, Greensboro_

This research investigates the influence of human-like attributes in robots (robotic anthropomorphism) on the likeability of robots. The study investigates the relationship between the Big Five personality traits and robot likeability and successful HRI implementation in varying human-robot Interaction (HRI) situations. This research fill the gap by providing an in-depth understanding of the Big Five human personality traits, robotic anthropomorphism, and robot likeability in social-collaborative robotics.

Tackling Alzheimer's Disease with Low Code Technology

Poster

Mr. Navaneeth Visagan [1], *Mr. Andrew Lai* [1], *Dr. Pamella Howell* [1]

1. *California State University Los Angeles*

In 2017, Alzheimer's disease killed 2.4 million people and was ranked among the top five causes of death worldwide, negatively impacting patients socially and economically. This study aims to contribute to the Alzheimer's community through the design of our low code Mendix mobile application prototype designed to help providers and patients with the early detection of Alzheimer's disease. The low code mobile health app focuses on early detection by administrating the Mini-Mental State Examination (MMSE). Our design shows that MMSE can be administered to patients more frequently with a simple low code technology which can help with identify cognitive impairment.

The Role of Robotic Process Automation on Business Transformation

Oral

Ms. Elizabeth Famodimu [1] , *Dr. Elif Kongar* [1]

1. *University of Bridgeport*

The application of robotic process automation (RPA) is increasing at a vast rate and driving business' digitalization efforts. This paper will examine the impact of RPA, risks and benefits, challenges, and provide suggestions for overcoming the challenges. An analysis of RPA vendors in the market and offering will be provided. A real-life case study is provided detailing deployment of RPA solution at a Bank. The study will include the company's RPA roadmap from conceptualization to rollout including RPA vendor selection, use cases and prioritization, implementation, and, governance. The advantages of implementation, challenges encountered, and use will also be analyzed.

Innovation and Creativity

Development and Testing of a Creative Strengths Instrument

Oral

__Dr. Eric W. Stein__ [1], *Dr. Denise Potosky* [1]

__1.__ Pennsylvania State University

Successful business organizations must innovate to remain competitive and innovation requires creative people. Identifying those people is a non-trivial problem.

The purpose of this work was to develop, refine, and test an instrument to measure creative strengths in four key areas: improvisation, design thinking, experimentation, and aesthetics.

The presentation will describe conceptualization of the measure, the measurement model, how the instrument was developed, how scales were refined and purified using factor analysis, validation procedures and normative values for scales.

We will briefly discuss applications of the instrument and how instructors may use the online instrument for teaching or research.

Entrepreneurial Opportunity Alertness and the Entrepreneurial Mindset

Oral

Dr. Marie Segares [1]

1. St. Francis College

Organizational researchers and entrepreneurship educators have long been intrigued by opportunity alertness, the recognition and unearthing of unexpected business opportunities by entrepreneurs. As initially conceived by economist Israel Kirzner, opportunity alertness contextualized the entrepreneur's role in a market system rather than providing insights into how entrepreneurs identified the links between disparate market signals, information, and new opportunities. This paper presents an overview of models and theories that explain and explore entrepreneurial opportunity alertness, with discussion of opportunity alertness as an underpinning of the entrepreneurial mindset.

Legal, Ethical, and Social Issues

A Study of the Relationship between Employment Attributes, Ethics and the Dampening Effect of Pressure

Oral

Dr. Pamela Harper [1] , **Dr. Pablo Rivas** [2], **Dr. John Cary** [1], **Dr. William Brown** [1]

1. *Marist College,* **2.** *Baylor*

This study attempts to fill an important gap in the behavioral ethics literature by examining the relationship between employment-related variables (employment level, tenure, company size) and ethicality. Specifically, we study the impact of pressurized environments on employees in organizations, to understand the extent to which they are conducive or debilitating to ethical conduct. A sample of 370 business employees of varying tenure and employment levels at companies of various sizes were surveyed. As hypothesized, we find support for a non-linear ("U-shaped") relationship between employment factors and ethicality and a dampening effect of pressure across these key relationships.

An alternative approach for Diversity Training based on visualization analysis of social media data

Oral

Dr. Shanggeun Rhee [1] , **Ms. Nesreen El-Rayes** [1]

1. *Kean University*

Diversity and Inclusion is one of the challenges facing organizations. Diversity training shall be fostering diversity, but it turns out to be non-effective in many cases. This study is based on retrieving more than 40,000 interactions in the year 2020 from three hashtags related to diversity on Twitter. The analysis was done to deduce the structure, network density, and sentiment of the crowd about diversity. An alternative approach for diversity training is suggested based on the results. Three of the top nodes followed are BOTS, and the top clusters are related to Black Lives, Women Leadership,and the Future of Work.

Critical Success Factor Model for Prison Entrepreneurship Program

Oral

Dr. Kihwan Kim [1] , **_Dr. Bok Gyo Jeong_** [1] , **_Dr. Patrick McManimon_** [1] , **_Mr. Leonard Grayson_** [2] , **_Dr. Deborah Spigner_** [3]

_1._ _Kean University,_ **_2._** _The City of Elizabeth Reentry Program,_ **_3._** _Dynamic Management Services Business Partners_

Recidivism is a big social problem in U.S. Government and nonprofit organizations have struggled in fighting this problem. Recently, the Prison Entrepreneurship Program (PEP) shed a silver lining on the effort to reduce the incarceration rate. However, despite the numerous successful cases of PEP, few efforts have been made to develop the theoretical framework of PEP. By analyzing 14 successful PEPs, the current study attempts to suggest a critical success factor model that embraces personal, organizational, and environmental levels. Based on the proposed model, the study discusses the practical implications of the model and future research issues.

Do They Really Care Less about Ethics? Exploring Consumer's Ethical Perceptions in a Developing Economic Entity

Oral

Dr. wenyeh huang [1]

1. National Taipei University

It is dangerous to assume that people in a corrupted environment tend to accept unethical conducts. This study explores whether consumers in an economically less developed, more corrupted environment have higher tolerance towards unethical retail practices than a more developed, less corrupted environment. A survey research questionnaire consisted of sixty-nine unethical practices from consumers or retailers was constructed and distributed to collect data from 608 Vietnamese and 516 Taiwanese sample. Results of data analyses generally indicate that Vietnamese respondents seem to be less tolerable towards ethically questionable retail practices than Taiwanese respondents.

Factors Attributing to the Making of Fortune 500 CEOs: Institutional Patterns of Prejudice

Oral

Dr. Maling Ebrahimpour [1] *, Ms. Bridget Cullinane* [1]

1. *The University of Rhode Island*

According to the U.S Census Bureau, 31.9% of the American people identify as a racial minority, while just over 5% of Fortune 500 executives identify as other than "white." Although the current list of Fortune 500 CEO indicates that it is still dominated by white males (about 87%), it is important to mention that this is a drastic improvement form 1991 where there were not one female or person of color in the list. Although there is a slow shift in the composition of CEOs, the education requirements for aspiring CEOs have increased by 67.0% in the last 40 years.

Give a Little Bit: Consumers Ask More of Women Entrepreneurs

Oral

Dr. Erin Percival Carter [1] *,* ***Dr. Jenni Dinger*** [2]

1. *University of Maine,* ***2.*** *Indiana University*

We examine consumer tendencies to request upgrades, samples, discounts, or other benefits that impose costs ("costly concessions") and find these requests disproportionately affect women entrepreneurs.

Pandemic Management with Mobile Applications: Designing an Experiment in Ethical AI

Oral

Dr. Tamara Schwartz [1], **Ms. Jena Jordahl** [2], **Ms. Christine Don** [2], **Mr. Gene Dragotta** [3]

1. *York College of Pennsylvania,* **2.** *Infinite IQ,* **3.** *Seacoast Solutions*

The Covid-19 Pandemic has overwhelmed hospitals globally, with nations quarantining to slow contagion but devastating economies. As communities seek to operate, contact tracking applications using GPS functionality have emerged throughout the world, raising significant ethical concerns. We discuss development of an experimental Covid-19 virus tracing capability to examine trade-offs between economics and public health in the community of Gettysburg, Pennsylvania. We used a consequential analysis to examine concepts of beneficence, justice, and respect for autonomy, as we considered data collection & analysis, informed consent, privacy, security, and outcomes. The design process led to developing a deontological framework for ethical AI.

The effect of changing job patterns in response to Covid-19 on Chinese female employees' work-family conflict and gender inequality

Oral

Dr. Shirley Law [1]

1. *Assistant Professor*

Working people may be required to work from home (WFH) because of COVID-19. WHF work pattern blurs the boundaries between work and private spheres and even leads to employees, especially female employees, having greater difficulties in "unplugging" from work demands. Gender-role ideology held belief that women need specifically to take care of the family issues that portrays them as less committed to their work than men. This research contributes on exploring the effect of changing job patterns in response to COVID-19 on how Chinese female employees' work-family conflict and to identify the barriers to women's career advancement.

The Roles of Technology, Transparency and Trust in Crises: Implications for COVID-19 Research

Oral

Dr. Laura Lally [1]

1. *Hofstra University*

Abstract: With the number and severity of crises increasing in number and propagating on a global level, a comprehensive framework for research in the key areas of crises is needed. This paper presents Crisis Compliance, a theoretically based framework for evaluating the role and appropriate use of technology across seven key characteristics of crises, and directions for research in each of these areas. This paper then extends the Crisis Compliance framework to address the issues of Transparency and Trust from the organizational literature and develops research directions for them. Examples of recent crises, including COVID-19, illustrate the analysis

Users' Reactions When Viewing the Prosocial Behavior on Social Network Sites

Oral

Ms. Li Liu [1] **_, Mr. Jiayuan Zhang_** [1] **_, Prof. Koray Ozpolat_** [1] **_, Prof. Gulver Karamemis_** [2]

_1._ _University of Rhode Island,_ **_2._** _Georgia Southern University_

This research investigates users' reactions to the prosocial behaviors posted on social network sites (SNSs). We first conduct interviews and find that people behave subsequent prosocial behaviors after they are exposed to prosocial behaviors. We then apply a laboratory experiment to test and validate the findings from the interviews.

Keywords: Prosocial behavior, Social network sites, interview, laboratory experiment

Operations Management/Operations Research

A Simulation Study of Kanban Production System for a Single Line Production System under Various Setup Times with Work in Process (WIP) Units as Performance Metric

Oral

Dr. Terrence Moran [1], **_Dr. Christopher Luchs_** [1], **_Dr. Pat Rondeau_** [1]

_1._ _Ball State University_

There are advantages to both Economic Production Quantity (EPQ) model and the Kanban model. (Nicholas, 1998). The objective of this study is to fill a research gap by evaluating Kanban for a single line, multi-product item production system under various setup times. The objective will be accomplished by utilizing simulation to evaluate the Kanban production systems. The primary variable is setup time. The performance measure is average WIP inventory units. This research will help practitioners determine the conditions under which the EPQ system is appropriate for them so that their companies could better compete in the competitive global marketplace.

Evaluating and Comparing the Outputs of Comparable Units

Oral

Dr. Ronald Klimberg [1] **, Dr. Samuel Ratick** [2]

1. *Saint Joseph's University,* **2.** *Clark University*

In order to improve the performance of comparable units of an operation producing a variety of results, decision-makers in public and private organizations often apply a number of different multi-criteria benchmarking techniques when comparing and evaluating performance. In this paper we apply the Data Envelopment Analysis (DEA), the Ordered Weighted Average (OWA), and the newly developed Order Rated Effectiveness (ORE) model, (Klimberg and Ratick 2018, 2020a, 2020b), to the Technology Achievement Index (TAI) data, a Weighted Linear Combination (WLC) composite measure. We then compare and evaluate the original TIA results to those obtained using the DEA, OWA and ORE methods.

Group Decision Making Problem – Under Hesitant Fuzzy Linguistic Terms Multiple Criteria and Dynamic Environment

Oral

Dr. Mahima Gupta [1]

1. *Indian Institute of Management Amritsar*

In group decision-making (GDM) problems, the members' varying opinions are suitably aggregated to obtain the group's representative opinion. In group settings, the consensus is evolved if a sub-group is able to influence or move the majority of the group through their interaction and reputation in the group. In this paper, we present an algorithm that maps the consensus evolution process of GDM based on interrelationships of members in the group. The members' views are taken in hesitant linguistic fuzzy term sets to incorporate qualitative aspects and vagueness/ confidence in their expressions.

Guest Recovery Costs in Hotels

Oral

Mr. Jonathan Brown [1] *, Dr. Thomas Schrier* [1]

1. Iowa State University

As major economic drivers, hotels should determine methods to reduce costs so that a decrease to its financial bottom line during lean economic times, is minimized. An important variable to reducing these costs is minimizing the amount spent on service recovery. For this study, the internal operational factors of employee empowerment, employee training, and employee turnover are examined in relation to the costs of service recovery. These factors help mitigate the potential for service failures and thus limit the negative financial impact on the hotel by empowering well trained and tenured employees to have the ability to correct a service.

Modeling the Effect of Big Data Analytics and Lean Capability on Firm Performance

Oral

Dr. Steve Zhou [1], *Dr. Xinxin Hu* [1]

1. University of Houston - Downtown

This research investigates the relationship between big data analytics, lean capability, and firm performance. We propose a conceptual model to examine the links among these constructs. Structural Equation Modeling (SEM) has been selected and utilized to estimate expected structural relationships. Based on this model, research hypotheses have been developed. Our preliminary results show that lean capability has a substantial effect on firm performance and that a higher level of big data analytics practice leads to higher lean capability. This implies that firms should emphasize the development of their lean capability and seek more engagement in big data analytics.

Optimal Inventory Policy for Systems with Bundled Supplies

Oral

Dr. MOHAMMAD EBRAHIM ARBABIAN [1]

1. _University of Portland_

In recent years, demand for different cloud services has faced a surge. This has resulted in a crucial question for cloud companies–how to optimally expand their capacity? The distinctive feature of could industry is that one unit of supply increases the capacity of different attributes (i.e., RAM, CPU, storage, network) simultaneously. To find the optimal expansion policy, we consider a cost minimization problem in a continuous review, finite time horizon setting. We, further, find the best server configurations to be deployed each cycle.

Palm to Palm: Another Outbreak

Oral

Mr. David Somoyah [1], Mr. Alejandro Lucena Mir [2], Mr. Neil Desnoyers [3]

1. *Palm to Palm,* **2.** *Africa Digna Foundation,* **3.** *Saint Joseph's University*

2020 was an unremarkable year for Palm to Palm (P2P), a sustainable operations project in rural Sierra Leone that processes the fruit of the oil palm tree into palm oil and soap and sells the products locally. The COVID-19 pandemic dominated global news in 2020, but the pandemic's impact on P2P has, to date, been small. To aid in local COVID-19 efforts, the project produced and distributed at no charge 10,000 bars of soap. Another notable 2020 achievement is the receipt of a small grant-in-kind to expand our production facility.

Resource Renting Problem with Discounted Cash Flows: A Genetic Algorithm Solution

Oral

Mr. Amir Asrzad [1] **_, Dr. Sina Shokoohyar_** [2]

1. *Sharif University of Technology,* **2.** *Saint Joseph's University*

In the problem of project scheduling, activities require resources to be implemented. The resource renting problem, assumes that the resources needed for the project are rented, thus making rental costs time-dependent. A standard resources renting problem tries to minimize the cost of having resources, where the objective function only includes costs and does not include time preferences. In the problem defined in this article, which is called the problem of resource renting with discounted cash flow, we consider the objective function to be the maximization of the net present value of money.

Summary Of Relative Quality Measures

Oral

Prof. Donald Holmes [1] , Dr. Erhan Mergen [2]

1. Stochos,Inc., 2. Rochester Institute of Technology

Abstract

The objective of this paper is to discuss some relative quality measures for process capability. We examine and interpret these measures for both bilateral and unilateral cases. A discussion on the process capability measures for non-Normal process distributions is also provided along with examples of some studies done in this area. In addition, use of the capability measures in a dynamic fashion is briefly discussed in the conclusion section. This is an extension of our prior work, in which we discussed some issues regarding different types of specifications provided by the customer.

Systematic literature review of ISO14000 certification and its impact on financial performance

Oral

Dr. Beate Klingenberg [1] ***, Prof. Tom Geurts*** [2]

1. *Independent researcher,* ***2.*** *Bucknell University*

The impact of operational excellence frameworks on financial performance is a well-recognized topic in operations management research. The methodological approaches vary as well as the results that appear to disagree on whether the impact is positive or negative.

To understand this discrepancy better, a systematic literature review is executed, focusing on ISO14000 certification. The objective is to gain an overview of the methodologies applied and to compare the respective findings in order to elucidate whether the methodological approach influences the said findings.

Marketing and Consumer Behavior

A DEA-Based DSS for Food Shoppers

Oral

Dr. THOMAS SEXTON [1] **_, Dr. Christine Pitocco_** [1] **_, Ms. Paula Messias_** [1]

1. _Stony Brook University_

We use Data Envelopment Analysis to build a multicriteria decision support system for food shoppers. The model measures the performance of each food item along each criterion (nutrient) relative to other food items in the same food group, identifies food items that lie on the frontier, and measures the distance that each food item lies from the frontier with respect to each criterion. These factor performances are critical for those who shop for people with nutritional constraints (sugar, salt, calories, etc.). The model uses data from the U.S. Department of Agriculture and can be made available in a smartphone app.

Choosing an Inferior Alternative: The Case of Disappearing "Inherited Options"

Oral

Dr. Rusty Stough [1]

1. *University of Maine*

How would you react when something promised to you later becomes unavailable? This arises in product stock-outs where consumers are unable to acquire their desired option (Fitzsimons, 2000). Through a series of four studies, we tested whether participants desire to acquire an inferior alternative after a loss to mitigate the loss. Importantly, our mechanism is different from loss aversion – because we are concerned with how people deal with actual losses and how they correct them, in contrast to people's tendency for avoiding losses, which does not directly imply what steps people may take to mollify their losses.

Data Analytics Applied to Business Advertising

Oral

Dr. Joseph Catanio [1] **_, Mr. Nathan Neil_** [2]

_1._ _Shippensburg University,_ **_2._** _LaunchUX_

What generates the most traffic of new users to a business's website? In this study, we apply data analytics to quantitatively measure internet user behavior and how consumers find a business for the first time. The goal of this study is to answer the question, "Where is the most effective place online to invest a business' marketing budget?" There are multiple channels of online advertising to consider with internet marketing. These channels are organic search, referral, social media, paid search, and email. Using data from a thirty-six-month data collection period this research measures the amount of traffic per channel.

DAY-OF-THE-WEEK AND MONTH EFFECT ON CUSTOMER COMPLAINTS BEHAVIOR: EVIDENCE FROM FINANCIAL SERVICES SECTOR

Oral

Prof. Rajesh Sinha [1]

1. Indian Institute of Management, Indore

Investigation about the timing of consumer registering a complaint is an ignored aspect in the marketing literature. This study is based on the U.S. data of customers daily aggregate number of registered complaints for eighteen categories of retail financial products and services involving a period beginning from January 13, 2012 through December 7, 2018. The analysis found that customers are less likely to register a compliant during weekends and that months around December. Also, it was observed that the number of complaints received was highest on Tuesday, Wednesday, and Thursday.

Keywords: Consumer complaints, day-of-the-week effect, financial services

Economics Of Privacy: Acquiring Customers Willing To Share Private Information

Oral

Prof. Rajesh Sinha [1]

1. *Indian Institute of Management, Indore*

Due to widespread sentiment toward privacy protection and privacy protection laws, it is not easy to obtain and use customer private information. Customer information are important for efficient marketing; therefore, in this new situation privacy should be purchased by marketer from willing customers, through mutually gainful exchanges. To address the problem, this research presents a theoretical model to suggest optimal number of willing customers to be acquired for information sharing by offering an optimizing benefit level. The model assumes that customers will opt-in for sharing private information, if adequate benefits are realized.

Keywords: Customer privacy, opt-in marketing

Service Capacity and Price Promotion Wars

Oral

Dr. Junhyun Bae [1]

1. SUNY Brockport

We first consider a base model in which customers' purchase decisions are affected ex-ante by the anticipation of a poor service experience. Our equilibrium analysis shows that firms would be less aggressive in engaging in price-cutting when customers care more about service quality and when firms have limited service capacity. We extend the base model to a two-period model in which customers may switch to a different firm ex-post after a poor service encounter.

Systematic Review and Meta-Analysis of the Relationship between Attitudes toward Socially Responsible Corporations and Purchasing Intentions

Oral

Dr. Meungguk Park [1] **_, Dr. Kihwan Kim_** [2]

_1._ _Southern Illinois University at Carbondale,_ **_2._** _Kean University_

This study was designed to conduct a meta-analysis of the association between consumers' attitudes toward corporate social responsibility (CSRA) and their purchase intentions (PI). A systematic search yielded 28 studies that met the criteria for a meta-analysis (total participants=12,242). The main result showed that the average weighted correlation (r_+) was .478, indicating that CSRA had a strong positive relationship with PI. Moderation analyses indicated no significant differences across continents, however, the difference for types of products was marginally significant. The high levels of heterogeneity (Q=535.199, I²=94.955) and a possible absence of publication bias were evident in the meta-analysis.

The impact of verbal prompts from store employees on sales

Oral

Dr. Siddharth Bhatt [1] , **_Dr. Dinesh Pai_** [2]

1. *Pennsylvania State University Harrisburg,* *2.* *The Pennsylvania State University at Harrisburg*

Verbal prompts by store employees are common in retail and their effectiveness has been investigated in past research. However, extant literature does not consider the impact of verbal prompts in the presence of other in-store promotions. This research is the first to examine the impact of verbal prompts on sales in the presence of a variety of in-store promotions. To do so, we use sales data for six products from a large retail chain. We find that verbal prompts increase sales for these products. We also demonstrate that there are other in-store promotions that have a positive effect on sales.

The influence of virtual reality on brand personality: The case of luxury brands

Oral

Dr. Eklou Amendah [1]

1. *University of Southern Maine*

The overall objective of this study is to examine the influence of virtual reality on consumer perception of luxury brand personality when buying luxury products. It explores the extent to which virtual reality immersion influences consumer's attitude in terms of favorability, originality and clarity of the luxury brand.

The specific purpose is first, to test the relationship between immersion and brand personality characteristics including sincerity, excitement, competence, sophistication and ruggedness. Second, test the relationship between brand personality characteristics and consumer attitude toward luxury brand in terms of originality, favorability and clarity. Third, test the relationship between attitude and buyers' intention.

The Role of Perceived Justice and Trust in Service Failure Recovery

Oral

Dr. Jing Yang [1], *Dr. Tao Wu* [1]

1. *SUNY Oneonta*

This study mainly focuses on negative reviews especially its relationships with perspective consumers' perceptions over products under discussion. Our discussion is rooted in the perception of justice and trust. We attempt to develop a linkage between the most-frequently discussed cues embedded in negative reviews and explore how practitioners can utilize these cues to improve their online complaint management.

Strategy and Organizational Behavior

Game Theory and Decision Making in Professional Football

Oral

Dr. Andrew Perry [1]

1. *Springfield College*

Football coaches in the National Football League have been widely criticized for decision making that is too conservative according to football analytics researchers. For example, according to the theory, coaches don't attempt fourth down conversions nearly as often as the numerical models would suggest. We consider the evidence behind these allegations of poor decision making as well as the reasons that coaches might stick with traditional coaching models that may be ineffective.

Meta-Analysis on the Antecedents of Social Entrepreneurial Intention in Developing Countries

Oral

Dr. Kihwan Kim [1] **_, Dr. Meungguk Park_** [2] **_, Dr. Jeonghwan Choi_** [3] **_, Dr. Bok Gyo Jeong_** [1] **_, Dr. Sookyoung Lee_** [3]

1. *Kean University,* **2.** *Southern Illinois University at Carbondale,* **3.** *Kean University, Wenzhou Campus*

The importance of social entrepreneurship increases in resolving social problems especially in developing countries. Social entrepreneurial intention (SEI) is considered an important prerequisite for founding a social enterprise. Contributing to the research on the antecedents of SEI in developing countries, we performed a meta-analysis of 33 studies (k=21, N=11,577) that include the samples from 17 developing countries. Results confirmed that self-efficacy (r+ =.440), empathy (r+=.332), moral obligation (r+=.308), experience (r+=.333), and social support (r+=.330) have positive correlations with SEI in developing countries. We elaborated implications, limitations, and future research based on the results.

PSYCHOLOGICAL CONTRACT, PSYCHOLOGICAL CAPITAL AND EMPLOYEE COMMITMENT IN GRADED ACCOMMODATION ESTABLISHMENTS IN THE FREE STATE PROVINCE

Oral

Mr. Bongani Mphirime [1] *, Prof. Desere Kokt* [1]

1. *central University of technology free state*

The Hospitality industry is a highly labour intensive sector.The sector is continuously looking for elements, which impact on organisational effectiveness.Noted amongst these elements is Positive Organisational behaviour (POB).POB focuses on measurable positive psychological states which include Psychological Capital and Psychological Contract.The population of the study consisted of 92 respondents within accommodation establishments. The PLS-SEM statistical model was used for analysis. It noted a negative statistical significant relationship between Transactional Contracts and Employee Commitment((β= -0.169,p<0.048),a positive statistical significant relationship between Rational Contracts and Employee Commitment *(β*=0.654,p<0.001),a positive statistical significant relationship between Optimism and Employee commitment (β=0.21, p<0.025).

The discussion on developing strategies through SST for pandemic decreasing-take Covid-19 as the example

Oral

Ms. Mei-Hsin Wu [1] ***, Prof. Ja-Shen Chen*** [1] ***, Prof. Yu Te Liu*** [2]

1. *College of Management, Yuan Ze University,* ***2.*** *College of Management, Yuan Ze University.*

Covid-19 severely hit economics and hugely changed people's lives. We hoped to develop strategies for pandemic decreasing. Research questions are: (1) what might be the good strategies? (2) how to implement? The main purpose is to explore effective strategies through SST for prevention, contingency, and control. A possible finding that high-tech, genomic test, and artificial intelligence are strategic to quarantine. Cultural differences and Taiwan's quarantine model are also addressed for the discussion. 3 models were built for explaining the whole structure under a review. We tried to contribute on academic, practice, and quarantine.

Key words: pandemic, prevention, contingency, control, SST

Supply Chain Management and Logistics

A Multicountry, Multicommodity Stochastic Game Theory Network Model of Competition for Medical Supplies Inspired by the Covid-19 Pandemic

Oral

Mr. Mojtaba Salarpour [1] **, Prof. ANNA NAGURNEY** [1]

1. *University of Massachusetts Amherst*

In this paper, we construct the first stochastic Generalized Nash Equilibrium model for the study of competition among countries for limited supplies of medical items (PPEs, ventilators, etc.) in the disaster preparedness and response phases in the Covid-19 pandemic. The government of each country is faced with a two-stage stochastic optimization problem. The results reveal that, in addition to the preparedness of countries before the pandemic declaration, their ability to adapt to the conditions in different scenarios has a significant impact on their overall success in the management of the pandemic crisis.

A Robust Goal Programming Model To Design Green Closed Loop Supply Chain Network

Oral

Mr. Murtadha Aldoukhi [1] *, Dr. Surendra M. Gupta* [1]

1. Northeastern University

This paper addresses the problem of designing a green closed loop supply chain network. We propose a model that considers multiple-periods and products from different generations. These products include new and remanufactured products where product substitution is allowed according to a pre-determined policy. The uncertainties considered in the model include product demand, the number of returned products and product substitution fraction. The objectives of the proposed model are to minimize the total cost, minimize carbon emission and maximize the service level. To model this problem, we integrated a robust optimization uncertainty set theory and non-preemptive goal programming approached.

Carriers optimal level of collaborative logistics in the vehicle routing problem with cross-docking

Oral

Dr. VAHID GHOMI [1]

1. *Penn State Mony Alto*

Collaborative logistics (CL) and merging operations are crucial for transportation companies to reduce costs. In this paper, we optimize a supply chain network efficiency by practicing CL among the inbound and outbound carriers in a centralized coordinated network with a cross-docking setting by applying an MINLP model. Our experimental results show that in a supply chain network with a cross-docking setting, *partial* CL among the carriers always outperforms *complete* or *no* collaboration. That is, collaboration can yield benefits for the supply chain, but managers should be cautious that too much or no collaboration can result in lower supply chain performance.

Collaboration among Private and Public Procurement Organizations

Oral

Mr. Chad Rutkowski [1] , **_Ms. Karen Eboch_** [2] , **_Dr. Amelia Carr_** [2] , **_Dr. Bertie Greer_** [3]

1. _United Way of Greater Toledo Ohio,_ **2.** _Bowling Green State University,_ **3.** _Wayne State University_

This paper shows how collaboration between public and private procurement during the COVID-19 pandemic benefits the community. This research is based on a case study that uses first-hand information from key participants. The findings shows that when private and public procurement professionals work together during a crises, critical items can be procured more efficiently and effectively. The procurement process discussed in the case study is transferable to other crises situations. This study helps local communities to better respond to crises situations such as a pandemic. The case study fills a gap in the research on public and private procurement collaboration.

Coordination in Vertical Channels with Manufacturer-Quality and Retailer-Effort Induced Demand in the Presence of Strategic Inventory

Oral

Dr. Abhishek Roy [1]

1. *Fox School Of Business At Temple University*

We study a vertical supply chain consisting of an upstream manufacturer and a downstream retailer facing a downward sloping demand, which is further influenced by the manufacturer's choice of quality, and the retailer's choice of selling effort. We examine how these choices are affected in a two-period setting by the presence of strategic inventory, which may be held by the retailer when the manufacturer does not commit to a long-term wholesale price.

Development of Sustainable Design Methods on Environmental and Economical Disassembly Systems

Oral

Mr. Kento Igarashi [1] , **_Prof. Tetsuo Yamada_** [1]

1. _The University of Electro-Communications_

Design methods on environmental and economical disassembly system are required for sustainable material recycling from numerous end-of-life assembled products. These design methods consider disassembly line balancing that assigns disassembly tasks to each work station. On the other hand, each part has environmental and economic characteristics such as recycling rates, CO_2 emissions during manufacturing, material selling profits and disassembly costs of materials contained in the product. Therefore, line balancing with selecting disassembled or disposed parts are also required. This study develops sustainable design methods on disassembly system that balance lines with selected environmental and economical parts.

Dyadic Supply Chain Coordination with Product Quality and Sales Effort Dependent Demand

Oral

Mr. Rajendra Baraiya [1] , *Prof. Rohit Kapoor* [1]

1. Indian Institute of Management, Indore

Coordination among the supply chain players is of the utmost importance when the efforts made in the improvement of quality and sales effort by one player are beneficial to both parties. We have studied six different contracts in the present paper and we observed that wholesale price, quality improvement cost-sharing, and revenue sharing contract fails to coordinate. However, sales effort cost-sharing, both sales effort and quality improvement cost-sharing, and profit-sharing contract coordinates the supply chain but not feasible to implement. It would interesting to propose the coordinating contract for the supply chain with product quality and sales effort dependent demand.

Evaluation of Manufacturing and Remanufacturing Mixed Production Systems for Environmental, Economical and Facilities Stability

Oral

Mr. Munehiro Sugiyama [1] *, Prof. Aya Ishigaki* [1] *, Prof. Keisuke Nagasawa* [2] *, Prof. Tetsuo Yamada* [3]

1. Tokyo University of Science, 2. Hiroshima University, 3. The University of Electro-Communications

Remanufacturing used electronic devices can reuse the resources contained in discarded electronic devices. However, the construction of a remanufacturing facility would reduce the availability of the production facility. The decrease rate utilization rate is a factor that causes the generation of wasted electricity, which is an environmental burden, and economic losses due to out-of-stocks. The purpose of this study is to model production systems of manufacturing and remanufacturing, in which used products collected from the market are recovered and reprocessed as new products, and to propose an optimal production strategy from the viewpoints of environment, economy, and facilities stability.

Fostering Sustainability in Supply Chain via MSMEs: A Conceptual Framework

Oral

Mr. NITIN JAIN [1]

1. *IIM Udaipur*

The study strives to understand the antecedents for the adoption of Triple Bottom Line (TBL) practices and the impact of these practices on the firm performance, holistically, in the case of micro, small, and medium enterprises (MSMEs). It applies organizational theories to develop a conceptual framework for understanding the drivers of adopting sustainability and the impact of sustainability practices on MSME performance.

Improving the Food Waste Management in the Design of a Sustainable Food Supply Network

Oral

Mr. Adel Fadhel [1], **Dr. Surendra M. Gupta** [2]

1. *King Fahd University of Petroleum and Minerals,* **2.** *Northeastern University*

In this paper, we will investigate the problem of designing a food donation distribution network in the context of nonprofit organizations. A mixed-integer linear programming (MILP) model is formulated for optimizing the distribution operations. The developed model is utilized to analyze the existing network of the Saudi Food Bank organization. By solving the model at different combinations of budgets, we obtain an optimal alternative solution that reduces the required budget by 26.7 %. Improvements in this field will address social issues such as food access equality. Finally, we discuss the best food waste management practices and discuss future research areas.

INTEGRATION OF TRUCK-DOOR ASSIGNMENT AND FORKLIFT UTILIZATION TO CONTROL FORKLIFTS CONGESTION IN A CROSS-DOCKING TERMINAL

Oral

Dr. VAHID GHOMI [1]

1. *Penn State Mony Alto*

Cross-docking performance and efficiency are maximized in an assignment problem by maximizing the forklifts' utilization inside the terminal using an MINLP model that encompasses both truck-door assignment and forklift utilization inside the terminal. We try to enhance the quality of truck-door assignment in such a way as to minimize the total transshipment cost including, the penalty cost associated with forklifts underutilization, the total forklift's traveled distance cost, and total weighted unloading and loading operators cost. Also, we try to control the forklift congestion by minimizing the total number of forklifts to transfer products between doors inside the terminal.

Livestock Feedstock Sourcing and Transportation Management

Oral

Dr. EUNSU LEE [1]

1. *New Jersey City University*

The Korean hay market has been steadily growing in transactions due to increased beef consumption. Korean feedstock importer has been operating a local factory in the United States to improve the procurement process and acquire sustainable supply. This study utilizes the Geographic Information System (GIS) to predict production and to estimate effective intermodal freight transport routes. The study uses mixed integer programming to find the best transportation options and suppliers based on the existing feedstock factory. Preliminary results of the study show that the location of inter-modal terminals is one of the critical factors of production site.

Managing Complexity for Enhanced Supply Chain Resilience in Post-Covid Era

Oral

Dr. SABAN ADANA [1] *, Dr. SEDAT CEVIKPARMAK* [2] *, Dr. Hasan Celik* [3] *, Dr. HASAN UVET* [4] *, Mr. Yavuz Idug* [5] *, Mr. Ethem Gurbas* [5]

1. *John Carroll University,* **2.** *DeSales University,* **3.** *Robert Morris University,* **4.** *Georgia Gwinnett College,* **5.** *University of North Texas*

Today's dynamic, global, and intricate supply chains (SC) operate in a highly complex and uncertain environment. This study investigates the impact of supply chain complexity on SC Resilience to provide normative guidance. Current literature focuses on the role of complexity on plant and delivery performance, etc. Accordingly, this study first investigates some of the major complexity drivers present in the supply chains in the context of disruptions. A framework including five practical strategies is developed. The framework provides insights to help practitioners understand the relationship between different sources of complexities and the impact of these sources of complexities on SCRES.

Multi-objective Problem of Reverse Supply Chain Network Design with Individual Material Weight Recovered by Using Linear Physical Programming

Oral

Dr. Hiromasa Ijuin [1] **, Prof. Tetsuo Yamada** [1] **, Prof. Aya Ishigaki** [2]

1. *The University of Electro-Communications, Informatics and Engineering,* **2.** *Tokyo University of Science, Industrial Administration*

The reverse supply chain is the network for transportation of the End-of-Life (EOL) products from collection centers to recovery and/or disposal facilities. In recent years, plastic garbage pollutes oceans and harms marine wildlife becomes a global serious problem. Therefore, the recovered material weight for each material type should be focused on. On the other hand, the relationship between the recycling rate and the total cost becomes a tradeoff. Linear Physical Programming (LPP) is one of the effective methods for solving multi-objective problems. This study designs reverse supply chain network to collect and recycle the EOL assembly products using LPP.

Optimal Inventory Policies in Disrupted Supply Chains During Pandemics: An Application to Diagnostic Test Kits

Oral

Dr. MOHAMMAD EBRAHIM ARBABIAN [1] *, **Dr. HOSSEIN RIKHTEHGAR BERENJI** [2]*

1. *University of Portland,* ***2.*** *College of Business, Pacific University*

The COVID-19 pandemic has changed the normal life and business environments across the globe. Not long after starting large-scale testing, countries hit a roadblock – the shortage of swabs used in the testing kits, which took place due to disruptions in the supply chain caused by COVID-19. This disruption translates to a variable production capacity of the swab suppliers. By considering different swab demand patterns and production capacity scenarios for swab suppliers, we develop analytical models to derive optimal policies and provide managerial insights as to how countries should optimally react to changes in the supply and demand of swabs.

PROBLEM OF REMANUFACTURING OPTION SELECTION WITH DISASSEMBLY FOR CO2 SAVING RATE AND COST

Oral

Mr. Jaeho HAN [1] *, Dr. Hiromasa Ijuin* [2] *, Prof. Tetsuo Yamada* [2] *, Prof. Shuho Yamada* [3] *, Prof. Masato Inoue* [4]

1. *Changwon National University,* **2.** *The University of Electro-Communications,* **3.** *The University of Tokyo,* **4.** *Meiji University*

This study considers CO_2 savings and profits achieved via remanufacturing option selection. Given the high costs associated with disassembling and reassembling a product, the remanufacturing option selection of end-of-life products through disassembly and assembly should be designed both from environmental and economic perspectives. The experiments with environmental objective functions and economic objective functions are formulated by 0–1 integer programs and ε constraint method. Throughout a laptop case study, it demonstrates that the proposed method afforded significant CO_2 savings and profits, compared to previous approaches, offering efficient economic and environmental benefits in case of additional costs.

Small world optimization algorithm for solving multi-objective U-shaped disassembly line balancing problem

Oral

Mr. Pengfei Yao [1] *, Dr. Surendra M. Gupta* [1]

1. Northeastern University

Environment waste is one of the most crucial problems to all of the countries and individuals. Remanufacturing aims to transfer End-of-life products to reusable products. Disassembly is the first and one of the most important steps of remanufacturing which aims to turn End-of-life products to different subassemblies/parts. U-shaped disassembly line is proposed to operate multi-objective disassembly task and small world optimization algorithm(SWOA) is proposed to help avoid long computation time and one previous instance is used to examine the superiority of SWOA among other meta-heuristics. What is more, results show several advantages of U-shaped line compared with straight line.

Stakeholder Pressure and Firm Sustainability Performance: The effects of Supply Chain Ambidexterity, Supply Chain Integration and Supply Chain Agility

Oral

Mr. Muhammad Hasan Ashraf [1] *, **Dr. MEHMET GOKHAN YALCIN*** [1]

1. *URI College of Business*

The impact of stakeholder pressure on the firm to achieve higher sustainability performance is well acknowledged in the management literature. In this paper, we posit that this direct effect is further mediated by the level of Supply Chain Ambidexterity within a firm. Moreover, we identify Supply Chain Agility and Supply Chain Integration as the antecedents of Supply Chain Ambidexterity. We investigate this relationship within the textile industry. The theoretical contribution of this paper is to introduce paradox theory in conjunction with stakeholder and resource-based view theory to explain this relation, and also generate pathways for firms to enhance sustainability performance.

Supply Chain Sourcing Plan to Achieve Sustainability and Cost Efficiency

Oral

Prof. GANG LI [1] , Prof. YU AMY XIA [2]

1. *Bentley University,* **2.** *College of William and Mary*

We develop a supply chain sourcing plan model that incorporates both sustainability and cost efficiency. The model selects suppliers and determines sustainability investments and order allocations among the selected suppliers. High sustainability performance as well as cost efficiency are achieved while a high service level is maintained. We formulate the problem as a nonlinear bi-objective integer-programming model, discover the model's special features, and propose an effective and computationally efficient algorithm to solve it. Numerical tests verify that our algorithm outperforms an existing sourcing algorithm. A simulation of Apple's sourcing decisions demonstrates the effectiveness of the model in business practice.

Tackling Product Refund Warranty Fraud For Remanufactured Products In Reverse Supply Chain

Oral

Mr. Aditya Pandit [1] *, Dr. Surendra M. Gupta* [1]

1. Northeastern University

The issue of warranty fraud in remanufactured products has been addressed in recent literature. This paper addresses the issue of warranty fraud arising from the customer. The study aims to examine problems in product refund and replacement in the consumer electronics remanufacturing sector, and examines strategies available to the warranty provider to tackle said fraud. Discreet event simulation is utilized to contrast how the use of sensors may mitigate product refund fraud by comparing relevant fraud statistics with the previously existing system. The study showed that the sensor embedded scenario was able to preemptively stop more frauds.

The Impact Of COVID-19 Disruption On Designing A Global Supply Chain Network Across The Trans-Pacific Partnership Agreement

Oral

Mr. Takaki Nagao [1]*, Prof. Tetsuo Yamada* [1]*, Dr. Hiromasa Ijuin* [1]*, Prof. Keisuke Nagasawa* [2]*, Dr. Lei Zhou* [3]

1. *The University of Electro-Communications,* **2.** *Hiroshima University,* **3.** *Tokyo Metropolitan University*

The global supply chain network consists cross-border trades. Then custom duty is imposed because of to protecting domestic industry. However, there is a trend of eliminating custom duties through free trade agreements such as the Trans-Pacific Partnership Agreement. On the other hand, the COVID-19 had a serious impact on a global supply chain. In this study, it is analyzed that the impact on a global supply chain network considering custom duties and disruptions. In the result, total cost is increased maximum 1.7% and TPP cannot be effect to the selection for suppliers in the model of this study.

Sustainability Management

CEO Overconfidence and Sustainability Performance

Oral

Dr. Yiming Zhuang [1]

1. Frostburg State University

Firms are increasingly emphasizing the importance of attaining superior sustainability performance given increasing stakeholder pressure. However, most prior studies have focused on the drivers or antecedents to improving sustainability performance. Few studies have focused on the factors that might potentially hinder a given firm's ability to achieve greater sustainability performance. This study decreases the gap in the existing literature by investigating the relationship between CEO overconfidence and a firm's sustainability performance with a sample consisting of 11,341 firm-year observations from 2010 to 2018 in China. CEO overconfidence worsened the sustainability performance of the firms that were studied.

Corporate - Nonprofits Partnerships to Improve Social Innovation and Corporate Social Responsibility

Oral

__Ms. Lauren Castagnola__ [1] *, __Prof. Robert Yawson__* [1]

__1.__ School of Business, Quinnipiac University

One of the best resources for businesses seeking to affect social change meaningfully is through working with, learning from, and partnering with nonprofits. Collective impact and its implications for corporate partners; increasing positive community engagement through progressive hiring practices instituted by non-profit organizations; fostering innovation within an organizational setting through NPO collaboration; and exploring a hybrid model of non-profit/for-profit business, with an examination of the advantages and disadvantages thereof. In this paper, we review these unique approaches to show how for-profits can learn from nonprofits and *vice versa* when it comes to social innovation and Corporate Social Responsibility.

CSR and ethical lessons from the COVID-19 pandemic

Oral

Mr. Sergii Aleksieiev [1], Dr. Vallari Chandna [1]

1. University of Wisconsin-Green Bay

Entire economies and social institutions along with individual lives, have been disrupted by the COVID 19 pandemic. As the pandemic continues to shed light on the imperfections of our current economic and social systems, at the very least, some valuable lessons should be gleaned from this tragic turn of events. Our work discusses some "silver linings" on this dark cloud, and how they may continue once normalcy is restored. These include government and private-sector collaborations in healthcare, increased focus on medical and strategic restocking, work-life balance benefits, reduction in natural resources consumption and decreased particulate emissions and other environmental benefits.

Demystifying the relationship between financial and ESG performance

Oral

Mr. NITIN JAIN [1]

1. *IIM Udaipur*

Over the years, there has been a growing concern around the need for firms to place more thrust on environmental, social and regulatory measures. The current study adds to the growing body of literature on ESG by conducting an empirical analysis on the S&P 500 firms for a much longer time horizon than that generally considered in the extant literature. It sheds light on the nature of relationship between ESG and financial performance.

Designing and Distinguishing Meaningful Artisan Food Experiences

Oral

Dr. Erin Percival Carter [1] , **_Dr. Stephanie Welcomer_** [1]

1. *University of Maine*

In this paper, we examine consumer expectations about how specialty versus conventional food products affect well-being and how small, artisan producers can use that information to design better customer experiences. Drawing on recent work examining costs and benefits of pleasure- and meaning-based consumption, we examine how consumer expectations that specialty products are more meaningful lead to increased desire for additional product information.

Exploring Issues of Zero-Waste Disclosures in SEC Filings on Strategy and Sustainability

Oral

Dr. Renee Flasher [1], **_Dr. Darrell Bartholomew_** [1]

1. *Pennsylvania State University Harrisburg*

We examine how companies have elected to disclose sustainability details in United States Securities and Exchange Commission (SEC) financial filings specifically focusing a zero-waste strategy. We focus on a strategy promoted by governments and consumers in the climate change fight. Based on 87 companies from 2016-2020, we find that companies sparsely disclose their zero-waste initiatives. The annual, required filings more frequently refer to overall company disclosures and involves the supply chain, as opposed to a product focus. Surprisingly, the waste companies specifically cited zero-waste as a risk. We discuss implications highlighting the need for more value chain accounting.

Remanufacturer's Sustainable and Innovative Acquisition in Textile Recycling: A Supply Chain Integration from Social Capital Perspective

Oral

Ms. Li Liu [1] *, Prof. Gulver Karamemis* [2] *, Prof. Seray Ergene* [1]

1. University of Rhode Island, 2. Georgia Southern University

Our research focuses on how remanufacturers realize their recycling and remanufacturing tasks by connecting with old garment suppliers from the upstream and garment producers from the downstream in the textile industry. We will analyze the supply chain integration of remanufacturers in garment recycling. Since resources and information can impact partners' importance in the integrated relationship, there will be great differences among partners for their negotiation power, social capital obtaining, and stability keeping in the recycling process. Our project contributes to the textile firms' sustainable performance and innovation improvement when they integrate with other partners in supply chain activities.

Spatio-Temporal Effects on Decision Making in Negotiated Green Fleet Procurement

Oral

Dr. Marc Scott [1]

1. *Georgia Southern University*

As regulations regarding the integration of alternative fuel vehicles (AFVs) increase, fleet procurement agents (FPAs) must make AFV-related procurement decisions, including supplier selection. A component of the selection supplier process requires that FPAs assign importance to supplier selection criteria (SSCs). We posit that the switch in purchasing context from conventional fuel vehicle (CFV) to AFV procurement would result in differences in the level of importance assigned to specific SSCs between these contexts, and further, that the extent of that difference is driven by the geospatial distribution of FPAs, and the recency with which they last completed the AFV procurement task.

The Circular Economy and Plastic

Oral

Dr. Vallari Chandna [1] **_, Ms. Anna Pluschakov_** [1]

1. _University of Wisconsin-Green Bay_

While the circular economy concept allows for the harmonizing of economic growth and environmental protection, existing research is scant when it comes to addressing how each moving part works within the greater model. Our paper explores the problems that plague the concept, and its adoption, while discussing potential solutions. Our discussions are in the context of plastic specifically and are applicable to a wider context. Beginning at the individual level and moving up to the firm and global levels, we discuss the implications of eliminating inefficiencies that prevent the circular economy model from operating at full capacity.

The Influence of Culture, Environmental Beliefs, Norms and Barriers on Solar Photovoltaic Rooftop Adoption in China

Oral

Dr. Xiangrong Liu [1], *Dr. Wanchunzi Yu* [1]

1. Bridgewater State University

With the rapid economic development and surging demand in energy, China has also observed severe environmental deterioration, which makes adopting clean energy especially solar photovoltaic (PV) rooftop systems critical. However, even with the largest production capacity, China's solar PV adoption at the distributed level is comparably low. This research aimed at investigating how cultures factors, environmental beliefs, norms and barriers influence solar PV adoption decisions. With the backward variable selection procedure in logistic regression, the data from 351 college students in China indicate that both culture factors and environmental behavior factors significantly affect the decision of solar PV panel adoptions.

Toward the Measurement of Green Tourism

Oral

Dr. Seung Hoon Jang [1] **, Mr. Kevin Kraus** [1]

1. Bloomsburg University of Pennsylvania

The purpose of this study is to examine how to measure environment-friendly tourism. The items and criteria of green tourism practices are suggested based on the literature review and discussions of tourism and related measures. Scholars and practitioners are expected to gain implications on how to quantitatively analyze the degree of greenness in the tourism products and services.

Undergraduate Student Poster Competition

An Analysis of Length of Stay and Readmissions of AMI Patients: A Nationwide Analysis Using Statistical Process Control

Poster

Ms. Hannah Beazoglou [1] *, Dr. Fatma Pakdil* [1]

1. *Eastern Connecticut State University*

Despite a high level of spending, the health care system is characterized by substandard quality and inefficiency. This study focuses on how to monitor process performance in LOS and readmissions by employing control charts for acute myocardial infarction (AMI) patients admitted to government hospitals in large metropolitan areas. Data were abstracted from 2010 to 2016 from the Healthcare Cost and Utilization Project (HCUP) Nationwide Readmissions Database (NRD). *I-MR* charts and *P* charts were used to analyze the datasets. The results showed *I-MR* and *P* charts could detect statistical abnormalities on LOS and 30-day readmissions on time.

An Analysis of Successful Crowdfunding Campaigns: Kickstarter

Poster

**Mr. William Riherd** [1] , **Mr. Omo-Dafe Uvieghara** [1] , **Mr. Alvaro Rodriguez** [1] , **Ms. Caitlyn Kim** [1]

1. _Boston College_

The global crowdfunding market has seen significant growth since its inception. As crowdfunding services continue to penetrate society at large, it is vital that modern firms and entrepreneurs understand how and when to capitalize on crowdfunding opportunities. This report includes a data-driven analysis of Kickstarter–a creativity and technology-focused crowdfunding platform. Employing classical statistics along with supervised and unsupervised machine learning methods, the analysis reveals key attributes relating to campaign success.

Analysis of Unemployment Rate and Mental Health Symptoms During the COVID-19 Pandemic

Poster

Ms. Miya Spinella [1] *, Prof. Keivan Sadeghzadeh* [1]

1. *University of Massachusetts Dartmouth*

The COVID-19 pandemic has caused billions of people's lives to be affected. The increased pressure of adapting to changes caused by the pandemic can create psychological distress. In this poster, the percentage of people with anxiety, depression, or either type of symptom nationally and for each state in the United States is examined from May through October 2020 to determine if mental health has been affected. Unemployment rate is also gathered to determine if the rate varies from 2019 to 2020 or throughout the 2020 year. The connection between mental health and national crises is also explored.

Artificial Intelligence in Marketing: Past, Present and Future

Poster

Ms. Leniqua'Domi Jenkins [1]

1. *University of the District of Columbia*

In the future, artificial intelligence (AI) will impact marketing strategies and challenge the way humanity prioritizes human labor. Prior research indicates that AI can be used as an effective response to the external contingencies of high volumes of data and uncertain environmental conditions, as well as being an effective response to the external contingencies of limited managerial cognition. As global economy learns how to incorporate AI/robots into systems, our institutions of higher learning will be forced to educate human workers on ways to utilize AI in various marketplaces. This research examines how AI will challenge customer interactions, and privacy.

Beyond Leader-Member Exchange Theory (LMX): Developing a New Typology Model of Followers

Poster

Ms. Janell Laws [1] *, Mr. Justin Antonio* [2]

1. Kean University, 2. Kean

Although followers' contributions play a crucial role in the success of leaders, there have been very few studies to understand the followers' motive for supporting a leader. The existing Leader-Member Exchange Theory has contributed to understanding the relationship between leaders and followers, but it's simple classification of the followers as either in-group or out-group. Our study attempts to develop a new typology to describe four different kinds of leader-follower relationships using two dimensions: Physical Distance and Psychological Distance. Our study discusses how the quality of leader-member relationships can be changed with both the leaders and followers' efforts.

Brain Tumor Classification using Graph Neural Networks

Poster

Mr. Daniel Babalola [1], *Dr. Hien Nguyen* [1]

1. *Pennsylvania State University Harrisburg*

Due to the high variation present in medical image data, classification has remained a fairly challenging task. Traditional classification methods fail to generalize well and often overfit. In this work, we explore how the accuracy of medical image classification can be improved using graph-based modeling techniques. We present a modification of the Graph Convolutional Network (GCN) to help classify brain scans, detecting whether a tumor is present or not. After training with an augmented dataset consisting of 253 original images, our results show that these graph networks tend to generalize better than traditional models and yield higher accuracy as well.

COVID-19 and Its Impact on Social Entrepreneurship

Poster

Ms. Victoria Vitale [1]

1. *Kean University*

The Coronavirus has played a crucial role in putting a damper on social entrepreneurship in multiple ways across nationwide societies. One of the largest changes was the transition from the traditional in-person work environment to having to work remotely, which created a downfall for the social entrepreneurial industry. This study has focused on both challenges and opportunities that the pandemic brings into social entrepreneurships. The amount of damage that needs to be recovered due to the pandemic is also increasingly large. However, the pandemic also provided opportunities for social entrepreneurships. The current study provides valuable practical and research implications.

Critical Success Factor Model of Virtual Internship Program under COVID-19

Poster

Mr. Mitchell Lanzl [1] , *Mr. Jephte Philippe* [1]

1. *Kean University*

Virtual internships; as new and as different as they are, will help everyone that is participating to prevent them from ever contracting the Covid-19 virus. The importance of this research grows as time goes on and we learn more and more about the current pandemic. The research conducted within this project is aimed to develop a critical success factor model for a successful virtual internship program. The CSF model will include three main stakeholders which include students, universities, and companies. This research will provide students and graduates both about how they can further accelerate their future plans.

Cultural Intelligence and Leadership: The Impact on Organizational Performance

Poster

Ms. Jessica Fonseca [1] *, Mrs. Sandra Orejarena* [1]

1. Kean University

In today's workplace it is crucial for organizations to develop and apply the ability for leaderships to engage in the knowledge of behavior by training programs. Cultural intelligence in organizational performance refers to "one's ability to understand one's own as well as other person's culture, understanding the similarities and differences across these cultures and having the capability to display verbal and nonverbal behaviors that are culturally appropriate" .There are four capabilities, include in cultural intelligence Cognitive CI ,Metacognitive CI,Behavioral CI,Motivational CI. This study will help Organizations to understand the importance leaderships to applying cultural intelligence in everyday workplaces. .

Deptford, NJ Starbucks Process Analysis

Poster

Mr. Tyler Bell [1]

1. Rowan University

An analysis on the current status of the Starbucks drive thru in Deptford, NJ was performed including graphical representation, statistical process capability, process capability index, forecasting using exponential smoothing, and suggested methods of improvement. These improvements include proposals for drive thru lane expansion and order modularization.

Emotional Intelligence, Trust, Self-efficacy and Task Behavior: Longitudinal Study of Achievement Approach to Leadership Emergence

Poster

Mr. Justin Antonio [1] , *Ms. Janell Laws* [1]

1. Kean University

Leadership emergence refers to the phenomenon where an individual voluntarily takes a leadership role when there is no designated leader. The current study attempts to explore the trait of the emergent leader and the process of leadership emergence. We collected data from 171 participants to test our hypotheses. The study found that an individual with high emotional intelligence is more likely to emerge as a leader by showing confidence in self and trust in the group and taking the initiative in group tasks. We discussed implications, limitations, and future research issues.

Environmental, Social, and Governance Performance of Top-Rated Supply Chain Companies: A Quantitative Assessment Model

Poster

Mr. Noah Tellier [1] *, Dr. John K. Visich* [1]

1. *Bryant University*

Corporate reporting has traditionally focused on the financial performance of the firm, but there is a growing trend to include environmental, social and governance (ESG) information. This is due to the importance of ESG to investors, government agencies and NGOs, and a variety of propriety methods have been developed to determine a company's ESG performance. In this research we use companies on the Gartner Supply Chain Top 25 for 2020 and compare their proprietary ESG scores from Gartner and Bloomberg with a scoring method we developed using publically available information and the Global Reporting Initiative framework.

Examining University Students' Multitasking Behavior with Online Learning

Poster

Ms. Terssa Kassahun [1]

1. _University of the District of Columbia_

This research examines university students' multitasking behavior in online courses and investigates the significant indicators of multitasking in online learning environments. It focuses on the students' multitasking behavior (related to self-efficacy for self-regulated learning (SE:SRL), Internet addiction, and multitasking tendency/behavior, in addition to student demographics (gender, age, classification, etc.)) in different online business courses. The study shows significant results and meaningful insights into multitasking tendency for students in online learning environments; and explores interrelationships amongst multitasking behavior, SE:SRL and internet addiction along with the correlations between multitasking and student demographics.

Explainable Artificial Intelligence and Benefits for Business Applications

Poster

Ms. Chasity Nadeau [1] *, Mrs. Jeannine Shantz* [1]

1. Saint Joseph's University

The National Institute of Standards and Technology (NIST) recognized the many challenges in designing, constructing and assuring a Cyber Physical System (CPS), and in response developed the CPS Framework, designed to break down the process of completing a CPS into three separate facets and to aid in the processes associated with the realization of a CPS.

We augment the Framework with AI and Explainable AI (XAI), through which we provide the tools promoting cross-functional collaboration and offer three high-level approaches to understand and explain the decisions made by AI that will be explored throughout the poster.

Exploring Relationships between Cognitive Load and Student Performance in Online Learning Environments

Poster

Ms. Brea Ellis [1]

1. *University of the District of Columbia*

The goal of this study is to explore the relationship between cognitive load and student performance in online learning environments. The research helps in distinguishing academic performance through its influences on cognition (from cognitive load) and motivation (from student satisfaction). A survey of one hundred students in different online business courses was conducted to examine how student performance and student satisfaction with online learning were related to cognitive load. The study helps in providing suggestions for potential improvements to guide instructional design in online learning environments by utilizing varying student perspectives.

Leadership in Energy and Environmental Design (LEED) in Education

Poster

Mr. Jonathan Hagenow [1], **_Dr. John K. Visich_** [1]

1. *Bryant University*

Environmentally sustainable practices within the construction industry has been supported through the US Green Building Councils Leadership in Energy and Environmental Design (LEED) building certifications. The advancement of LEED in higher education has led to the question of which point-awarding areas should be focused on when developing a project with the goal of LEED-certification. Our research has shown that generally no one area should be focused on extensively when developing a LEED building proposal. Instead, a project should focus on those categories and possible points which are most compatible with the building design, surrounding landscape, and geographic location.

Mobilization of Healthy Foods to Urban Food Desert

Poster

Mr. Anthony Picciano [1], *Ms. Natalia De LaFuente* [1]

1. New Jersey City University

The disaster of COVID-19 has exacerbated food access issues for the citizens of Jersey city. This project develops a plan to to improve food access in Jersey city, through use of mobile food units selling fresh produce in locations that are closest to those in need. The study utilizes nonlinear programming models to minimize travel distance from households to per-assigned food unit locations, and forecast the food expenses per location to illustrate the mobile food unit's market.

Proposal of preventive care service considering the factors that prevent the elderly from going out

Poster

Mr. Tomoki Sanada [1] **_, Prof. Aya Ishigaki_** [1]

1. *Tokyo University of Science*

In Japan, where the birthrate is declining and the population is aging, an increase in social security costs has become a serious problem. Japanese government is promoting efforts to preventive care so that the elderly people can lead an independent daily life. However, some elderly people are very reluctant to go out. Moreover, it is also known that elderly people can be bedridden if their activity space is limited to their home. In this study, we propose appropriate preventive care services by identifying the factors that prevent the elderly from going out from the results of the questionnaire survey.

The Effect of Positive Reading on the Development of College Students' Self-efficacy, Self-esteem, & Locus of Control

Poster

Mr. Mitchell Lanzl [1]

1. _Kean Uni_

Social learning theory states the people learn through the observations of others. Since developing positive altitudes is critical to the success of students, we decided to test if observing positive behavior through reading will impact a student's core-self evaluation. High core-self evaluations (CSEs) have shown to have beneficial effects on individuals and finding ways to raise scores can contribute to students' success. The data analysis revealed that motivational book reading significantly increased students' self-efficacy and locus of control, but not self-esteem. Additional exploratory analysis revealed that students' emotional intelligence positively influence the change of self-efficacy and locus of control.

The Effect of Socioeconomic Status on Mental Health Readmission Rate; An Investigation in the Commonwealth of Massachusetts

Poster

Ms. Yasaman Asayesh [1] *, Prof. Keivan Sadeghzadeh* [1] *, Prof. Soheil Sibdari* [1] *, Prof. Joohyun Chung* [2]

1. *University of Massachusetts Dartmouth,* **2.** *University of Massachusetts Amherst*

In 2019, the United States had 51.5 million adults with mental illnesses who are approximately 20.6% of the adult population. Generally, investigation of Any Mental Illness (AMI), especially the readmission rate associated with that, can expose the significant expenditures and debilitating impacts of AMI on people's life. On the other hand, many studies have shown that socioeconomic status (SES) is associated with mental disorders, with the higher prevalence of mental disorders evident in lower SES compared to higher SES groups. We investigate the association between SES variables and readmission rate via non-parametric methods over counties of the Commonwealth of Massachusetts.

The Impact of COVID-19 on Consumer Behavior in Social Commerce

Poster

Mr. zhangliang pan [1] *, Ms. Zyasia Nash* [1]

1. Kean University

Under the impact of the pandemic, social commerce in e-commerce takes benefits and is developing dramatically. This study aims to analyze consumer behavior in social commerce under the impact of COVID-19. To find the result, this study used a systematic literature review and content analysis. Finally, this research found that consumer behavior of impulsive purchase, fear purchase, purchasing decision, purchase frequency, product selection have been influenced by COVID-19. In conclusion, this study offered a systematic literature review about consumer behavior in social commerce under the COVID-19 pandemic which contributes to future studies in this area.

Authors Index

Disruptive Technologies in a Post Pandemic World

51st NEDSI Annual Conference
Newark, NJ, April 7-9, 2022

CONFERENCE ANNOUNCEMENT

NEDSI, the northeast regional division of the Decision Sciences Institute, will be holding its 51st annual conference in Newark, NJ, from April 7-9, 2022. The three-day conference will commence on Thursday morning and end at lunchtime Saturday. The conference's gala dinner and awards ceremony will be on Friday evening.

HOST INSTITUTION

Martin Tuchman School of Management
New Jersey Institute of Technology

CALL FOR PAPERS

Full papers, abstracts, and workshops are invited for, but not limited to, the topic areas listed. Undergraduate students may submit proposals for poster sessions. Sessions involving practitioners will be given consideration. Submissions will be blind refereed and accepted papers will be published in the Conference Proceedings. By submitting a manuscript, the author certifies that it is not copyrighted or previously published, has not been presented or accepted for presentation at another professional meeting, and is not currently under review for presentation at another professional meeting. At least one of the authors certifies that he/she intends to register for and attend the conference to present the paper if it is accepted.

All papers, abstracts, and posters must be submitted electronically by January 15, 2022 through the conference website at nedsi2022.exordo.com. If you have proposals for workshops or roundtable discussions, please email the program chair. Details on conference registration are at https://nedsi.decisionsciences.org/.

OUTSTANDING PAPER AWARDS

Outstanding papers are eligible for the following awards:
- David M. Levine Best Paper Award in Innovative Teaching
- Richard Briotta Best Paper Award in Knowledge Management/Strategy
- Bryant University Best Paper Award in Supply Chain Management and Logistics
- Best Ph.D. Student Paper Award
- Best Contribution to Theory Award
- Best Application of Theory Award
- Best Overall Conference Paper Award

PROGRAM TRACKS

- Accounting, Finance, Economics
- Big Data, Analytics, and Knowledge Management
- Cyber Security, IT, and Emerging Technologies
- Decision Making: Public Administration and Policy
- DSS, Machine Learning, and Artificial Intelligence
- Education, Curriculum, and Cases
- Healthcare Analytics and Services Management
- Human-Technology Interface
- Innovation and Creativity
- Legal, Ethical, and Social Issues
- Operations Management/Operations Research
- Marketing and Consumer Behavior
- Strategy and Organizational Behavior
- Supply Chain Management and Logistics
- Sustainability Management
- Undergraduate/Master Student Poster Competition

HOTEL ACCOMMODATIONS

The conference venue will be at a centrally located hotel in Newark, NJ. There will be a special conference room rate. The hotel will permit easy access to all of Newark's main attractions such as NJPAC, Newark Museum, Ironboud, and the annual Cherry Blossom Festival at Branch Brook Park.

CONTACT INFORMATION

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