

**Decision Sciences Institute**  
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# Northeast Decision Sciences Institute

**51st Annual Conference Proceedings**

**April 7-9, 2022**

**Newark, NJ**



**DISRUPTIVE TECHNOLOGIES IN A POST PANDEMIC WORLD**

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# **NEDSI 2022**

**Northeast Decision Sciences Institute**

**51st Annual Conference Proceedings**

**DISRUPTIVE TECHNOLOGIES IN A  
POST PANDEMIC WORLD**

**HOST INSTITUTION**

**Martin Tuchman School of Management  
New Jersey Institute of Technology**

**April 7-9, 2022**

**Newark, New Jersey**



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## ■ TABLE OF CONTENTS

Welcome Letters

**4** Mayor of the City of Newark

**5** Dean of Martin Tuchman School of Management

**6** Program Chair of NEDSI 2022 Conference

**7** Keynote Speaker

**8** Lifetime Service Award Recipient

**9** About the Decision Sciences Institute

**9** About the Northeast Decision Sciences Institute

**10** NEDSI 2022 Conference Sponsors

**11** NEDSI 2022 Conference Exhibitor

**12** NEDSI Board of Directors 2021-2022

**12** Officers at Large 2021-2022

**12** Presidential Advisory Council 2021-2022

**12** Advisors at Large 2021-2022

**14** Program Track Chairs

**15** Conference Reviewers

**17** NEDSI Lifetime Service Award

**17** NEDSI Service Recognitions to Program Chairs

**18** NEDSI Service Recognitions to Past Presidents

**19** Best Paper Committee

**19** Undergraduate/Master Student  
Poster Competition Committee

**20** Best Paper Awards

**21** Undergraduate/Graduate Research  
Poster Participants

**24** Undergraduate Student Research Poster Awards

**24** Best Graduate Student Research Poster Awards

**28** Conference Program Proceedings



CITY OF **NEWARK**  
Mayor Ras J. Baraka



April 7, 2022

Northeast Decision Sciences Institute  
c/o Robert Treat Hotel  
50 Park Place  
Newark, New Jersey 07102

Dear Friends of the Northeast Decision Sciences Institute:

On behalf of the people of Newark, it is a great pleasure to welcome the Northeast Decision Sciences Institute (NEDSI) to our City for its 51st Annual Conference. The conference's theme is very timely—Disruptive Technologies in a Post Pandemic World. Given this theme, it is truly appropriate that the Martin Tuchman School of Management at New Jersey Institute of Technology is the conference's host institution.

NEDSI, a regional division of the Decision Sciences Institute, is internationally recognized as a scholarly professional organization that fosters forums to create, enhance, and improve managerial decision-making by integrating all the disciplines of the decision sciences. NEDSI conferences are well known for the research contributions presented by both practitioners and scholars. Your work has a dynamic and positive impact on how we act in the present and prepare for the future.

We are delighted that NEDSI chose the City of Newark to have its conference this year. While you are here, we encourage you to enjoy Newark's many attractions—such as the Cherry Blossom Festival, our diverse dining in the Ironbound, the New Jersey Performing Arts Center, and The Newark Art Museum.

All the best for an enjoyable conference!

Sincerely yours,

Ras J. Baraka  
Mayor





On behalf of New Jersey Institute of Technology’s Martin Tuchman School of Management, I welcome all participants of the 2022 Northeast Decision Sciences Institute (NEDSI) Annual Meeting, taking place in our beautiful City of Newark.

I am thoroughly appreciative of the NEDSI organizing committee for selecting Newark as the conference venue. The city has a rich history as a leading industrial center, with a strong and diverse workforce, and houses the world’s leading seaports and airports. Newark is also known for its Branch Brook Park, celebrated for its Japanese cherry trees, as well as the Newark Museum of Art and the New Jersey Performing Arts Center, which I hope you will get a chance to visit.

As part of a public polytechnic university, rated R1 by the Carnegie Classification® for “Very High Research Activity,” Martin Tuchman School of Management positions itself as a “Business School With the Power of Technology.” We teach and research cutting-edge technology within a business context. You will hear presentations from our Ph.D. students, who are in the Ph.D. program in Business Data Science, a leading-edge interdisciplinary program that integrates business analytics with scientific methods from statistics, computer science and engineering to improve knowledge discovery and decision-making in management.

We are delighted to host this event as part of our commitment to provide a platform for researchers, scholars, practitioners and students to share and disseminate new knowledge and advance management sciences and technology. I hope that you enjoy the conference and your stay in Newark.

Oya Tukel  
*Dean*  
*Martin Tuchman School of Management*



Dear Colleagues,

It is with great pleasure that I have the honor to welcome you to the 51st Annual Conference of NEDSI. This is a very special conference. It is NEDSI's first in-person conference in three years, for the pandemic resulted in the cancellation of the 2020 conference and required the 2021 conference to be a virtual one.

The interest expressed by our many colleagues and friends in this year's conference is a testament to the importance and relevance of NEDSI. NEDSI is relevant and will continue to be relevant into the future for scholars and practitioners. It is an organically vibrant institution where scholars and practitioners present their research and keep abreast of their areas of expertise and interlace into new horizons; it is an association where salient networking occurs, and friendships are made for a lifetime. Conference participants have frequently commented how much they enjoy the amicable nature of NEDSI's conferences. It is with this spirit that all the officers of NEDSI cordially welcome you to our NEDSI 2022 Conference in Newark, N.J. The venue for NEDSI 2022 is the centrally located historic Robert Treat Hotel in Newark, N.J. The hotel allows for easy access to many of Newark's main attractions such as New Jersey Performing Arts Center, The Newark Museum of Art, Ironbound and the annual Cherry Blossom Festival at Branch Brook Park — which will be during our conference.

Economists have a concept referred to as creative destruction, a dynamic transformational process by which de novo technologies replace prior modes of production and thus propel society forward. It is in this spirit that the theme for NEDSI 2022 is "Disruptive Technologies in a Post Pandemic World." So, let our synergetic interactions at NEDSI 2022 reflect on how the postpandemic world is being transformed by the creative-destructive process fomented by the pandemic itself.

NEDSI 2022 has over 50 sessions representing a multitude of disciplines in the decision sciences. They are the contributions of approximately 300 scholars. In addition, please participate in our trip to the Cherry Blossom Festival and the President's Reception, both on Thursday, and the Gala Awards Dinner on Friday, to be followed on Saturday to a trip to The Newark Museum of Art.

Again, on behalf of all the officers of NEDSI, we welcome you to NEDSI 2022. Enjoy the conference!

Cordially,

Theologos Homer Bonitsis, Ph.D.  
*Program Chair NEDSI 2022*  
*Associate Professor of Finance*



■ **KEYNOTE SPEAKER Steven Saperstein**



Steven Saperstein is currently the president of Linvale Consulting, LLC, where he consults for a large global investment management firm on a business transformation project as an external steering committee member. Before this current project, Saperstein retired (2020) as the chief operating officer (COO) of PGIM Fixed Income, where he served as the COO for over 20 years. As COO, he managed operations, technology, securities lending, finance and business management. PGIM Fixed Income is a global investment manager with over \$900 billion in assets. Saperstein served in many governance roles during his tenure, including the chairman of Prudential Trust Company, which manages over \$50 billion. Before assuming the role of COO, he held several other roles at Prudential Financial including the controller of Prudential Individual Insurance and Prudential Real Estate Investors. He spent several years in corporate tax and other finance functions at Prudential Financial, which he joined in 1984 shortly after receiving a bachelor's degree in industrial administration from NJIT. He also holds a master's degree in business administration from Rutgers University.

In addition to his corporate accomplishments, Saperstein has been a dedicated alumnus of NJIT. He served as a member of the NJIT Board of Overseers, where he chaired the Foundation's Investment Committee, and was president and vice president of the Alumni Association of NJIT. He was a foundational member of the Young Alumni Association, served as a member of NJIT's College of Science and Liberal Arts Board of Visitors and Martin Tuchman School of Management Board of Visitors, and served on the editorial board for *NJIT Magazine*. In 2012, Saperstein received the Edward F. Weston Medal, which is presented to alumni in recognition of outstanding personal, professional and civic achievement and commitment to the development of the university. Then, in 2015, he received the Alumni Association's Distinguished Alumni Achievement Award. Saperstein also was a dedicated board member to the JCC of Somerset and Hunterdon Counties, New Jersey, for many years. He currently resides in Newtown, Pa., with his wife Alison.

■ **NEDSI LIFETIME SERVICE AWARD RECIPIENT Maling Ebrahimpour**  
**University of Rhode Island**  
**College of Business**



Dean Maling Ebrahimpour earned his Ph.D. from the University of Nebraska-Lincoln under the mentoring of the venerable Sang Lee, who introduced him to the Decision Sciences Institute (DSI). He has tirelessly served DSI and NEDSI since 1983 in many roles including chairing several committees and as a member of the Board of Directors and Advisory Committee, and as program chair and president of both organizations. His first NEDSI award was Best Application of Theory paper in 1990, which he repeated in 1997, 2000 and 2003. He became program chair of NEDSI's annual conference in 1996 and president in 1997. Due to his excellence in running conferences, Ebrahimpour was also selected as program chair for DSI in 2010, made a "Fellow" of DSI in 2012 and then elected as president in 2013. Ebrahimpour has supported the institute financially through several administrative roles. During his tenure as department chair in management science at URI (1992-1999), associate dean at URI (1999-2002), dean of the Gabelli School of Business (2002-2008) and then dean of the URI College of Business (2014-2022), he has supported faculty and doctoral students at NEDSI conferences and sponsored numerous coffee breaks, luncheons, dinners and speakers for NEDSI. He has served the institute in some capacity for almost 40 years and is loved and respected by all who know him. Ebrahimpour's commitment and service to NEDSI has been instrumental to its robust organic growth. NEDSI is what it is today as a result of his service and vision. The NEDSI community is profoundly grateful for this.



## The 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 DSI provides an international forum for presenting and sharing research in the study of decision processes across disciplines. The DSI 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 DSI. Each region has its own elected officers and representative on the Board of Directors and holds annual meetings.

The DSI, an independent nonprofit 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.

## The Northeast Decision Sciences Institute

The Northeast Decision Sciences Institute (NEDSI) is one of five regions in the Americas Division of the professional society, the Decision Sciences Institute. This 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, a placement service, case writing and other interesting innovations in the fields of accounting, business education, finance, HRM, management, marketing, MIS/DSS/expert systems and IT, organizational behavior, operations management, strategic management and supply chain management, among others. Awards for “Best Paper” in several categories are given each year.

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- MBA in Marketing

### Research Areas

- Accounting
- Finance
- Marketing
- Operations & Decision Analytics
- Organizational Behavior
- Strategy & Entrepreneurship



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**Maling Ebrahimpour**  
University of Rhode Island  
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School of Business  
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<b>Pedro M. Reyes</b>	Baylor University
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<b>Krista Hill</b>	Babson College
<b>Kellyann Berube Kowalski</b>	UMass Dartmouth
<b>Jennifer A. Swanson</b>	Stonehill College

**David M. Levine Best Paper Award in Innovative Teaching**

*Simi Bot: A Text Data Mining Teaching Tool*

Andres Fortino, New York University

Wukon Chen, New York University

**Richard Briotta Best Paper Award in Knowledge Management/Strategy**

*Text Data Mining to Track Information Technology Trends*

Andres Fortino, New York University

Yiying You, New York University

**Bryant University Best Paper Award in Supply Chain Management and Logistics**

*Co-creation in New Product Development: Collaborating with the Competitor in the Presence of a Shared Supplier*

Abhishek Roy, Temple University

**Best Ph.D. Student Paper Award**

*A Conceptual Framework: The Role of Parents' Personal Mores and Trust in a School-Based Telemedicine Program*

Farnaz Ghashami, Drexel University

Christopher Gantz, Jefferson University Hospitals

**Best Contribution to Theory Award**

*The Network Factor of Equity Pricing: A Signed Graph Laplacian Approach*

Ajim Uddin, New Jersey Institute of Technology

**Best Application of Theory Award**

*A Game-theoretic Model of the Consumer Behavior Under Pay-What-You-Want Pricing Strategy*

Vahid Ashrafimoghari, Stevens Institute of Technology

Jordan Suchow, Stevens Institute of Technology

**Best Overall Conference Paper Award**

*Network Centrality, Leadership, and Institutional Investors Portfolio Performance*

Ajim Uddin, New Jersey Institute of Technology

Xinyuan Tao, New Jersey Institute of Technology



**Assessing Cyber Security Threats Through Sentiment Analysis on Social Media**

Grace Yepez, University of the District of Columbia  
Demario Asquitt, University of the District of Columbia  
Amit Arora, University of the District of Columbia  
Anshu Arora, University of the District of Columbia

**Chatbots for Cyber Security: Reducing Threats and Vulnerabilities**

Chevell Parnell, University of the District of Columbia  
Allan Muir, University of the District of Columbia  
Amit Arora, University of the District of Columbia  
Anshu Arora, University of the District of Columbia

**Detection of COVID-19 & Pneumonia with X-Rays Images, Using Neural Networks (Graduate)**

Natalia De La Fuente, New Jersey City University

**How Social Robotics Supports Learning Development**

Emily Osbourne, University of the District of Columbia  
Anshu Arora, University of the District of Columbia  
Amit Arora, University of the District of Columbia

**Inflation Forecasting in Changing World**

Dhwani Shah, New Jersey City University  
EunSu Lee, New Jersey City University

**Loyal to Leader vs. Organization? The Influence of the Goal Discrepancy  
Between Leader and Organization on Followers' Behaviors**

Rosa Pelaez Vinuela, Kean University  
Zyasia Nash, Kean University

**Marketing Research on Brockopp Brewing Expansion Plan: Family-Owned Brewery in Valley  
City, ND**

Taylor Sargent, Valley City State University  
Reagan Ingstad, Valley City State University  
Jocelyn Braunberger, Valley City State University  
Jacob Gottenborg, Valley City State University  
Minqwei Guo, Valley City State University

**Slick Road Prediction Modeling to Support MBTA Winter Storm Planning (Graduate)**

Yiwei Song, Boston University

**Solar Power Industry in Colombia and the Cultural Impact on Its Development**

Muriel Mena, Bridgewater State University

Xiangrong Liu, Bridgewater State University

**TEAM – ROB-I-LEARN: Robotic Interventions for Learning. Developing Ethical Robots Engaged in Robotic Interventions for Students with Learning Disabilities**

Grace Yopez, University of the District of Columbia

Andrew Sammonds, University of the District of Columbia

Chevell Parnell, University of the District of Columbia

Anshu Arora, University of the District of Columbia

Amit Arora, University of the District of Columbia

**The Cross-National Comparative Business Practices Between the Philippines and United States of America**

Glynnis Tan, Kean University

Justin Antonio, Kean University

**The Effect of Emotional Intelligence and Shared Leadership and the Mediation Effect of Team Cohesion and Team Trust: IMOJ Model Approach**

Justin Antonio, Kean University

Glynnis Tan, Kean University

**The Effects of Length of Stay and Readmission on Total Charges of Total Knee and Hip Arthroplasty Patients (Graduate)**

Tyler Wright, Eastern Connecticut State University

Fatma Pakdil, Eastern Connecticut State University

**The Scale Development of a New Typology Model of Leader-Follower Relationships**

Janell Laws, Kean University

Jephte Philippe, Kean University

**Transparency in Online Community Moderation: The Case of Shadowbanning**

Lea Burton, Stevens Institute of Technology

Jordan W. Suchow, Stevens Institute of Technology

Vahid Ashrafimoghari, Stevens Institute of Technology

**Vaccine Supply Chain Systems: A Systematic Literature Review Using Operations Management Perspective**

Fatma Pakdil, Eastern Connecticut State University

Merita Cecunjanin, Eastern Connecticut State University

Aidan Dunn, Eastern Connecticut State University

Nancy Gonzalez, Eastern Connecticut State University

Nicole Thomassen, Eastern Connecticut State University

**Video-Based Risk Assessment for Insurance Companies and Drivers: Demonstrating the Design Science Methodology**

Pete Treebumrung, California State University, Los Angeles

Pamella Howell, California State University, Los Angeles

**What Will Be the Future Regarding Remote Work and Will Remote Work Continue or Go Back to Face to Face Interactions?**

Zyasia Nash, Kean University

Rosa Pelaez Vinuela, Kean University



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## ■ NEDSI 2022 UNDERGRADUATE STUDENT RESEARCH POSTER AWARDS

### First Place

*Assessing Cyber Security Threats Through Sentiment Analysis on Social Media*

Grace Yepez, University of the District of Columbia

Demario Asquitt, University of the District of Columbia

### Second Place

*The Effect of Emotional Intelligence and Shared Leadership and the Mediation Effect of Team Cohesion and Team Trust: IMOJ Model Approach*

Justin Antonio, Kean University

Glynnis Tan, Kean University

### Third Place

*Marketing Research on Brockopp Brewing Expansion Plan:*

*Family-Owned Brewery in Valley City, ND*

Taylor Sargent, Valley City State University

Reagan Ingstad, Valley City State University

Jacelyn Braunberger, Valley City State University

Jacob Gottenborg, Valley City State University

### Fourth Place

*Video-Based Risk Assessment for Insurance Companies and Drivers:*

*Demonstrating the Design Science Methodology*

Pete Treebunrung, California State University, Los Angeles

## ■ NEDSI 2022 BEST GRADUATE STUDENT RESEARCH POSTER AWARDS

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# Table of Contents

## Papers

### Accounting, Finance, Economics

**Business Ethics: Talmudic View** 3

Prof. Chani Mintz<sup>1</sup>, Dr. Hershey Friedman <sup>1</sup>

1. *Koppelman School of Business, Brooklyn College, CUNY*

**Middle-Income Countries: Today's Changes for the Purpose of the Future** 9

Ms. Turana Zamanova<sup>1</sup>

1. *The University of Rhode Island*

### Big Data, Analytics, and Knowledge Management

**Analytical Models for Predicting Bitcoin Price** 33

Ms. Bianca Berman <sup>1</sup>, Dr. Ahmad Vakil<sup>2</sup>

1. *St. John's University*, 2. *St. John's University, Business Analytics & Information Systems, Tobin College of Business*

**CHAC-olate: A Machine Learning Approach to Understanding the Effects of Rainfall on Cacao Trees During the Mayan Era** 52

Ms. Amanda Nitting<sup>1</sup>, Dr. Jay Liebowitz <sup>1</sup>

1. *Seton Hall University*

**Developing Story in Analytics Course** 78

Dr. Anil Aggarwal<sup>1</sup>

1. *University of Baltimore*

**Opportunities and Challenges of Implementing Real-Time Data Warehousing in Higher Education** 81

Ms. Liping Qin<sup>1</sup>, Dr. Rhoda Joseph <sup>1</sup>

1. *Penn State Harrisburg*

### Cyber Security, IT, and Emerging Technologies

**Effects of IT-Enabled Dynamic Capabilities on Organizational Agility in Innovation: Empirical Research in the Context of Developing Economy** 95

Dr. Adilson Yoshikuni<sup>1</sup>, Mr. Murilo Almeida <sup>2</sup>, Dr. Rajeev Dwivedi <sup>3</sup>

1. *Mackenzie Presbyterian University*, 2. *Fundação Getulio Vargas - EASESP*, 3. *Eastern Washington University*

## Decision Making: Public Administration and Policy

**An Overview of Chinese Joint Ventures and “Made in China 2025” Plan** 114

Dr. Shaoping Zhao<sup>1</sup>, Dr. Haidong Liu<sup>1</sup>

1. *Stockton University*

**Reengineering Bureaucracy in Public Administration for Better Decision Making** 122

Dr. Mysore Ramaswamy<sup>1</sup>

1. *Southern University, Baton Rouge*

**Using Data Envelopment Analysis to Measure and Improve Organizational Performance** 138

Prof. THOMAS SEXTON<sup>1</sup>, Prof. Christine Pitocco<sup>1</sup>, Prof. Herbert Lewis<sup>1</sup>

1. *College of Business, Stony Brook University*

## DSS, Machine Learning, and Artificial Intelligence

**Severity Prediction Models to Support MBTA Winter Storm Planning** 181

Prof. John Maleyeff<sup>1</sup>, Mrs. Yiwei Song<sup>1</sup>, Ms. Ruoqia Peng<sup>1</sup>, Ms. Xiaotong (Claire) Ding<sup>1</sup>

1. *Boston University*

## Education, Curriculum, and Cases

**Culturally Adaptive Thinking in Education (CATE): Strategies for Assuaging Algorithmic Bias and Artificial Intelligence Risks Concerns in Learners** 190

Dr. Yana Samuel<sup>1</sup>, Dr. Margaret Brennan - Tonetta<sup>2</sup>, Dr. Jim Samuel<sup>2</sup>, Dr. Rajiv Kashyap<sup>3</sup>, Dr. Alex Pelaez<sup>4</sup>

1. *Northeastern University*, 2. *Rutgers University*, 3. *William Paterson University of New Jersey*, 4. *Hofstra University*

**Disruptive Technologies to Build an Integrative Entrepreneurial Experience in a Post Pandemic World** 199

Prof. Eda Sanchez-Persampieri<sup>1</sup>, Prof. Katja Schroeder<sup>2</sup>, Prof. vincent vazzana<sup>1</sup>

1. *St Francis College*, 2. *St. Francis College*

**Identifying the Core Antecedents to Positive Online Learning** 209

Mr. Amal Jacobson<sup>1</sup>, Dr. Alex Pelaez<sup>2</sup>, Dr. Elaine Winston<sup>2</sup>

1. *Progressive School of Long Island*, 2. *Hofstra University*

**Integrating Sustainability and Data Analysis in Teaching Service Operations Management through a Collaborative University Business Experiences (CUBEs) Project** 220

Dr. Xiangrong Liu<sup>1</sup>, Dr. Robert Hellström<sup>2</sup>, Dr. Stephanie Jacobsen<sup>2</sup>

1. *Bridgewater State University*, 2. *Bridgewater State University*

**Text Data Mining To Track Information Technology Trends** 228

Dr. Andres Fortino<sup>1</sup>, Ms. Yiyang You<sup>1</sup>

1. *NYU*

## Healthcare Analytics and Services Management



**A Conceptual Framework: The Role of Parents' Personal Mores and Trust in a School-Based Telemedicine Program** 247

Ms. Farnaz Ghashami<sup>1</sup>, Dr. Christopher Gantz<sup>2</sup>, Dr. David Gefen<sup>1</sup>

1. Drexel University, 2. Jefferson University Hospitals

**Climate Change Impacts on Boston Hospitals** 265

Mr. David Weidman<sup>1</sup>, Dr. Canan Corlu<sup>1</sup>, Ms. Pennart Klanwari<sup>1</sup>, Ms. Jiayi Pan<sup>1</sup>

1. Boston University

**Using Data Analytics to Improve Nursing Home Performance** 275

Prof. Christine Pitocco<sup>1</sup>, Prof. THOMAS SEXTON<sup>1</sup>

1. College of Business, Stony Brook University

## Human-Technology Interface

**Mobile Based Augments Reality Games: A Study from Hedonic Motivation System Adoption Model Perspective** 293

Mr. Syed Abdullah Ashraf<sup>1</sup>, Mr. Aariz Faizan Javed<sup>1</sup>, Dr. Pradip Kumar Bala<sup>1</sup>, Dr. Rashmi Jain<sup>2</sup>

1. Indian Institute of Management Ranchi, 2. Montclair State University

## Innovation and Creativity

**Creativity and Innovation: A Critical Review** 304

Mr. Neil Desnoye<sup>1</sup>

1. Saint Joseph's University

## Legal, Ethical, and Social Issues

**Corporate Social Responsibility and Prosocial Motivation in the Workplace During Covid-19 Pandemic** 315

Dr. C. Christopher Lee<sup>1</sup>, Dr. Heechang Shin<sup>2</sup>, Mr. Juan Murillo<sup>1</sup>, Mr. Michael Inabinet<sup>1</sup>, Mr. Kyle Welch<sup>1</sup>, Mr. Elijah Amoah<sup>1</sup>, Mr. Benjamin Lee<sup>3</sup>

1. Central Connecticut State University, 2. Iona College, 3. Cornell University

**Innovative Approaches to Teaching Ethics** 335

Dr. Hershey Friedman<sup>1</sup>, Prof. Deborah Kleiner<sup>2</sup>, Prof. James Lynch<sup>1</sup>

1. Koppelman School of Business, Brooklyn College, CUNY, 2. St. John's University, Tobin College of Business, Department of Law

## Operations Management / Operations Research

**Poisson-Binomial Distribution for Conforming Units in a Continuous-Review (s,Q) Model with Backorders and Reworks** 356

Dr. Javad Paknejad<sup>1</sup>, Dr. John F. Affisco<sup>1</sup>, Dr. Farrokh Nasri<sup>1</sup>

1. Hofstra University

## Sustainability Management

<b>Plastic Crisis: A Business Data-Driven study on the Evolution of its Practice and Research</b>	<b>371</b>
<u>Ms. Nesreen El-Rayes<sup>1</sup>, Dr. Jim (Junmin) Shi<sup>1</sup></u>	
<i>1. New Jersey Institute of Technology Martin Tuchman School of Management</i>	

## Strategy and Organizational Behavior

<b>“Fighting the Last War”: The Importance of Organizational Resilience and Leadership Agility in the Digital Age</b>	<b>398</b>
<u>Dr. Sarah Hertz<sup>1</sup>, Dr. Hershey Friedman<sup>2</sup></u>	
<i>1. Empire State College, SUNY, 2. Koppelman School of Business, Brooklyn College, CUNY</i>	

<b>Analysis of Tactical Decision-Making of Undergraduate Course Coordinators of a Community Higher Education Institution in Brazil</b>	<b>418</b>
<u>Dr. Eduardo Bugallo<sup>1</sup>, Dr. Paulo Fossatti<sup>1</sup>, Dr. Jefferson Monticelli<sup>1</sup></u>	
<i>1. La Salle University</i>	

<b>Competences of the manager of the XXI century from the leader chat series of the newspaper of Canoas</b>	<b>437</b>
<u>Dr. Paulo Fossatti<sup>1</sup>, Ms. Louise da Silva<sup>1</sup>, Ms. Charlene Luz<sup>1</sup>, Dr. Eduardo Bugallo<sup>1</sup></u>	
<i>1. La Salle University</i>	

## Supply Chain Management and Logistics

<b>Inditex’s ESG Performance in a Global Financial Market</b>	<b>458</b>
<u>Ms. Sara Habig<sup>1</sup>, Prof. Cathy Zheng<sup>1</sup></u>	
<i>1. Bryant University</i>	

<b>Port Congestion Chaos and Our Remedy</b>	<b>480</b>
<u>Mr. Alexander Singer<sup>1</sup>, Prof. Yu Xia<sup>2</sup></u>	
<i>1. College of William &amp; Mary, 2. College of William and Mary</i>	

<b>Shuffled Frog Leaping Algorithm for Solving Multi-Objective U-Shaped Disassembly Line Balancing Problem</b>	<b>502</b>
<u>Mr. Pengfei Yao<sup>1</sup>, Dr. Surendra Gupta<sup>1</sup></u>	
<i>1. Northeastern University</i>	

<b>Strategic Design of Humanitarian Supply Chain System Using General Two-Stage DEA Model</b>	<b>511</b>
<u>Prof. Jae-Dong Hong<sup>1</sup></u>	
<i>1. South Carolina State University</i>	

## Marketing and Consumer Behavior

<b>A Game-theoretic Model of the Consumer Behavior Under Pay-What-You-Want Pricing Strategy</b>	<b>518</b>
<u>Mr. Vahid Ashrafimoghari<sup>1</sup>, Prof. Jordan W. Suchow<sup>2</sup></u>	
<i>1. Stevens Institute of Technology, 2. Stevens Institute of Technology</i>	

<b>Shortening the Sales Cycle: A Quantitative Study Linking Construal Level Theory and Choice in Financial Services</b>	<b>530</b>
<u>Dr. Kevin McGarvey</u> <sup>1</sup> , Dr. David Gefen <sup>1</sup>	
<i>1. Drexel University</i>	
<b>Using Analytics to Quantify the Best Advertising Medium</b>	<b>550</b>
<u>Dr. Joseph Catanio</u> <sup>1</sup> , Mr. Nathan Neil <sup>2</sup>	
<i>1. Shippensburg University, 2. LaunchUX</i>	
<b>What Factors Influence Hypermarket Sales? Using Buyer Behavior Framework to Explore the Consumer Buying Habits</b>	<b>558</b>
<u>Mr. Aariz Faizan Javed</u> <sup>1</sup> , Mr. Syed Abdullah Ashraf <sup>2</sup> , Dr. Pradip Kumar Bala <sup>2</sup> , Dr. Rashmi Jain <sup>3</sup>	
<i>1. IIM Ranchi, 2. Indian Institute of Management Ranchi, 3. Montclair State University</i>	
<b>Abstracts</b>	
<b>Accounting, Finance, Economics</b>	
<b>A Comparative Analysis of the Determinants of the United States and United Kingdom Banks' Profitability</b>	<b>565</b>
<u>Dr. Ikechukwu Ndu</u> <sup>1</sup> , Dr. Emmanuel Anoruo <sup>2</sup> , Dr. Chiaku Chukwuogor <sup>3</sup>	
<i>1. University of Southern Maine, 2. Coppin State University, 3. Eastern Connecticut State University</i>	
<b>Disruptive Education of College of Business Students after the 2008 U.S. Financial Crisis in a Post-Pandemic World</b>	<b>566</b>
<u>Dr. Carmen Quirvan</u> <sup>1</sup>	
<i>1. The University of Rhode Island</i>	
<b>Disruptive Taxation—A Case Study of How Financial Engineering Failed to Enhance Shareholder Value</b>	<b>567</b>
<u>Dr. A J Stagliano</u> <sup>1</sup>	
<i>1. Saint Joseph's University</i>	
<b>Employee Reviews Dispersions and Firm Performance</b>	<b>568</b>
<u>Ms. Ji Sui</u> <sup>1</sup> , Dr. Feng Mai <sup>1</sup> , Dr. Jing Chen <sup>1</sup>	
<i>1. Stevens Institute of Technology</i>	
<b>Extreme Weather Patterns and Risk Assessment Strategies by Banking Industry: A survey</b>	<b>569</b>
<u>Dr. Demetri Tsanacas</u> <sup>1</sup>	
<i>1. William Paterson University</i>	
<b>Option pricing with machine learning</b>	<b>570</b>
<u>Dr. J.D Jayaraman</u> <sup>1</sup>	
<i>1. New Jersey City University</i>	
<b>Simplification May Not be so Simple: Adoption of ASU 2021-08</b>	<b>571</b>
<u>Dr. Nathan Slavin</u> <sup>1</sup> , Dr. Jianing Fang <sup>2</sup>	
<i>1. Hofstra University, 2. Kean University</i>	

---

**Toward a Single Framework of Environmental and Financial Disclosure by Companies, An Unsustainable Silence** 572

Dr. Carmen Quirvan<sup>1</sup>

1. *The University of Rhode Island*

**Big Data, Analytics, and Knowledge Management**

**AI-Enabled Knowledge Management in Organizations: Incentives for Knowledge Sharing** 574

Dr. Shankar Sundaresan<sup>1</sup>, Dr. Zuopeng Zhang<sup>2</sup>

1. *Rutgers University-Camden*, 2. *University of North Florida*

**An Investigation of the predictability of uncertainty indices on Bitcoin returns** 575

Dr. Carolyn Wang<sup>1</sup>, Dr. Geoffrey Ngene<sup>2</sup>, Dr. Yan Shi<sup>3</sup>

1. *New Jersey Institute of Technology*, 2. *Mercer University*, 3. *University of Wisconsin*

**Big Data Analytics and Supply Chain Management, and Firm Performance** 576

Dr. Steve ZHOU<sup>1</sup>

1. *University of Houston Downtown*

**Big Data: Concerns and Clarifications** 577

Dr. Jinchang Wang<sup>1</sup>

1. *Stockton University*

**Latent Dirichlet Allocation Topic Modeling and Doc2Vec with Genism: A Survey of Text Analysis Methods on Yelp Reviews** 578

Mr. Mojtaba Talaei-Khoei<sup>1</sup>, Prof. Asil Oztekin<sup>1</sup>, Prof. Ann Kronrod<sup>1</sup>, Prof. Ali Dag<sup>2</sup>

1. *Manning School of Business, University of Massachusetts Lowell, MA, USA*, 2. *Heider College of Business, Creighton University, Omaha, NE, USA*

**Opinion Leader Detection Using Deep Learning** 579

Dr. Yang Li<sup>1</sup>, Dr. Yanni Ping<sup>2</sup>, Dr. Abdullah Albizri<sup>1</sup>

1. *Montclair State University*, 2. *St. John's University*

**Re-examining Social Media Data: Reducing Bias and Disinformation in Natural Language Processing Systems** 580

Dr. Jin-A Choi<sup>1</sup>, Dr. Rajiv Kashyap<sup>1</sup>, Dr. Cyril Ku<sup>1</sup>, Dr. Jim Samuel<sup>2</sup>

1. *William Paterson University of New Jersey*, 2. *Rutgers*

**Understanding and Analyzing the Strengths and Weaknesses of Corporate Social Actions** 581

Mrs. JIE LI<sup>1</sup>, Prof. Peter Tashman<sup>1</sup>, Dr. Joseph Gonzales<sup>2</sup>, Prof. Asil Oztekin<sup>3</sup>

1. *Manning School of Business, University of Massachusetts Lowell, Massachusetts, USA*, 2. *Department of Psychology, University of Massachusetts Lowell, MA, USA*, 3. *Manning School of Business, University of Massachusetts Lowell, MA, USA*

**Cyber Security, IT, and Emerging Technologies**

**A Research Study Proposed to Examine the Effect of Software Customization on Software Startup Projects.** 583

Dr. Sudhaman Parthasarathy<sup>1</sup>, Dr. Girish Subramanian<sup>2</sup>

1. *Thiagarajar College of Engineering*, 2. *Penn State Harrisburg*

---

<b>Evaluation and Review of Cybersecurity Forensic Tools Available for the Raspberry Pi</b>	584
<u>Prof. Stanley Mierzwa<sup>1</sup>, Mr. Benjamin Lorenc<sup>1</sup></u>	
<i>1. Kean University</i>	
<b>Hotel Technology Selection</b>	585
<u>Dr. Jin Fang<sup>1</sup>, Dr. Fariborz Partovi<sup>2</sup></u>	
<i>1. Clark University, 2. Drexel University</i>	
<b>IT Transformation at Smithfield Foods: From On-Premises Data Center to a Cloud-Based ERP System</b>	586
<u>Dr. Dmitriy Shaltayev<sup>1</sup>, Dr. Robert Hasbrouck<sup>1</sup></u>	
<i>1. Christopher Newport University</i>	
<b>DSS, Machine Learning, and Artificial Intelligence</b>	
<b>A Virtual Assistant for Moderators: Enforcing Social Norms in Online Communities</b>	588
<u>Mr. Necdet Gurkan<sup>1</sup>, Prof. Jordan W. Suchow<sup>1</sup></u>	
<i>1. Stevens Institute of Technology</i>	
<b>Clustering Uncertain Data with Fuzzy Kernel K-Medoids Algorithm</b>	589
<u>Prof. Behnam Tavakkol<sup>1</sup>, Prof. Youngdoo Son<sup>2</sup></u>	
<i>1. Stockton University, 2. Dongguk University-Seoul</i>	
<b>Deep Modular Co-Attention Networks for Online Product Matching</b>	590
<u>Ms. Yangyang Yu<sup>1</sup>, Ms. Ruijing Yang<sup>1</sup>, Dr. Jordan W. Suchow<sup>1</sup>, Dr. Rong Liu<sup>1</sup></u>	
<i>1. Stevens Institute of Technology</i>	
<b>Ensemble Learning Framework to identify the key factors that leads to attrition in software professionals</b>	591
<u>Mr. Aariz Faizan Javed<sup>1</sup>, Mr. Syed Abdullah Ashraf<sup>1</sup>, Dr. Pradip Kumar Bala<sup>1</sup>, Dr. Rashmi Jain<sup>2</sup></u>	
<i>1. Indian Institute of Management Ranchi, 2. Montclair State University</i>	
<b>Ensemble Learning Framework to Identify the Key Factors that Leads to Attrition in Software Professionals</b>	592
<u>Mr. Aariz Faizan Javed<sup>1</sup>, Mr. Syed Abdullah Ashraf<sup>1</sup>, Dr. Pradip Kumar Bala<sup>1</sup>, Dr. Rashmi Jain<sup>2</sup></u>	
<i>1. Indian Institute of Management Ranchi, 2. Montclair State University</i>	
<b>Exploring the Perceptions of Chinese Business Professionals Towards AI Technology</b>	593
<u>Dr. Sung Shim<sup>1</sup></u>	
<i>1. Seton Hall University</i>	
<b>Forecasting Electronic Waste Using Improved Multi-Variate Grey Models with Residual Modification</b>	594
<u>Dr. Gazi Duman<sup>1</sup>, Dr. Elif Kongar<sup>2</sup>, Dr. Surendra Gupta<sup>3</sup></u>	
<i>1. University of New Haven, 2. Fairfield University, 3. Northeastern University</i>	
<b>Leaf Classification using FGIC Tasks via Transfer Learning</b>	595
<u>Dr. Hien Nguyen<sup>1</sup>, Mr. Dev Juneja<sup>1</sup></u>	
<i>1. Penn State Harrisburg</i>	
<b>Learning Low-Dimensional Representations of Marketing Data with Quantum Machine Learning</b>	596
<u>Dr. Pablo Rivas<sup>1</sup>, Dr. Liang Zhao<sup>2</sup></u>	
<i>1. Baylor University, 2. St. Ambrose University</i>	

<b>Performance of Machine Learning under Noise</b>	597
<u>Prof. Amit Das</u> <sup>1</sup>	
<i>1. IFMR Graduate School of Business, Krea University</i>	
<b>Shared-Mobility Recommendation Through Reducing Repetitions in Traffic Networks</b>	598
<u>Mr. Mohammad Bakhsh</u> <sup>1</sup> , <u>Prof. Josephine Namayanja</u> <sup>1</sup>	
<i>1. University of Massachusetts Boston</i>	
<b>Shifts in Religious and Social Attitudes and Behaviors in Response to COVID-19: Understanding the Change in Work Orientation Dynamics within the American Workforce in Response to the Pandemic</b>	599
<u>Mr. Mojtaba Talaei-Khoei</u> <sup>1</sup> , <u>Dr. Joseph Gonzales</u> <sup>2</sup> , <u>Prof. Asil Oztekin</u> <sup>1</sup> , <u>Prof. Kimberly Merriman</u> <sup>1</sup>	
<i>1. Manning School of Business, University of Massachusetts Lowell, MA, USA, 2. Department of Psychology, University of Massachusetts Lowell, MA, USA</i>	
<b>The Role of AI Ethical Guidelines in Regulating Human Behavior</b>	600
<u>Dr. Uma Gupta</u> <sup>1</sup>	
<i>1. University of South Carolina Upstate</i>	
<b>Education, Curriculum, and Cases</b>	
<b>Best Practices for Online Live Asynchronous Interaction in Online Courses</b>	602
<u>Dr. Bhupinder S. Sran</u> <sup>1</sup> , <u>Dr. John W. Weber</u> <sup>1</sup>	
<i>1. DeVry University</i>	
<b>Bringing Industry into the Classroom: Supply Chain Mapping Project in Global Supply Chain Management Courses</b>	603
<u>Mr. Muhammad Hasan Ashraf</u> <sup>1</sup> , <u>Dr. Koray Ozpolat</u> <sup>1</sup> , <u>Dr. Mehmet Yalcin</u> <sup>1</sup>	
<i>1. University of Rhode Island, College of Business</i>	
<b>Developing a Marketing Elective to Incorporate Personal Branding Concepts with Career Service Resources</b>	604
<u>Dr. Kathleen Ferris-Costa</u> <sup>1</sup>	
<i>1. Bridgewater State University</i>	
<b>Engagement Fellows: Partnerships to Improve Learning and Support in Quantitative Courses</b>	605
<u>Dr. Julia Fullick-Jagiela</u> <sup>1</sup> , <u>Dr. Nitish Patidar</u> <sup>1</sup> , <u>Dr. Yan Jin</u> <sup>1</sup>	
<i>1. Quinnipiac University</i>	
<b>Entrepreneurship Education with Societal Significance: Protocols for Aiming Higher</b>	606
<u>Dr. Cesar Bandera</u> <sup>1</sup> , <u>Dr. Regina Collins</u> <sup>1</sup>	
<i>1. New Jersey Institute of Technology</i>	
<b>Exemplars: Show me, then I'll show you</b>	607
<u>Dr. Carolyn LaMacchia</u> <sup>1</sup>	
<i>1. Bloomsburg University of Pennsylvania</i>	
<b>Exploring the Role of Emotional Intelligence in Online Learning</b>	608
<u>Dr. Mohammed Raja</u> <sup>1</sup> , <u>Dr. Ravi Narayanaswamy</u> <sup>2</sup>	
<i>1. York College of Pennsylvania, 2. University of South Carolina - Aiken</i>	



<b>Exploring the UTAUT Model for Learning Management System Use with Business Analytics Education</b>	<b>609</b>
<u>Dr. Ellen Belitzky<sup>1</sup>, Dr. Gazi Duman<sup>1</sup></u>	
<i>1. University of New Haven</i>	
<b>Implementing a Mobile Technology in an Online Healthcare IT Course: A Case Study</b>	<b>610</b>
<u>Dr. Colleen Carraher Wolverton<sup>1</sup></u>	
<i>1. University of Louisiana at Lafayette</i>	
<b>Increasing Student Engagement and Interaction in the Online Classroom: An Intensive Diverse High Impact Multi-Strategy Mini-Teaching Approach</b>	<b>611</b>
<u>Dr. Ikechukwu Ndu<sup>1</sup></u>	
<i>1. University of Southern Maine</i>	
<b>Introducing Causal Inference Using Bayesian Networks and do-Calculus</b>	<b>612</b>
<u>Dr. Tim Lu<sup>1</sup></u>	
<i>1. University of Maine</i>	
<b>Marketing the Olympic Games and the Winter Olympics: What's Changed Over Time?</b>	<b>613</b>
<u>Dr. Elizabeth Elam<sup>1</sup>, Mr. Curt Hamakawa<sup>1</sup></u>	
<i>1. Western New England University</i>	
<b>PESTLE Analysis and Organizational Strategy: Coal in WY</b>	<b>614</b>
<u>Dr. Heidi Hughes<sup>1</sup></u>	
<i>1. Central Connecticut State University</i>	
<b>Simi Bot: A Text Data Mining Teaching Tool</b>	<b>615</b>
<u>Dr. Andres Fortino<sup>1</sup>, Mr. Wukun Chen<sup>1</sup></u>	
<i>1. NYU</i>	
<b>Teamwork and Collaboration Tools for the Virtual Classroom</b>	<b>616</b>
<u>Dr. Kellyann Kowalski<sup>1</sup>, Dr. swanson, jennifer<sup>2</sup></u>	
<i>1. University of Massachusetts Dartmouth, 2. Stonehill College</i>	
<b>Technology Readiness: Does it Matter in Online Learning Environments?</b>	<b>617</b>
<u>Dr. Mohammed Raja<sup>1</sup>, Dr. Ravi Narayanaswamy<sup>2</sup></u>	
<i>1. York, 2. University of South Carolina - Aiken</i>	
<b>The Lived Experiences of Adult Learners in an Individualized Program: Empowerment, Responsibility, Tensions, and Anxiety</b>	<b>618</b>
<u>Prof. Daniel Woldeab<sup>1</sup>, Prof. gemma punti<sup>1</sup>, Prof. Richard Bohannon<sup>1</sup></u>	
<i>1. Metropolitan State University</i>	
<b>Healthcare Analytics and Services Management</b>	
<b>Clustering Hospitals to Analyze the Feasibility of Community Paramedicine Interventions</b>	<b>620</b>
<u>Dr. Mehmet Kilinc<sup>1</sup></u>	
<i>1. Le Moyne College</i>	

<b>Competition and Coordination Between Traditional Hospital and Internet Hospital</b>	<b>621</b>
<u>Dr. Aichih Chang</u> <sup>1</sup> , <u>Dr. Zhongping Li</u> <sup>2</sup>	
<i>1. New Jersey Institute of Technology, 2. Anhui University</i>	
<b>Digitalization of the Medical Field and the Use of Healthcare Information Systems</b>	<b>622</b>
<u>Dr. Edward Chen</u> <sup>1</sup>	
<i>1. University of Massachusetts Lowell</i>	
<b>Economics of Introducing a Mobile Clinic as an Added or Exclusive Modality for Dialysis Service</b>	<b>623</b>
<u>Dr. Mona Jabbari</u> <sup>1</sup> , <u>Prof. Nagesh Murthy</u> <sup>2</sup> , <u>Dr. Eren Cil</u> <sup>2</sup>	
<i>1. Providence College, 2. University of Oregon</i>	
<b>Improving Data Transparency in Clinical Trials Using Blockchain Technology</b>	<b>624</b>
<u>Prof. Afrooz Moatari-Kazerouni</u> <sup>1</sup> , <u>Prof. Amin Keramati</u> <sup>1</sup>	
<i>1. Assistant Professor, Widener University</i>	
<b>Improving Outpatient Appointment Scheduling in Multi-Domain Clinics by Machine Learning Techniques</b>	<b>625</b>
<u>Prof. Davood Golmohammadi</u> <sup>1</sup> , <u>Prof. David Dreyfus</u> <sup>2</sup> , <u>Mr. Lingyu Zhao</u> <sup>1</sup>	
<i>1. University of Massachusetts Boston, 2. Rutgers Business School</i>	
<b>Is it Time for the Healthcare Providers to Rethink Their Service Delivery Strategy? A Regression Analysis Using PA Hospitals</b>	<b>626</b>
<u>Dr. Chamila Kalpani Dissanayake</u> <sup>1</sup> , <u>Dr. Dinesh R. Pai</u> <sup>2</sup>	
<i>1. Penn State University at Brandywine, 2. Pennsylvania State University at Harrisburg</i>	
<b>Machine Learning Models for Prediction of COVID-19 Cases and Deaths: Hyperparameter Optimization and Performance Evaluation</b>	<b>627</b>
<u>Mr. Mojtaba Talaei-Khoei</u> <sup>1</sup> , <u>Mr. James Rolleri</u> <sup>1</sup> , <u>Prof. Asil Oztekin</u> <sup>1</sup>	
<i>1. Manning School of Business, University of Massachusetts Lowell, MA, USA</i>	
<b>Monitoring Length of Stay and Readmissions of Chronic Obstructive Pulmonary Disease (COPD) Patients: A Control Chart-Based Time Series Analysis</b>	<b>628</b>
<u>Prof. Fatma Pakdil</u> <sup>1</sup> , <u>Prof. Nasibeh Azadeh Fard</u> <sup>2</sup> , <u>Prof. Steve Muchiri</u> <sup>1</sup>	
<i>1. Eastern Connecticut State University, 2. Rochester Institute of Technology</i>	
<b>Monte Carlo Simulation for Power Analysis Designing Longitudinal Studies</b>	<b>629</b>
<u>Dr. Simcha Pollack</u> <sup>1</sup>	
<i>1. St. John's University</i>	
<b>Predicting and Explaining Quality in Home Healthcare Agencies: A Machine Learning Approach</b>	<b>630</b>
<u>Dr. Mehmet Kilinc</u> <sup>1</sup> , <u>Dr. Furkan Oztanriseven</u> <sup>1</sup>	
<i>1. Le Moyne College</i>	
<b>Using DEA to Determine Hospital Performance in Reducing HAI Prevalence</b>	<b>631</b>
<u>Prof. Herbert Lewis</u> <sup>1</sup> , <u>Prof. Christine Pitocco</u> <sup>1</sup> , <u>Ms. Veda Sripada</u> <sup>2</sup>	
<i>1. College of Business, Stony Brook University, 2. Department of Applied Mathematics and Statistics, Stony Brook University</i>	

## Innovation and Creativity

- Leveraging IDEAs for Individual and Organizational Development** 633  
Dr. Eric W. Stein<sup>1</sup>, Dr. Denise Potosky<sup>1</sup>  
*1. Penn State*

## Legal, Ethical, and Social Issues

- Elderly Fraud: Profiling the Crime using Data** 635  
Dr. Ahmet Ozkul<sup>1</sup>, Ms. Francesca Tujak-Weiss <sup>1</sup>  
*1. University of New Haven*

- Investigating the Influence of Learning Robotic Process Automation on Artificial Intelligence Anxiety** 636  
Dr. Alsius David<sup>1</sup>  
*1. SUNY Oneonta*

- Meta-Analysis on the Antecedents of Social Entrepreneurial Intention: Comparison between Developed and Developing Countries** 637  
Dr. EunSu Lee<sup>1</sup>  
*1. Kean University*

- Social Entrepreneurship Development: From the Perspective of Michael Porter's Diamond Model** 638  
Dr. EunSu Lee<sup>1</sup>  
*1. Kean University*

- Triple-Effect of Corporate Governance, Managerial Ability, and Corporate Social Responsibility on Firm Performance: a Longitudinal Study** 639  
Prof. Qing (Ray) Cao<sup>1</sup>, Prof. Vicky Gu <sup>2</sup>  
*1. University of Houston-Downtown, 2. University of Houston-Clear Lake*

## Operations Management / Operations Research

- A New Formulation for Multi-Mode Resource-Constrained Project Scheduling Problem** 641  
Prof. Amin Keramati<sup>1</sup>, Prof. Afrooz Moatari-Kazerouni <sup>2</sup>, Prof. Joseph Szmerekovsky <sup>3</sup>  
*1. Assistant Professor, Widener University, 2. Assistant Professor, 3. Professor, North Dakota State University*

- A Real Options Approach to Evaluating Ergonomics Projects to Reduce Musculoskeletal Disorders in the Workplace** 642  
Dr. Cheickna Sylla<sup>1</sup>  
*1. MTSM, NJIT*

- Developing Scheduling Methods to Meet Quantities and Due Dates of Orders** 643  
Prof. sangoh shim<sup>1</sup>  
*1. Hanbat National University*

<b>Forecasting for Datasets with Seasonality: Is it necessary to de-seasonalize the data first?</b>	<b>644</b>
<u>Dr. Mustafa Canbolat</u> <sup>1</sup>	
<i>1. SUNY Brockport</i>	

## Strategy and Organizational Behavior

<b>Collaborative Management Strategies: An Analysis of Success Factors to Achieve Organizational Success</b>	<b>646</b>
<u>Dr. Haleh Karimi</u> <sup>1</sup>	
<i>1. Bellarmine University</i>	

<b>Gen Z: Our Future</b>	<b>647</b>
<u>Mr. Jonathan Adrien</u> <sup>1</sup> , <u>Dr. Minyoung Cheong</u> <sup>2</sup>	
<i>1. Penn State University - Great Valley, 2. PSU at Great Valley</i>	

<b>Generation Z and Workplace Expectations and Attitudes</b>	<b>648</b>
<u>Dr. Heidi Hughes</u> <sup>1</sup> , <u>Dr. Joo Eng Lee-Partridge</u> <sup>1</sup>	
<i>1. Central Connecticut State University</i>	

<b>Narcissism, Leadership, Societal Culture and Firm Performance: A Cross-National Study of American, Chinese and Polish Firms</b>	<b>649</b>
<u>Dr. Mark Somers</u> <sup>1</sup> , <u>Dr. Jose Casal</u> <sup>1</sup> , <u>Dr. Yuchao Ma</u> <sup>2</sup> , <u>Dr. Tsutomu Ito</u> <sup>3</sup> , <u>Dr. Takao Ito</u> <sup>4</sup> , <u>Dr. Jolanta Mazur</u> <sup>5</sup> , <u>Dr. Rajiv Mehta</u> <sup>1</sup>	
<i>1. New Jersey Institute of Technology, 2. Wuhan University of Textiles, 3. Ube National College of Technology, 4. University of Hiroshima, 5. Warsaw School of Economics</i>	

<b>The Role of CEO Compensation in Explaining R&amp;D Investment and Corporate Political Strategy</b>	<b>650</b>
<u>Dr. Mine Ozer</u> <sup>1</sup>	
<i>1. SUNY Oneonta</i>	

<b>Who Matters, and How Does it Matter? Examining Differences in Stakeholder Influences and Environmental CSR Actions</b>	<b>651</b>
<u>Prof. Shobha Das</u> <sup>1</sup>	
<i>1. IFMR Graduate School of Business, Krea University</i>	

## Supply Chain Management and Logistics

<b>Analytics Driven Decisions for Supply Chain Strategy in an Era of Change</b>	<b>653</b>
<u>Dr. Ashok Viswanathan</u> <sup>1</sup>	
<i>1. Best Buy</i>	

<b>Analyzing the Impact of Vessel Size and Investment into a Port</b>	<b>654</b>
<u>Dr. EunSu Lee</u> <sup>1</sup>	
<i>1. New Jersey City University</i>	

<b>Barriers to Blockchain Implementation within Supply Chain: Analysis in Manufacturing, Transportation and Retailing Sectors</b>	655
Ms. Soode Vaezinejad <sup>1</sup> , Prof. Douglas Hales <sup>1</sup>	
<i>1. university of rhode island</i>	
<b>Did We Go too Far with JIT Inventory Planning and Control?</b>	656
Dr. Pedro M. Reyes <sup>1</sup> , Dr. Patrick Jaska <sup>2</sup> , Dr. John Visich <sup>3</sup>	
<i>1. Baylor University, 2. University of Mary Hardin-Baylor, 3. Bryant University</i>	
<b>Human Related Factors and Supply Chain Integration in Non-profit Organizations</b>	657
Dr. Cigdem Ataseven <sup>1</sup>	
<i>1. Cleveland State University</i>	
<b>Logistics Digitization and the firm performance: The moderating role of Paradoxical Leader Behavior</b>	658
Mr. Muhammad Hasan Ashraf <sup>1</sup> , Dr. Anis Triki <sup>1</sup> , Dr. Mehmet Yalcin <sup>1</sup>	
<i>1. University of Rhode Island, College of Business</i>	
<b>Managerial Capital in the Supply Chain: An Antecedent to a Superior Firm Performance</b>	659
Dr. Yan Jin <sup>1</sup> , Dr. Julia Fullick-Jagiela <sup>1</sup>	
<i>1. Quinnipiac University</i>	
<b>Renewable hybrid energy supply chain network: A dynamic optimization model for a cleaner energy mix</b>	660
Dr. Raza Rafique <sup>1</sup> , Dr. Mohsin Jat <sup>2</sup> , Dr. Hakeem-Ur- Rehman <sup>3</sup> , Dr. Muhammad Adnan Zahid Chudhery <sup>4</sup>	
<i>1. Kean University, School of Management and Marketing, Union, 07083, NJ, 2. Edwards School of Business, University of Saskatchewan, Saskatoon, Canada, 3. University of the Punjab, Lahore, Pakistan, 4. International Institute of Finance, School of Management, University of Science and Technology of China, Hefei, 230026, Anhui, China</i>	
<b>Responsible Sourcing and Supply Chain Traceability</b>	661
Dr. Jen-Yi Chen <sup>1</sup>	
<i>1. Cleveland State University</i>	
<b>Revisiting Supply Chain Flows: A Road Map Through Paradox Lens</b>	662
Mr. Muhammad Hasan Ashraf <sup>1</sup> , Dr. Mehmet Yalcin <sup>1</sup>	
<i>1. University of Rhode Island, College of Business</i>	
<b>Sourcing for Critical Supplies in the Healthcare Supply Chain</b>	663
Dr. Amelia Carr <sup>1</sup>	
<i>1. Bowling Green State University</i>	
<b>Supply Chain Agility for Competitive Advantage in Apparel Industry: The Role of SCM Practice and Partnership Quality</b>	664
Dr. Mohammed Jahed <sup>1</sup>	
<i>1. St. Bonaventure University</i>	
<b>The Effects of Gray Swan Phenomena on Operational Performance</b>	665
Dr. Tony Lynch <sup>1</sup> , Dr. Joo Jung <sup>2</sup>	
<i>1. Penn, 2. University of Texas Rio Grande Valley</i>	

<b>The Evolution of Supply Chain Network Structures of Major Global Brands</b>	<b>666</b>
<u>Dr. James Minas<sup>1</sup>, Dr. Natalie Simpson<sup>2</sup></u>	
<i>1. St. John's University, 2. University at Buffalo</i>	
<b>The US Port Congestion, the Value Destroyer for the Supply Chain Competitiveness</b>	<b>667</b>
<u>Mr. Anish Surya<sup>1</sup>, Prof. Douglas Hales<sup>2</sup></u>	
<i>1. University of Rhode Island, College of Business, 2. university of rhode island</i>	
 <b>Marketing and Consumer Behavior</b>	
<b>Event-Related-Potential (ERP) as a Scale Validation Tool: Understanding Individual Neuropsychological Differences based on the Style of Processing (SOP) Scale</b>	<b>669</b>
<u>Dr. William Jones<sup>1</sup>, Dr. Meng Hsien (Jenny) Lin<sup>2</sup></u>	
<i>1. Ramapo College of New Jersey, 2. California State University Monterey Bay</i>	
<b>Impact of Covid-19 on Consumer Preference for an App-Based vs. Street-Hailed Taxi Ride: An Empirical Analysis of New York City Taxi Industry</b>	<b>670</b>
<u>Dr. Prashanth Ravula<sup>1</sup></u>	
<i>1. New Jersey City University</i>	
<b>Impact of Various Marketing Theories and Software Applications on Small Colleges</b>	<b>671</b>
<u>Dr. Melissa Ford<sup>1</sup></u>	
<i>1. County College of Morris</i>	
<b>Impact of Various Marketing Theories and Software Applications on Small Colleges</b>	<b>672</b>
<u>Dr. Melissa Ford<sup>1</sup></u>	
<i>1. County College of Morris</i>	
<b>The Case for Intuitive Advertising</b>	<b>673</b>
<u>Dr. Francisco Quevedo<sup>1</sup>, Dr. Pradeep Gopalakrishna<sup>2</sup></u>	
<i>1. Rutgers University, 2. Pace University</i>	
<b>The Limits of Artificial Intelligence in Customer Relationship Management: An Implicit Mindset Perspective</b>	<b>674</b>
<u>Mr. Uttam Paudel<sup>1</sup>, Dr. Ozge Aybat<sup>1</sup></u>	
<i>1. Penn State Harrisburg</i>	
<b>Using Regression Analysis to Estimate the Impact of Human Trafficking Interventions in the U.S.</b>	<b>675</b>
<u>Dr. Vernon Murray<sup>1</sup>, Ms. Ashlyn Smith<sup>1</sup></u>	
<i>1. Marist College</i>	



# Papers

# **Accounting, Finance, Economics**

## **Business Ethics: Talmudic View**

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### **Introduction**

Ethics may be viewed as an essential skill taught in institutions of higher learning, especially in the postfactual age. Still, it is unclear whether classes in the subject transform students into more virtuous individuals. Scholars such as Milton Friedman and Peter Drucker felt that ethics could not be taught in a classroom, and there is substantial evidence supporting this opinion (Altmyer, Yang, Schallenkamp, and DeBeaumont, 2011; Bowden & Smythe, 2008; Friedman, Fogel, and Friedman, 2005; Etzioni, 2002; Holland, 2009; Hühn, 2014; MacDonald, 2007; Stape, 2002; Wang and Calvano, 2015).

Bazerman and Gino (2012) posit that the correct way to teach ethics is by using a behavioral ethics approach. Behavioral ethics takes a descriptive rather than a normative approach and attempts to assist professionals and students in understanding their behavior when facing an ethical dilemma. By making people aware of the contradictions between how they act and contrasting it with how they would ideally behave, they can develop their moral sensitivity. It may be challenging to teach individuals to be ethical, but it does appear possible to instill ethical awareness into students (Altmeyer et al., 2011; Bowden & Smythe, 2008; Koehn, 2005; Williams

& Dewett, 2005).

In the postfactual age, we should use various tools to teach values and ethics and not limit ourselves to one particular method. Two widespread approaches to teaching courses in ethics, especially business ethics, are examining case histories and studying the works of great philosophers such as Aristotle, Kant, and Mill. It is believed that cases enhance students' critical thinking skills because they expose them to all kinds of issues that may arise in the real world (Corey, 1998; Pomykalski, 2010). Studying the different concepts of philosophy such as Kantian deontology (duty-based), Millian utilitarianism (consequences-based), and virtue ethics (character-based) will purportedly develop the ethical thinking of students. It appears, however, that these techniques are not doing the job, and other approaches to teaching ethics may be needed.

### **The Talmud**

The Talmud, Judaism's Oral Law, primarily contains rabbinical discussions and commentaries on the Torah's written text. The Talmud, mainly concerned with *halachah* (Jewish law), also provides a detailed record of Jewish people's beliefs, philosophy, traditions, culture, and folklore, *i.e.*, the *aggadah* (homiletics), is replete with legal, ethical, and moral questions. The Midrash, a separate scripture, records the views of the Talmudic sages and is mainly devoted to the exposition of Biblical verses. The Babylonian Talmud, a product of the academies in Babylon, was completed in 500 CE; the Jerusalem Talmud, a creation of the academies in Israel, was finished in 350 CE.

The Talmud has much to say about the proper way to live an ethical, rewarding life (Friedman, 2012). Friedman and Fischer (2014) demonstrate how the ethical and moral principles of *Avot* (Ethics of the Fathers), one of the 63 tractates of the Talmud, can influence people's behavior to improve the world. According to Socken (2009), the Talmud is as relevant today as

when compiled about 1,500 years ago. Solomon (2009: xi) agrees: "The Talmud, frequently censored and occasionally banned and burned by the Catholic Church, is one of the most influential, though seldom acknowledged or properly understood, writings of Late Antiquity."

The Talmud sees obeying the strict letter of the law as insufficient; therefore, one must go beyond the requirements of the law — *lifnim mishurat hadin* (literally, inside the line of the law). Indeed, the Babylonian Talmud (Bava Metzia 30b) declares that Jerusalem was destroyed for following the strict letter of Torah law and not doing more than the law required. The following story is a classic going beyond the letter of the law case. What is remarkable about this narrative is that it suggests that one who only follows the basic rules is a "barbarian."

Shimon ben Shetach was struggling in the flax business. His students said: Rabbi, abandon this business and let us buy you a donkey, and you will not have to work so hard. They went and bought a donkey from an Ishmaelite, which had a jewel hanging on its neck. They returned to him happily, saying, thanks to this good luck, you'll never have to work again! When he learned about the jewel, he asked his students whether the donkey's owner knew of it at the time of the sale. When they said no, he ordered them to return the jewel. [The voice of the Talmud's editor intervenes and asks:] But why should this be so?! For later, in Rabbi Yehuda HaNassi's time it was ruled that although stealing from pagans is forbidden, one may keep an item that a pagan has lost. [So why did Shimon ben Shetach not permit himself to benefit from the pagan's mistake?]

Rabbi Shimon answered them: Do you think Shimon ben Shetach is a barbarian?! Shimon ben Shetach would prefer to hear the words "Blessed be the God of the Jews" than all the money in the world (Jerusalem Talmud, Bava Metzia 2:5; translation by Halberstadt, 2019 and Amital, 2016).

The following is another example of a Talmudic story. Shmuel was an expert in astronomy/astrology (back then, the two were not separate disciplines). It was essential to teach people about free choice and not believe that the stars controlled their fate. This story emphasizes the importance of charity.

Shmuel and Avleit [Avleit was an astrologer] were once sitting together watching people go to the swamp to cut reeds. Avleit said to Shmuel, "That

man over there is going to go to the swamp, but he won't return because a snake is going to bite him and he will die." Shmuel said: "If he is a Jew, he will return." While they were sitting, the man returned. Avleit stood up and threw off the man's pack of reeds. He found among the reeds a snake that had been cut in two pieces. Shmuel said to the man: "What did you do to be saved from death like that?" The man replied: "Every day, all of us pool all our bread together and then share it. Today, one man had nothing to contribute, and he was ashamed. I, therefore, told everyone: "Today, I am going to collect the bread." When I got to him, I pretended to take something from him so that he would not be ashamed." Shmuel said to him: "You have done a good deed." Shmuel went out and lectured: "Charity saves one from death" (Proverbs 10:2), and not just from an unnatural death, but even from death itself (Babylonian Talmud, Shabbos 156b; ).

The subsequent narrative demonstrates that wealthy people have to use their wealth to help their communities, i.e., social responsibility.

On cloudy and windy days, they would carry Rabbi Huna about in a golden palanquin, and he would inspect every part of the city, and he would order the demolition of any wall that was unsafe. If the owner was in a position to do so, he had to rebuild it himself; but if not, then Rabbi Huna would have it rebuilt at his own expense...

Whenever Rabbi Huna discovered some new medicine not available to the public, he would fill a water jug with it and suspend it from the doorframe of the house and proclaim: "Whoever desires it let him come and take of it." ... When he had a meal, he would open the door wide and declare, "Whoever requires food, let him come and eat "(Babylonian Talmud, Taanis 20b; based on the translations of Soncino and ArtScroll)

A Talmudic story about Abba Umna, the surgeon/bloodletter who merited to receive greetings from the Heavenly Academy every day, sends important lessons to doctors.

When he performed his operations, he would separate men from women [for modesty reasons]. He had a garment that had a cup for receiving the blood and which was slit at the shoulder to accommodate the surgeon's knife. Whenever a female patient came to him, he would put the garment on her shoulder to avoid seeing her exposed body. He also had a private place where the patients deposited the fees he would charge; those who could afford it put their payments there, and thus those who could not pay were not embarrassed. Whenever a young scholar consulted him, he would not accept any payment. When the scholar would leave, he would give him money and tell him: "Go and regain your health" Babylonian Talmud, Taanis 21b-22a).



The Sages of the Talmud did everything possible to keep the price of necessities low and denounced hoarding (Friedman and Mizrachi, 2020). One is supposed to use whole myrtle branches for the holiday rituals of Sukkot. Shmuel warned the sellers of myrtle branches that he would allow individuals to use myrtles with broken tips if merchants raised prices on the whole myrtle branches when the holiday was approaching (Babylonian Talmud, Sukkah 34b). A similar problem occurred after Passover. The people used to break the pots in which leaven was cooked and thereby absorbed and had to buy new pots after Passover. Shmuel warned the pot sellers not to raise prices, or he would take the more lenient position regarding the absorbed leaven in cookware and not require the use of new ones after Passover (Babylonian Talmud, Pesachim 30a). Shmuel and his father were known to buy, and subsequently sell, produce in such a way as to keep the market price stable and low throughout the year (Babylonian Talmud, Baba Bathra 90b).

### **Conclusion**

The mission statement of every organization should be based on Hillel's 2,000-year-old maxim: "If I am not for myself, who will be for me? If I am only for myself, what am I? If not now, when?" (Avot1:14). The profit motive has to be balanced out with social responsibility. This paper demonstrates that the Talmud is a valuable ethics teaching tool, and educators should not limit themselves solely to cases and studying philosophers. Hundreds of stories from the Talmud may be found in *The book of legends: Sefer Ha-Aggadah* by Bialik and Ravnitzky (1992). Future research should compare and contrast the various techniques used to teach ethics and determine the effectiveness of each.

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## **Middle-Income Countries: Today's Changes for the Purpose of the Future**

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*Source:* Guardian Africa Network, Somali children in class at a refugee camp North of Dadaab in 2011.

*Photograph:* Jerome Delay/AP, <http://www.theguardian.com/world/2012/oct/04/african-aid-no-more-pity>

### **Abstract**

A dilemma has emerged from the flow of migrants from the poorest section of the world population to middle-income countries thus aid issue. The ultimate goal of this article is to analyze the pros and cons of the aid, and to find new ways of improving efficiency and effectiveness. The role of the aid is undeniable in the development of a world community, but this does not guarantee that poverty countries will develop due to these aids. The aid will not be always a center of priority for leading states of the world and it is assumed that the countries claiming that the current aid is insufficient are going eventually achieve stability and will no longer had the aid. That is why, it is necessary to improve the present aid programs to unsure their sustainability beyond the sake of the future community present for the sake of the future community so that middle income countries will no longer need the aid. It is possible to start this plan by bringing up the generation with a new way of thinking, of course, without forgetting other social dimensions such as cultural, politics, etc. and through establishing a complex system in order to ensure sustainable development.

**Key words:** Shift, middle-income countries, sustainable development, complex system, education, critical thinking, aid, poverty, management, solution

**Acronyms**

AAA	Analytic and Advisory Activities
CAS	Country Assistance Strategy
DAC	Development Assistance Committee
GHA	Global Humanitarian Assistance
GNI	Gross National Income
HICs	High-Income Countries
LICs	Lower-Income Countries
LMICs	Lower-Middle-Income Countries
MDG	Millennium Development Goals
MDNet	Mobile Doctors Network
MICs	Middle-Income Countries
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
SAADA	Somalia Aid and Development Association
SEAM	Skills Education and Microfinance
SLP	School Lunch Program
UMIC	Under-Middle-Income Countries
UN	United Nations

**A. Introduction**

Poverty is associated with a global character in our globalizing world. Although in past few years low-income countries (LICs) used to be typical for the inhabitation of poor people, middle-income countries (MICs) are becoming the main residence and destination for people in need. The central question of this paper is whether this represent a significant problem for MICs and whether MICs are able to solve this issue themselves?

One of the interesting facts is that middle-income countries keep their status even though they comprise the majority of the world population living in need, but low-income countries experience

transformation into middle-income countries. It is feasible to evaluate this situation according to the statistics, but by what mean is this applicable? Furthermore, will middle-income countries stay in their current position? Why are middle-income countries in the center of interests of the world community today?

While considering possible solutions to this issue, an approach must be developed based on the following factors: the past of LIC's and MIC's administrative and economic systems, the positive and negative aspects of these systems today, the practices of countries that have experienced similar problems and succeeded through cooperation, the effect of economic aid and the advantages and disadvantages of shifts in economic status. Additionally, it is important to consider how effective sustainable development requires a complex system to be implemented and finally, also requires a new generation of critical thinkers who question the information that they receive from authority figures (i.e. government, education, family members, religious, leaders).

All of the sections of the article are interrelated and contain the time turnover of the past, present and future whereas it reflects the main parts of this interaction. Through analyzing the past of a country, it is possible to determine destiny of a country and affect its development. It would be a sign of failure even before starting the process if the sample is taken from a successful country and applied directly to another country. Actually, that is right policy to build economy of a country up based on the practices of developed countries. However, there is a stereotype that a country developing today is equivalent to the past of a country that is developed. Of course, it is not so simple. For example, when we look at the history, we can see that high-income countries today have never been low-income countries before. Therefore, there is a need for a different kind of approach. In this paper I would like to suggest how shift impact on all development in the world and how we can assist to solving this process accurately, because every country is so unique and with specific cases, especially history.

The most important is setting questions properly, and the answers will follow. To answer these questions require drawing on information from relevant sources.

## B. Why is the notion of middle-income countries more attractive than low-income countries currently?

The statistical indicators of middle-income countries are averaged figures, so it is not clear about the precise amount of income of individuals. When we research further, there is a big opportunity to find new interesting facts about those countries. We should also consider other income categories when analyzing middle-income countries and their characteristics. Today low-income countries are able to evolve and surpass their colleagues and have a place among middle-income countries. We can see the income ranges designated by the World Bank in Table 1 below.

**Table 1. Income categories**

Categories	2014	2020
Low-income (LICs) economies	\$1,045 or less	\$1,045 or less
Lower-middle-income (LMICs) economies*	\$1,046 to \$4,125	\$1,046 and \$4,095
Upper-middle-income (UMICs) economies*	\$4,126 to \$12,745	\$4,096 and \$12,695
High-income (HICs) economies	\$12,746 or more	\$12,696 or more

*Table 1: The categories illustrated according to the amount of income that the World Bank makes systems out of them. Source: Country and Lending Group, The World Bank, <http://data.worldbank.org/about/country-and-lending-groups> (accessed 16 August, 2014 and 4 April 2022)*

\* MICs

Over time, the list of low-income countries decreases while the poor population increases in middle-income countries. That is why, from the core of the issue, it is important to analyze low-income countries. If we pay close attention to Table 2, we may see that most of the countries assumed to be high-income countries are actually middle-income countries.



The need for donor organizations rises every year in the world, however financing government and donor organizations is one of the unresolved problems. At this point, there are some attempts to provide diversification of aid sources through attracting non-governmental organizations to fill the gap (Table 3)<sup>1</sup>. Is the rise of donors a positive tendency? How sufficient are the funds proposed to solve the current recession?

**Table 2. List of MICs (eg)**

<b>Lower Middle-income</b>	Egypt, India, Indonesia, Nigeria, Philippines, Ukraine, Pakistan
<b>Upper Middle-income</b>	China, Argentina, Peru, Brazil, Russia, Colombia, South Africa, Malaysia, Turkey, Mexico, Thailand,

**Source:** Ralph van Doorn, Vivek Suri and Sudarshan Gooptu, Do Middle-Income Countries Continue to Have the Ability to Deal with the Global Financial Crisis?, *The World Bank*, Poverty Reduction and Economic Management Network, Economic Policy and Debt Department, July 2010, page 2/ modified info by [World Bank Country and Lending Groups – World Bank Data Help Desk](#)

**Table 3. Donor organizations**

<b>Donors</b>	Bill and Melinda Gates Foundation	Qatar Charity	Khalifa Bin Zayed Al Nahyan Foundation	International Relief Organization	Oman Charitable Organization
<b>USD</b>	51,370,153	44,697,236	39,727,327	25,241,190	23,900,000

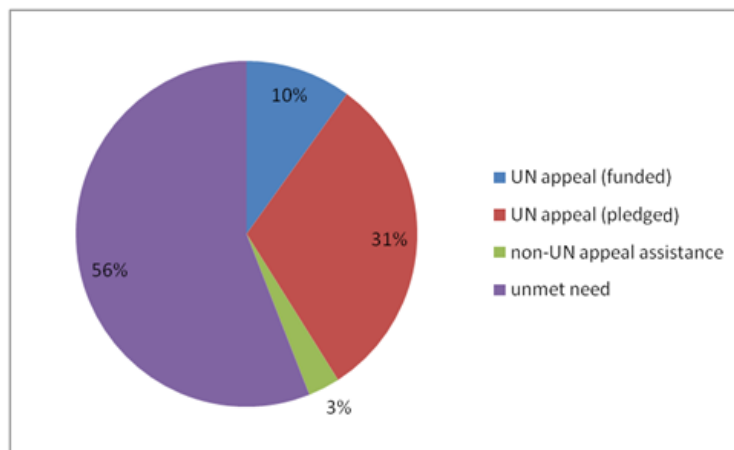
**Source:** Chloe Strik, Humanitarian Assistance from non-state donors: What is it worth?, *Delivery*, April 2014, <http://www.globalhumanitarianassistance.org/wp-content/uploads/2014/05/Humanitarian-assistance-from-non-state-donors-2014.pdf>, page 9.

<sup>1</sup> Chloe Strik, “New report from the GHA Programme launched: Humanitarian assistance from non-state donors: what is it worth?”, *The Global Humanitarian Assistance (GHA)*, last modified April 29, 2014, <http://www.globalhumanitarianassistance.org/new-report-gha-programme-launched-humanitarian-assistance-non-state-donors-worth-5051.html> (accessed August 16, 2014)

The countries suffering from serious problems in their economic development among middle-income countries (in particular, African countries in the south of Sahara (except South African Republic)) bear the reasons like inappropriate external causes, petroleum problems (for instance, 1970s crisis), ineffective economic policy and deterioration of the environmental conditions. The core of the problem here is that economic development cannot stand the growth of population. Referring to history, in the 1980s negative growth of Gross National Income (GNI) was observed in Kenya, Senegal and other countries which were associated with high development rate. Furthermore, it made the social-economic conditions of the population worse and deepened food and ecological problems.

In order to industrialize the economy, middle-income countries tended to import necessary products which caused dependence on external debts as a result. Because of the world economic crisis interest rates rose and commercial banks suspended loans in the late 1970s. Most of the enterprises faced deficits. In order to delay the deadlines of debts., middle-income countries applied for credits to give those debts back, thus they ended up with the collapse of financial system<sup>2</sup>. Borrowing debts to repay is supposed as a breakup of the process.

**Graph 1. Syria (USD 6.5 bn)**



**Source:** Anna Osborne, “Comparing funding to 2014 humanitarian crises: How does funding to Syria, CAR and South Sudan compare?”, *Development Initiatives*, last modified February 10, 2014, <http://devinit.org/comparing-funding-2014-humanitarian-crises/> (accessed August 22, 2014)

<sup>2</sup> Problems of economic development of third world countries [Проблемы Экономического Развития Стран Третьего Мира], *World Economy [Мировая Экономика]*, <http://mirovaja-ekonomika.ru/problemy-ekonomicheskogo-razvitiya-stran-tretego-mira/> (accessed August 24, 2014)

We can analyze several aspects in the worsening of the economic processes, but the most important is a result of aid processes conducted by countries who want to influence each other (For instance, Syria 6.5 bn, however 56% unmet need). Coming back to the most topical issue over the world: the shift that hinders donor countries in their choices of location.

Let us refer to some statistics. According to the World Bank, 90% of the world's poor population lived in low-income countries in 1990. 30% of absolute poverty is observed in low-income countries and 70% lived in middle-income countries in 2007. With the same tendency all the following aspects spread: hunger, diseases and mortality. As you see from the range (1990-2005) the poverty rate in LIC decreased from 41% to 25% and according to the experts' opinions the number of LIC will continue to reduce. On the contrary, in MIC the number will be positive and this case brings the mentioned category countries to the analyzed level <sup>3</sup>.

In global poverty the changes reveal various methodological questions. One of the main reasons that explains this factor is that people travel to another country according to the “no waiting for death” principle. Stability of poverty in MICs countries and even its growth necessitates changes on the backdrop of economic growth. Because as it is clearly seen, the reduction in LIC is not the result of successful economic-political growth of all these countries.

In South-East Asia Indonesia<sup>4</sup> and Vietnam are the only countries that received MIC status. Their economic development and decreasing of extreme poverty are not deniable<sup>5</sup>. Maybe by considering an exemplary economy it is possible to see daylight, but each country has its singularity and approaching each of them individually is the appropriate choice. Although most countries receive aid and support, they maintain the actuality of LIC and MIC conceptions, by returning to the same situation over the years. And the main reason is that the appropriate programs are not implemented in the right way.

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<sup>3</sup> Andy Sumner, Asep Suryahadi and Nguyen Thang, “Poverty and Inequalities In Middle-Income Southeast Asia”, April 3, 2012, 5.

<sup>4</sup> Although Indonesia could achieve LMIC status till Asian financial crisis

<sup>5</sup> Andy Sumner, Asep Suryahadi and Nguyen Thang, “Poverty and Inequalities In Middle-Income Southeast Asia”, April 3, 2012, 5.

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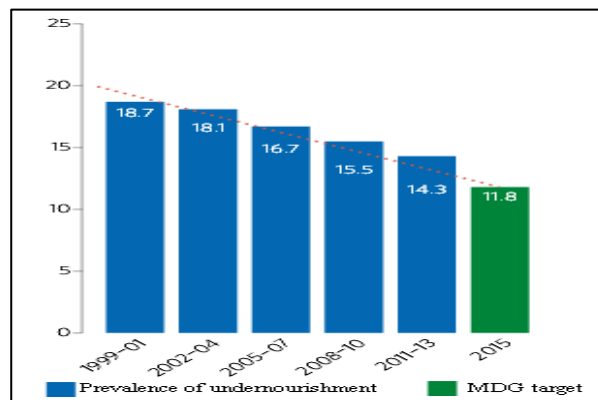
The main direction is to bring the poverty level to a manageable level in these countries. As each process in the world is closely linked to each other, even if MICs could handle poverty, the process in LICs will affect MIC again. That is why analyzing LICs is one of the necessary aspects.

### C. Millions of indigent peoples and programs

2000: The United Nations (UN) planned a proposal to decrease world poverty in half by 2015. This aim has real importance and has been started to be valued as the Millennium Development Goals (MDG).

Our target here is not mentioning the goals of MDGs. The success of the project is based on how each goal is reached and how these goals impact each other<sup>6</sup>. The issue is that these solutions package, which includes in it 8 goals, is not comprehensive and does not cover all regions. For instance, it has shown much better results in Asia rather than in the Great Desert. Undoubtedly, when the deadline for the MDGs is reached, there will be questions if the goals have been reached or not. 2015 is not that far and these questions obviously will be raised soon. One can see in Graph 2 that there are developments. However, the question is whether this goal is a double reduction of poverty? Moreover, in the first part of this section, we mentioned the goal for 2015, but this is also not a sign for double reduction.

**Graph 2. Proportion of undernourished people in developing regions, 1999–2013 (%)**



**Source:** The Millennium Development Goals Report 2014, (New York: United Nation, 2014), <http://www.un.org/millenniumgoals/2014%20MDG%20report/MDG%202014%20English%20web.pdf>, page 12, (accessed August 2, 2014)

<sup>6</sup> The Millennium Development Goals - Keeping the Promise for 2015, *Results*, last modified July 23, 2008, <http://results.techriver.net/website/article.asp?id=2142> (accessed September 2, 2014)

Currently, paying attention to the results one can confirm that impacts are convincing. When paying attention to outside factors irrelevant to the MDG program, and listening to those who explain these factors, one can again witness satisfactory results. As an example, poverty reduction in Asia is related to the sustainable enrichment and development of China. In addition,, there is a probability that China will lead this enrichment and influence other countries, guiding them on how to eliminate poverty. Another example would be the exporters of raw materials from Africa. On the other hand, in Brazil prompt reduction of poverty is managed by development of social security<sup>7</sup> and etc.<sup>8</sup> There is no doubt that these signs are not necessarily positive or negative of MDGs, but one must not forget the probability of other factors that also impact the power of these signs.

Today, by sitting at home you could be a participant of programs, which are directed to millions of indigent people. When you enter the web pages of programs, first you are faced with a “donate” button and you think “I know the problem of these people and I should help them.” And you choose an easy way, you press a button and implement an operation. We are not aiming to present it as the wrong activity, and we even could say that you are living in a human society, where not everybody cares about aid. The ways that are mentioned above, just these simple ways take us to unseen trouble. Short cuts solve problems temporarily. In the previous part we have mentioned that poverty in MICs are affected by LICs, and now we try to draw a conclusion by considering conduct with these problems.

We would like to draw your attention to the sentence from Somalia Aid and Development Association (SAADA) organization mission:

*“Saada as an organization and a charity believes that any form of development can only take place once the potential of the people is truly unlocked. Saada believes in investing directly into people and the*

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<sup>7</sup> With social welfare program of the Brazilian government (eg: Bolsa Familia)

<sup>8</sup> Matthew Lockwood, What have the MDGs achieved? We don't really know..., *Oxfam*, last modified August 31, 2012 <http://oxfamblogs.org/fp2p/what-if-we-applied-the-results-agenda-to-the-mdgs-quasi-heretical-guest-post-from-matthew-lockwood/> (accessed August 30, 2014)

*institutions that better people with the aim being to create a culture of innovation where people strive to find solutions to their own problems”<sup>9</sup>.*

The main question here is that people are directed to make an effort to solve their own problems by themselves. Really this issue requires special attention and it would be appropriate to find problem solutions through participants in the aid.

We would like to present 3 programs: Mobile Doctors Network (MDNet), Skills Education and Microfinance (SEAM), and School Lunch Program (SLP). MDNet is directed to the medical area, it creates a free mobile network on communication issues among doctors in African countries and if there are any emergency situations with the help of the medical knowledge it becomes possible to save lives. SEAM consists of small credits to enhance women’s and men’s capacity; this process is realized in Ghana and the program goal is directed to provide access to the world market. SLP is the program that supports attending school for children. Most parents in African countries want their children to make a profit instead of attending school and that is related to the situation in the country. Thanks to the program, attending school increased 20%, owing to free food service in the classes. All of these are worthy of praise, but because of their scope level it is under the question, would they continue for a long time?

There is often distrust about the right financing implementation of organizations, subsidiary organizations, programs and other assistance-oriented processes. Instead of long discussions and expenditures that were wasted on them, it would be possible to save lives by providing help to millions of people in their own countries. In 2008 the right question was put out: is it right to accept private expenditure as Official Development Assistance (ODA<sup>10</sup>)? Sometimes it is accepted as normal, but sometimes it is considered as a waste of financial means. Let’s disclose the issue.

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<sup>9</sup> About SAADA, *Saada - Somali Aid and Development Association*, <http://www.saaduk.org/aboutSaada.html#mission> (accessed August 21, 2014)

<sup>10</sup> Official development assistance is defined as those flows to countries and territories on the DAC List of ODA Recipients and to multilateral development institutions which are: 1. provided by official agencies, including state and local governments, or by their executive agencies; and 2. each transaction of which: a) is administered with the promotion of the economic development and welfare of developing countries as its main objective; and b) is concessional in character and conveys a grant element of at least 25 % (calculated at a rate of discount of 10%).



As Development Assistance Committee (DAC) statistic based on operations, credits for 1 year or less. Some contracts are not registered as transfers, although they have the right to register as ODA. There included secondary and high education expenditure<sup>11</sup>.

When we consider the programs, we do not face any problems with their writing; their realization is usually one of the difficult questions. Mainly, the programs solve problems temporarily. It is also possible that not all of the goals will be achieved. Maybe it is arising from the nonreciprocal activity of donor and acceptor countries.

As a country example, one can look at Ethiopia and Tunisia, where one can see that they have really managed a huge development in education and health. However, in parallel to this there were real problems and shortages in the basics of the strategy. Some of the strategies were based on government regulations, while some were not<sup>12</sup>. The basic process is in providing a complex development and in the fundamentals of each development there should be a legal basis.

#### **D. Effects of indigent countries to world's development if they cannot break free from poverty**

At the present there are 110 MIC and 71% of the world population is living in these countries. But the position of indigent people in the world attracts attention more than the mentioned indicators.

In 1990 94.4% of world population, that was living for USD 1 per day, was in LIC, in 2008 this number decreased to 23.3%, in MIC the number of indigent people was increased from 5.6% to 76.7%<sup>13</sup>.

In 2030 two-thirds of the world's indigent people will live in urban areas. The other part will live in medium income countries. Donor countries face a double dilemma: in reality countries that have a medium level of incomes, on the other hand weak countries do not use this aid in a right

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<sup>11</sup> Is it ODA?, Factsheet, *OECD*, November 2008

<sup>12</sup> David Mepham, "Putting Development to Rights, Integrating Rights into a Post-2015 Agenda", *Human Rights Watch*, <http://www.hrw.org/world-report/2014/essays/putting-development-to-rights?page=3> (accessed August 30, 2014)

<sup>13</sup> Jonathan Glennie, "The role of aid to middle-income countries: a contribution to evolving EU development policy", London: Overseas Development Institute, (June 2011): 5., <http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7189.pdf>

way (in other words: Medium-income countries do not need the aid, while lower-income countries cannot effectively use the aid.). Drastic changes in poverty require formal recurrent aid explanation<sup>14</sup>. But what will be the explanation?

Not repeating mistakes that were made in world practice, is a technique used in management. Which country does not want to develop by benefiting from the neighboring countries' practices even without looking to countries far away? Which country does not want to create an appropriate system by considering developed countries? African countries are different from the other countries of the world, but they cannot see their own power. This power and the large quantity of working staff draw the attention of developed countries and prompt questions about the future.

By Huntington's opinion, the bright representatives of this civilization are Nigeria and South Africa, South Africa is the bright example of development for Africa. He listed success of Africa: outlet from apartheid, industrial potential, and high level of economic development in comparing with other African countries, military power, natural resources, political system of government with the participation of white and black-skinned people<sup>15</sup>. Of course, the state role in all of this is considerable, but the indispensable role of the natural reserve should be considered, too. Such countries present new partners to the world's leading countries and that is in the center of their interests.

In the table 4 you are seeing characteristics that reflect both sides of aid to MICs. While you are looking through these characteristics you can see the effectiveness of aid. Even so, in all questions there should be regulation and control under administration.

**Table 4. Common reasons given for and against aid to MICs**

<b>For</b>	<b>Against</b>
Better value-for-money	Scarce resources
Crowding in private capital	Crowding out private capital

<sup>14</sup> The world has an astonishing chance to take a billion people out of extreme poverty by 2030, Hong Kong and Washington, DC, *The Economist*, last modified June 1, 2013, <http://www.economist.com/news/briefing/21578643-world-has-astonishing-chance-take-billion-people-out-extreme-poverty-2030-not> (accessed August 26, 2014)

<sup>15</sup>How do South Africa develop? [Как развивается ЮАР], [*International affairs*]/Международные дела, last modified November 27, 2012, <http://voprosik.net/kak-razvivaetsya-yuar/> (accessed August 26, 2014)

Moral hazard	Perverse incentives
Targeted interventions	Limited influence
Sub-national support	Fungibility
Support to civil society	Intergenerational poverty
Sharing expertise and knowledge transfer	

**Source:** Jonathan Glennie, “The role of aid to middle-income countries: a contribution to evolving EU development policy”, London: Overseas Development Institute, (June 2011):13., <http://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7189.pdf>

We mentioned population problems as a priority, and if we look at Table 5 despite the process in Somalia, there is a high growth of population. Large quantity of man power provides a base of cheap man power for industrial development. But in the next part we will disclose the useful adaptation of air.

**Table 5. Rate of population growth in Somali in 2016-2020**

	2016	2017	2018	2019	2020
Somalia	14185635	14589165	15008225	15442906	15893219

**Source:** Population, total, *The World Bank*, <http://data.worldbank.org/indicator/SP.POP.TOTL> (accessed April 5, 2022)

Poverty level in MIC by 2020 could be high, but prognoses show that poverty could be decreased to the solution level inside the country. Of course, the meaning of solution level inside country has disputable character<sup>16</sup>. And now the role of accepting countries is getting exposed, and this case shows negative and positive sides with changes and constancy in development areas today.

We analyze interest rather than the question of the effects of indigent countries on the world's development. Because interest is a significant part of world development. So they would not break free from the current situation, because development rises from interests. All processes in the

<sup>16</sup> Andy Sumner, “Global poverty, aid, and middle-income countries: Are the country classifications moribund or is global poverty in the process of ‘nationalizing’?”, *United National University*, (June 2013):16

world are linked to each other and bringing development to a stable position is always under attention.

#### **D. Areas that need aid: role of acceptors in this area**

How can we be sure about the right theoretical policy chosen for development of the world population that is suffering from lack of development? The world is changing every moment, every minute: only the phrase “change” is not changing. These changes affect the planned strategy. One of the important factors in the selection of the right theoretical policy is to look over the economic and social history of the country, as these bases made the foundation of lack of development. Most researchers, by analyzing the history of developed countries, put developing countries outside of attention. That is why theoretical bases of development strategy are not appropriate to middle-income countries: the historical practice of developed countries is completely different from middle-income countries. We leave the issue out of mind because middle-income countries seemed to be the past of the developed countries<sup>17</sup>.

Each crisis has its own difference and difficulty. As a result, there are many problems arising from the increasing population number in certain countries. Increasing of population number is the main reason of inequality of incomes. Also, the expansion of climate change results, pandemic situation, political chaos, migration and urbanization in those countries affect the development level of the country. These changes place the majority of the world’s population under threat. One-fourth of the supposed 3.6 billion town population of the world live in ruins and they are powerless against natural disaster. Let us present statistics, where the prognoses say that in 2030 the number of town population will be 5 billion<sup>18</sup>.

In providing aid the main issue is not the quantity or the goal, the main thing is effectiveness of aid. Of course, the quantity and goal of the aid is important when we review any annual report, but

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<sup>17</sup> Andre Gunder Frank, “The Development of Underdevelopment”, *Thinking about Development*, reprinted in full from: *Monthly Review*, (September, 1966):28,

[http://www.colorado.edu/geography/class\\_homepages/geog\\_3682\\_f08/Articles/FrankDevofUnderdev.pdf](http://www.colorado.edu/geography/class_homepages/geog_3682_f08/Articles/FrankDevofUnderdev.pdf)

<sup>18</sup> OCHA in 2014 and 2015: plan and budget, *United Nations Department of Public Information*.

we need to see results and we can achieve good results with effective implementation of aid. That is why it is important to choose the right area of aid.

Currently, it is accepted that modern, reliable and effective energy facilities are an important impulse for development. Modern power industry supports productive activities: it is one of the factors that determine staunchness of productive expenditures and global competition and services, and it is the first needed condition for strong economic growth and social development. In this case for African tropical zone countries, modern power industry service is at a low level and in most villages electricity level is only 10%. Adaptation to climate change also could contribute to the strengthening of African countries' potential<sup>19</sup>. Certain countries of Africa are ready with their climate conditions to help such areas. One of the main issues there consists of an attentive approach to regulation and control questions by acceptors, which accept help from donors.

As MIC countries comprise most of the world and contain the majority of the world's population, it is possible to become HICs. Just a question is arising, we know that capitalism creates precipice. The poverty situation of LIC could be passed to MIC and maybe could pass to HIC and even in certain places it is so. Then who will need help? Sometimes we get lost in questions and cannot find answers, but while there are no questions, that means there will be no solution. Society, where uncertainty culture is formalizing, will always change and maybe we sometimes do not observe it, but they are positive changes.

#### **F. Situation of young generation and changes in Middle-Income Countries**

Every day 61 million<sup>20</sup> children because of poverty, various diseases and internal clashes cannot attend school. Of course, not all of these children are from MIC, but as we mentioned in other parts, we are in one world. And one day every step taken will have an effect. For example, today Ukraine has electricity problem so they cut trees and use it, and they mention that they will

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<sup>19</sup> Stephen Karekezi, John Kimani, Duncan Brack, Oscar Onguru, "Energy poverty, renewable energies and the Economic Partnership Agreements", *ICTSD, Trade Negotiations Insights*, Volume 8 - Number 10, December 15, 2009, <http://www.ictsd.org/bridges-news/trade-negotiations-insights/news/energy-poverty-renewable-energies-and-the-economic> (accessed August 16, 2014)

<sup>20</sup> Education, *Caritas Australia*, <http://www.caritas.org.au/learn/global-poverty-issues/education> (accessed August 22, 2014)

continue do this for a while. And the world is indifferently to this issue, does not environmental violation of certain territory affect other territories? Are you able to restrain natural problem far from your political border? Let us mention that it is not Far Africa, it is near Ukraine.

In 2014 donors cited that after UN call for Syria and South Africa, they will increase their aid. But every time the processes in the country results with the massive displacement of population, then the difference in demands and relation of the donors<sup>21</sup>. How we could solve the problem? Solution of all problems is the importance of changes in human thinking formalization. If we want to change anything in our life, firstly we should change our perspective on the issue and this is possible through projects not only to show our activity, but also for sustainable cooperation with theoretical and regulatory institutions. Education is the only means that could save people from poverty. It is because, education plays important role in ideology formalization of each youth. Ideology is the foundation of new thinking, that is directed at not being indifferent to certain processes.

This is not the first time such question has been raised. Indeed, as we mentioned it has been more than 10 years since the world states approved 8 development goals of Millennium. Decreasing of mother and child death and making general secondary education available for indigent children by 2015<sup>22</sup>. The importance of education issue is always topical, but it should be remembered when we say education we do not mean everybody should attain a science degree. The main issue here is to let citizens of these countries know their rights by improving their world outlook and expressing their opinions in order to demand their own rights.

Our main goal is not to achieve high income status, butto create conditions, which make education, health, pure water, chance of expressing own opinion available everywhere. This process has to be protected by the right government system and be far from discrimination. That is economic, social, cultural, civil and political rights.

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<sup>21</sup> Anna Osborne, "Comparing funding to 2014 humanitarian crises", *GHA*, last modified February 10, 2014, <http://www.globalhumanitarianassistance.org/comparing-funding-2014-humanitarian-crises-5005.html> (accessed 27 August, 2014)

<sup>22</sup> World Report 2014, United States of America:Human Rights Watch, 2013: 9  
[http://www.hrw.org/sites/default/files/wr2014\\_web\\_0.pdf](http://www.hrw.org/sites/default/files/wr2014_web_0.pdf)



Poverty is the biggest barrier for education. But we should take into account how this two issues are linked with each other, so we can highlight that lack of education is also the biggest reason for poverty. Of course, we should remember the fact: about half of world population live for USD 2 per day and even lower, for that reason struggle for living has become their life style, so they do not prioritize education. From the other point of view, lack of education increases the possibility of non-access to pure water and hygiene, increasing poverty and diseases.

Free primary education is an integral part of human rights, but most countries have problems with primary education. Today's 30 million children are non-educated, from Sahara to South of Africa 75% of children do not attend school and 774 million adults do not have basic knowledge<sup>23</sup>.

Education is therefore a reliable tool for the future generation in struggling with poverty. More specifically, education for girls has “multiplication effect”. This means that educated girls get married later and do not have a lot of children, which have more chances for living by oneself: in the terms of food and education. Participation of educated girls in social and economic issues also has positive character<sup>24</sup>.

In table 6 and 7 indicators of education in countries are shown by percentage. As you can see, the literacy rate among adults is lower than the percent of literacy among youth.. The question is whether the lack of education creates high poverty rates or whether the poverty rates lead to lower education? Educational status is important in order to have chance for changing future generations.

**Table 6. Youth literacy rate (15-24 years) -%**

Country	Data year	Total	Male	Female
Central African Republic	2011	66	72	59
South Africa	2011	99	98	99
Ethiopia	2007	55	63	47

<sup>23</sup>Education, Caritas, Australia, <http://www.caritas.org.au/learn/global-poverty-issues/education> (accessed August 22, 2014)

<sup>24</sup>Education is vital to meeting all Millennium Development Goals, UNICEF, <http://data.unicef.org/education/overview> (accessed August 20, 2014)

Niger	2005	37	52	23
Mali	2011	47	56	39
Chad	2011	48	54	42

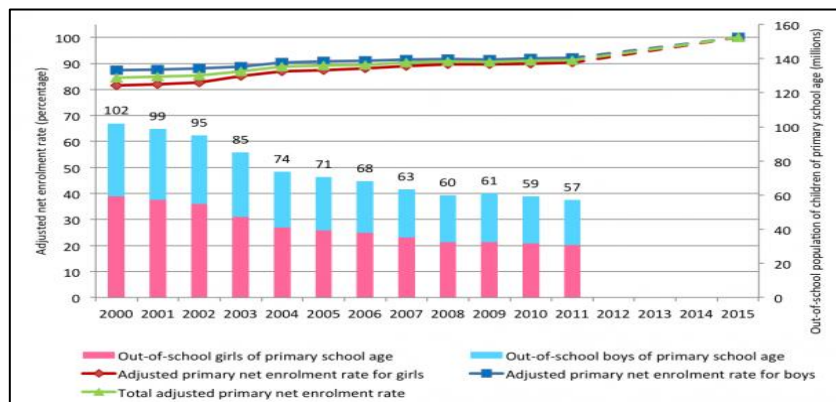
Source: UNESCO Institute for Statistics, September 2013, <http://data.unicef.org/education/overview>

**Table 7. Adult literacy rate (15 years and older) -%**

Country	Data year	Total	Male	Female
Central African Republic	2011	57	70	44
South Africa	2011	93	94	92
Ethiopia	2007	39	49	29
Niger	2005	29	43	15
Mali	2011	33	43	25
Chad	2011	35	46	25

Source: UNESCO Institute for Statistics, September 2013, <http://data.unicef.org/education/overview>

**Graph 3. Net enrolment rate and out-of school population among children of primary school age**



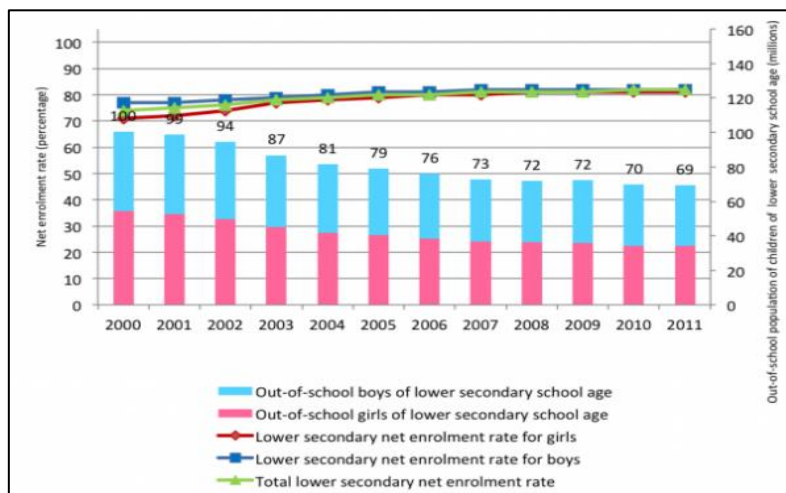
Source: UNESCO Institute for Statistics global databases, 2013.

What should we do in order to reduce poverty? If we give an empirical answer to this simple question: many countries have specific characteristics. Bringing new practices to a whole country

has never been easy<sup>25</sup>. It is difficult process as each country has specific capacities. Maybe this question is not appropriate and instant we should focus on providing stable regulation.

In order to strengthen responsibility of MIC countries, the World Bank has formed better relationship with such countries by approaching them individually.. For that purpose, with the requirement of the management of the bank will develop according to its experience with Analytic and advisory activities (AAA) task within the plan of Country Assistance Strategy (CASs)<sup>26</sup>. Maybe through these procedures the way could discover greater means for development. But there could be a question; self-improvement is really for world development. Alex Kremerin states that “Big expenditures are not the solution. It is known from the global experience. Benefits are not in appropriate mount from temporary and financial side.” (From World Bank report)<sup>27</sup>, the question in not is it right as an idea or not, but from the other side expenditures wasted for providing World Bank’s principal, we can understand that it is not a little amount even without considering statistics.

**Graph 4. Net enrolment rate and out-of school population among children of lower secondary school age**



Source: UNESCO Institute for Statistics global databases, 2013.

<sup>25</sup> Martin Ravallion, Pro-Poor Growth: A Primer, , Washington DC:Development Research Group.

<sup>26</sup> Development Results in Middle-income countries, Washington, DC., The World Bank, (2007): 71., [https://ieg.worldbankgroup.org/Data/reports/mic\\_evaluation.pdf](https://ieg.worldbankgroup.org/Data/reports/mic_evaluation.pdf)

<sup>27</sup> Call for help from the World Bank for poor countries [Dünya Bankasından yoksul ülkelere yardım çağrısı], *Ekohaber*, [http://www.ekohaber.com.tr/Dunya\\_Bankasindan\\_yoksul\\_ukelere\\_yardim\\_cagrisi-ekohaber-5-haberid-10748.html](http://www.ekohaber.com.tr/Dunya_Bankasindan_yoksul_ukelere_yardim_cagrisi-ekohaber-5-haberid-10748.html) (accessed August 21, 2014)

In graph 1 and 2 it is shown the education process in general with all aspects, looking at these diagrams we can conclude that there is no problem with the education in the world. It could be possible, because certain statistic indicators show that the world is in progress. But the one case is real and undeniable that sectors of society create a gap between people and it is timely and growing in every country of the world. It is the biggest challenge that is not resolved.

## **G. Conclusion**

How aid is being used in the present? Sometimes members of society create systems in order to have limitations and constraints that make it less challenging to follow societal focuses expectations, however it is also possible to forget or take for granted that these systems can also be changed once again in another direction. Does this mean that system, programs, etc., are therefore inefficient because they can be constantly changed overtime? NO, this is not the case; rather, when regulation and other forms of the controls are implemented correctly then these systems can work effectively for the benefit of member of society. Although the expenditure of these programs could be more helpful for indigent countries. The negative side of aid today is that they are typically directed only to present problems. In indigent countries, global processes are happening each year and people save themselves from death by moving and this process should be controlled by right organized program.

The one central issue currently is the need more flexible in conceiving political-economic borders involved in world development. Global processes have been witnessed in several poor countries as a result of people moving to live in foreign nations in order to save themselves and secure opportunities for their families. Therefore, there is a need for preparing new approaches to sustainable development as well as concepts and programs that would allow middle-income and low-income countries to have more control over their outcomes.

We all are called human, who lives on the same ground and under the same sun. The processes that are happening in one part of the world also affects us, even if we cannot see it visually. Of course,, thanks to people who are still struggling with ecological, political and economic processes, we do not avoid the word “future” from our vocabulary. And of course,, the future should be brighter than the present. And we should not forget that all of these are dependent on us. MICs

have a powerful tool in order to improve upon from this situation: which is the future generation. By directing aid to them HIC will have a significant chance to decrease the number of aids in future. Moreover, without right policies in LIC it is impossible to decrease the poverty in MIC. Maybe the flow and increase of poverty in HIC is appropriate choice for them. Because as is known while there is population growth in LIC and MIC, in HIC population growth is getting lower and it results in a lack of man power.

On the other hand if we consider this issue as “to use employees in their homeland”, it could be a direction for the solution. Two-sided interest to the aid is also important issue, because only interests were the reason of development. Arising of interest is not an easy process, but now by aid it could be gained.

We see problem from the far distance. Even if we travel, look at the statistics, analyzes we are not the human of this region. As a solution it is important to grow up experts, new youth with new thinking is very important. Otherwise donors will not know how to direct and MICs, HICs conceptions will completely mix. Of course, there is a question why LIC needs education if it has poverty problem, but people of economy period we should ignore such kind of thoughts. By complex means poverty problems in MIC should be solved through LIC, everyone would like to live their lives in own motherland, so let's support them in order to solve their problem through themselves. Future generation is forming through the present changes. The best way of formalizing opinions is firstly providing of minimum package. But the process should not be stopped by this. The main issue is to provide interest to self-improvement in addition to getting rid of their susceptibility to death due to poverty. As it was mentioned in an article this process will be gained by education and changes of thinking. In the example of my country - Azerbaijan -, we should mention reading-rooms of 19th century, only through them the measures were taken in the purpose of population progress. Although social-history development of Azerbaijan at that period was different. All these processes affected development of scientist-philosophical opinion of Azerbaijan. A developed future generation could be achieved through today's aid.

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# **Big Data, Analytics, and Knowledge Management**

## ANALYTICAL MODELS FOR PREDICTING BITCOIN PRICE

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**ABSTRACT:** The purpose of this research is to examine the relationships between Bitcoin and several financial metrics, such as indexes and commodities, in an effort to reveal any significant relationship between a specific index/commodity (or set of combinations) and the price value of Bitcoin. The interested parties pertaining to this research include investors of crypto (in particular investors in Bitcoin), researchers, and university students specializing in cryptocurrencies. The indexes being analyzed for this research consist of the following: Nasdaq 100, S&P 500, Dow Jones Industrial Index, Russell 2000, Nikkei 225, and S&P 500 Volatility Index (VIX). The commodities being analyzed for this research consist of the following: Gold and Oil. The final variable included within this article will be the Euro Exchange Rate, as studies have shown previously the Euro Exchange Rate may have an influence on the price of Bitcoin. A series of statistical models will evaluate the relationships among the above indexes/commodities and Bitcoin price.

**Key Words:** Bitcoin, Indexes, VIX, Exchange Rate

### INTRODUCTION:

Bitcoin officially launched in 2009, however it is hypothesized to be invented in 2008, in response to the financial crisis.<sup>1</sup> On October 31st, 2008, an individual named Satoshi Nakamoto posted the white paper for Bitcoin on a mailing list. The identity of Satoshi Nakamoto is actually unknown to this day. Satoshi Nakamoto can either be an individual or even a group of people.<sup>2</sup> Discussion of some characteristics of Bitcoin and some related terminologies would be helpful here. Bitcoin (BTC) is a decentralized digital currency that is the first digital currency to utilize a peer-to-peer system. A peer-to-peer system means the digital currency is not backed by any financial intermediaries or governments. Bitcoin maintains a decentralized authority, and that means that there are several technologies and entities in charge of the credibility of the Bitcoin

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<sup>1</sup> Investopedia. 2021. *Bitcoin's Price History*. [online] Available at: <https://www.investopedia.com/articles/forex/121815/bitcoins-price-history.asp> [Accessed 24 December 2021].

<sup>2</sup> U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <https://money.usnews.com/investing/articles/the-history-of-bitcoin> [Accessed 24 December 2021].

platform. These several entities are called “miners.” Miners are the decentralized authority of Bitcoin, and their responsibility is to solve complex mathematical equations that mine Bitcoins. Once enough mathematical equations are solved, eventually a Bitcoin is created or “mined”, and then that Bitcoin is distributed via the Blockchain. It is important to mention that the process of mining a Bitcoin requires a lot of computer power to complete.<sup>3</sup> The Blockchain is a decentralized digital ledger, and the blockchain’s responsibility involves recording, storing, and verifying transaction costs on the Blockchain. A blockchain is made out of blocks, and each block is a collection of Bitcoin transactions. Every time a miner mines a couple hundred thousand bitcoins, miners receive bitcoins as a reward. To fully understand the components that is Bitcoin, an overview of Bitcoin’s history is imperative.

As previously mentioned, Bitcoin was launched in 2009 and was officially created in late 2008. On January 3rd, 2009, the first Bitcoin, named “Block 0” or “the genesis block”, was mined. The first code encrypted to Block 0 states “The Times 03/Jan/2009 Chancellor on brink of second bailout for banks.” (*Bitcoin Definition: How Does Bitcoin Work?, 2021*)

The relevance of typing that message was most likely intended to keep a record of the first Bitcoin mined. On January 9th of 2009, the second Bitcoin was mined, titled “Block 1.”<sup>4</sup> Bitcoin, from its first ICO to around July of 2010, Bitcoin was worth fractions of a penny. It wasn’t until August 2009 it went over a penny.<sup>5</sup>

Moving onward with the history of Bitcoin, in 2016, the cryptocurrency market started to become more popular. In 2017 the price of Bitcoin reached an all-time high (at the time) of \$10,000. More individuals were learning about the digital currency and even banks, such as Citigroup and Barclays, started to strategize how they could benefit by including Bitcoin exchanges into their business model.<sup>6</sup> In December 2017, Bitcoin reached another all-time-high

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<sup>3</sup> Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?* [online] Available at: <<https://www.investopedia.com/terms/b/bitcoin.asp>> [Accessed 24 December 2021].

<sup>4</sup> Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?* [online] Available at: <<https://www.investopedia.com/terms/b/bitcoin.asp>> [Accessed 24 December 2021].

<sup>5</sup> Investopedia. 2021. *Bitcoin's Price History*. [online] Available at: <<https://www.investopedia.com/articles/forex/121815/bitcoins-price-history.asp>> [Accessed 24 December 2021].

<sup>6</sup> Marr, B., 2021. *A Short History Of Bitcoin And Crypto Currency Everyone Should Read*. [online] Forbes. Available at: <<https://www.forbes.com/sites/bernardmarr/2017/12/06/a-short-history-of-bitcoin-and-crypto-currency-everyone-should-read/?sh=392c09583f27>> [Accessed 24 December 2021].

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price of \$19,650.<sup>7</sup> Two months later in February of 2018, Bitcoin crashed, and its price fell just under \$6,000. That loss is estimated to be around \$13,800, nearly a 70% decrease from December. Some people believe that this decrease in price may be connected to short sellers in the derivative market. The analysts from the San Francisco Fed have brought this information to light. The reason why those analysts have reason to believe this was connected to short sellers is because not only did Bitcoin's price peak on December 17th, 2017, but also the Chicago Mercantile Exchange began exchanging derivatives on the same day, December 17th 2017. At the same time, Bitcoin's price started to decline, in conjunction with the 70% drop-off, led the analysts to believe that short sellers in the derivative market made an influence on Bitcoin's price at that time.<sup>8</sup>

At this point in 2017-2018, cryptocurrencies were extremely popular. In fact, In a lot of people were utilizing Bitcoin to seek investments for their startups, and investors were looking for ICO's to invest in, hoping it would lead them to large returns. ICO stands for Initial Coin Offering, and it works similarly to an IPO (Initial Public Offering). However, a majority of the ICO's published on the Blockchain from 2017 fell through due to investors acquiring that venture capital for themselves.<sup>9</sup> Ever since then, from 2017 to now (2022), Bitcoin's price has increased over time. However, in early Nov of 2022 we observed a significant decline in the price of Bitcoin.<sup>10</sup> Just before its decline in Nov 2021, Bitcoin's price has reached its all-time high, recording a value of \$64,400 on November 12th, 2021, In fact, many individuals familiar with cryptocurrencies are nervous that the crash in 2017 looks familiar to the statistics of Bitcoin today, and some are suggesting a crucial drop-off of price again.

Some individuals familiar with the Bitcoin crash of 2017 believe a similar crash can happen again, especially after analyzing Bitcoin's prices at the end of 2021. Realistically it can crash again, but other individuals familiar with cryptocurrency believe we are not in a similar

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<sup>7</sup> U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <<https://money.usnews.com/investing/articles/the-history-of-bitcoin>> [Accessed 24 December 2021].

<sup>8</sup> Yahoo.com. 2021. *Derivative caused Bitcoin to crash, San Francisco Fed says*. [online] Available at: <<https://www.yahoo.com/news/st-louis-fed-suggests-short-sellers-crushed-bitcoin-131420239.html>> [Accessed 24 December 2021].

<sup>9</sup> U.S. News & World Report. 2021. *The History of Bitcoin | Investing | US News*. [online] Available at: <<https://money.usnews.com/investing/articles/the-history-of-bitcoin>> [Accessed 24 December 2021].

<sup>10</sup> Investing.com. 2021. *Bitcoin Historical Data - Investing.com*. [online] Available at: <<https://www.investing.com/crypto/bitcoin/historical-data>> [Accessed 24 December 2021].

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situation as we were in 2017. The reason for this is because back in 2017, Bitcoin was still a controversial idea and not that many people invested at first, making the market not only small but invaluable also. Expert investors also decided not to participate, as they thought Bitcoin was a type of financial deceit. This is important to keep in mind because Bitcoin has been known to be used for illicit virtual activities, which is a probable reason as to why more people than not didn't trust the digital currency for so many years. Additionally, Bitcoin back then was primarily used for trading purposes. For example, holders of Bitcoin back then were more so focused on making returns in the short-term, hence selling whenever the price was expected to decline. However, in today's market, more people are holding onto their bitcoins instead of trading them. Because bitcoins are being held onto, there is now a value associated with those bitcoins. In fact, over 62% of bitcoins have not circulated in over a year, suggesting its owners are holding onto their shares. Pertaining to bitcoins that are continuously in circulation, they make up about just under 15% of the total bitcoins in circulation. The total bitcoin in circulation right now is around over 80 billion, which is estimated to cost over \$4.5 billion dollars of bitcoins in circulation. This suggests that we may not be in the same situation as we were in 2017, thanks to the accumulated value over the last four years.<sup>11</sup> Once again, the main reason why investors are holding onto their bitcoins is because most people see bitcoin as a risk asset that has great potential to grow in the future. There were many individuals who believe that the price of Bitcoin is going to reach \$100,000 before the end of the year (2021), based on supposedly accurate prediction models. However, that did not materialize. In summary, Bitcoin has fascinated the world with its new technology and financial hope for the future, especially keeping in mind the state of the economy, which is currently going through extremely low interest rates, which is a good indicator for inflation. Pertaining to today's inflation rate increasing, some individuals are purchasing bitcoins in order to hedge inflation.

Bitcoin is a considerable option when considering hedging against inflation because Bitcoin is programmed to be scarce, meaning, only a certain amount of bitcoins will ever be produced, once again consisting around 21 million total and the last Bitcoin planned to be mined

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<sup>11</sup> Bitcoin Magazine: Bitcoin News, Articles, Charts, and Guides. 2021. *Bitcoin 2017 Vs. 2021: How This Bull Run Is Different*. [online] Available at: <<https://bitcoinmagazine.com/markets/bitcoin-2017-vs-2021-how-this-bull-run-is-different>> [Accessed 24 December 2021].

will occur sometime in 2140.<sup>12</sup> Because inflation typically decreases demand in risk assets,<sup>13</sup> that can explain the recent drop in price for Bitcoin, from \$84,400 to \$56,800, all occurring in November of 2021. So far in this article, the history of Bitcoin has been discussed and analyzed, now this information will be utilized for our purposes, to interpret previous studies that coincide with our research purposes.

## **PREVIOUS RESEARCH**

There are a few previous studies that were introduced to the researchers of this article. The first previous study pertaining to the price of Bitcoin is called *Analyzing Bitcoin Price Volatility* by author Julio Cesar Soldevilla Estrada, from the University of California, Berkeley.<sup>14</sup> The purpose of this paper was to examine variables that may be related to each other in terms of Bitcoin's price and volatility. The variables included within this data set include Bitcoin price, S&P 500, VIX and Bitcoin realized volatility. More specifically, the author wanted to run statistical models to test the relationships amongst these variables, specifically: Bitcoin Price and S&P 500, Bitcoin Price and VIX, Bitcoin Realized Volatility and S&P 500, and Bitcoin Realized Volatility and VIX.

The author did not find a significant relationship between Bitcoin price and S&P 500, which suggests financial metrics have no influence on the price of Bitcoin. Regarding the relationship between Bitcoin price and the VIX (S&P 500 Volatility Index), there was also no defined relationship between these two variables within the results of the statistical model. However, the author was able to find a significant relationship between Bitcoin price realized volatility and S&P 500, at the 5% level. The results further explain that Bitcoin price realized volatility may have information that could predict future S&P 500 prices. In other words, Bitcoin price "Granger-causes" S&P 500 prices. However, the S&P 500 does not have information that can influence future Bitcoin prices. The relationship between Bitcoin price realized volatility and

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<sup>12</sup> Investopedia. 2021. *Bitcoin Definition: How Does Bitcoin Work?*[online] Available at: <<https://www.investopedia.com/terms/b/bitcoin.asp>> [Accessed 24 December 2021].

<sup>13</sup> Bloomberg.com. 2021. *Using Bitcoin as an Inflationary Hedge*. [online] Available at: <<https://www.bloomberg.com/news/videos/2021-11-23/bitcoin-as-an-inflationary-hedge-video>> [Accessed 25 December 2021].

<sup>14</sup> Smallake.kr. 2021. *Analyzing Bitcoin Price Volatility*. [online] Available at: <[http://www.smallake.kr/wp-content/uploads/2017/12/Thesis\\_Julio\\_Soldevilla.pdf](http://www.smallake.kr/wp-content/uploads/2017/12/Thesis_Julio_Soldevilla.pdf)> [Accessed 25 December 2021].

S&P 500 is very interesting because information from both variables influences the others' price. Therefore, the variables Granger-cause each other.

The second previous study relevant for the purposes of this article is called *What Are the Main Drivers of the Bitcoin Price? Evidence from Wavelet Coherence Analysis*. This study was published April 15th, 2015. This study primarily focuses its analysis on factors that may drive the price of Bitcoin, which are generally categorized financially, economically, and socially. More specifically, this study identifies six variables that may contribute to the price of Bitcoin, which include economic indicators, technical aspects, transaction instances, influence of Chinese markets, investor interest, and the overall collective concern of Bitcoin being considered a safe haven. This study utilized a statistical method known as a wavelet. A wavelet is a form of a mathematical and statistical analysis that identifies the location of specific frequencies, strongly correlated or negatively correlated, amongst the relationships of selected variables.<sup>15</sup> Researchers of this study also utilized six different series data in order to compute their analysis, which are summarized as the following: Bitcoin Price Index, Blockchain, exchanges, search engines, Financial Stress Index, and the price of gold. The authors conclude five crucial aspects regarding what indicators are the main drivers for Bitcoin price. The first conclusion pertains to bitcoin's price relationship to standard economic theories, such as the quantity theory of money, with respect to traditional supply and demand fundamentals, and this can be credited to bitcoin's limited supply as a vital aspect. The second conclusion that authors describe concerns bitcoin's price to be motivated by the incentive to mine bitcoins. This presents a cause-and-effect relationship with mining bitcoins when the computational power becomes too difficult for an individual to mine, hence transitioning into a direct consumer relationship. The third conclusion indicates investor interest as another main driver of bitcoin price. Thus far, this is the third study to conclude investor interest as a crucial indicator for bitcoin price. Researchers conclude Bitcoin is not technically established as a safe haven as a means of trade and investment. Finally, researchers conclude that the USD and CNY markets have no definite relationship due to no clear evidence, however they indicate there may be instances of connections amongst the markets. Once again, that can be attributed to the markets' high correlation and/or short-term

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<sup>15</sup> ScienceDirect. 2021. *Wavelet Analysis*. [online] Available at: <<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/wavelet-analysis>> [Accessed 25 December 2021].



volatility within those markets. This article will introduce one last previous study to demonstrate bitcoin's progression within financial markets.

The last previous study to be analyzed is titled *A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets* which was posted by the Multidisciplinary Digital Publishing Institute (MDPI). This study utilized bitcoin prices ranging from September 2014 - September 2021 and analyzed those prices against the S&P 500 Index, gold, and Treasury bonds.<sup>16</sup> The findings within this study are especially imperative for our purposes because it analyzes bitcoin data before and during the COVID-19 pandemic, which helps to objectively analyze bitcoin behavior. Statistical models utilized include correlation analysis amongst the cryptocurrency and the financial assets, in addition to a measurement of the mean absolute percentage error in regard to bitcoin volatility before and throughout the pandemic, as well as an augmented Dickey-Fuller (ADF) test.

In efforts to better understand what predicts Bitcoin price, author *Vieira (2017)* from the MDPI study collected data such as daily bitcoin price, daily price of gold in USD (per ounce), daily amount of bitcoin transactions and the total amount of distinctive bitcoin addresses, transaction fees paid to miners, the total value of coin base block rewards, daily treasury yield rates of "Treasury Inflation-Protected Securities", and accumulated Wikipedia views related to the term "Bitcoin."<sup>17</sup> For additional reference, the value of coin base block rewards is a representation of the rewards miners receive whenever a block is created, in which the current reward for every block is 50 bitcoins. In summary of this analysis, Vieira concludes that volatility amongst the cryptocurrency relationship with the identified financial assets represents significance in recognition of bitcoin price. For example, decreases in Bitcoin price have a more dramatic effect on its volatility and the markets involved versus increases in Bitcoin price. Vieira also makes a claim that bitcoin price has an inverse relationship with daily gold prices and the total amount of verified bitcoin transactions.

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<sup>16</sup> Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <<https://www.mdpi.com/journal/risks>> [Accessed 25 December 2021].

<sup>17</sup> Mdpi.com. 2021. *Risks - A Critical Analysis of Volatility Surprise in Bitcoin Cryptocurrency and Other Financial Assets*. [online] Available at: <<https://www.mdpi.com/journal/risks>> [Accessed 25 December 2021].

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## **DATA SET**

The main objective for this article is to determine through statistical modeling if there are any significant relationships amongst the indexes/commodities/exchange rate (from now would be referred to variables), especially if these relationships are effect the Bitcoin price. The indexes/commodities/exchange rate included in this study are: Nasdaq 100, S&P 500, Dow Jones Industrial Index, Russell 2000 Index, Nikkei 225, Gold, Oil, S&P 500 Volatility Index (VIX), and the euro exchange rate. Of these variables, seven are indexes, two are commodities, and one is an exchange rate. The data set ranges from July 18th, 2010 – December 12th, 2021. There are two sets of data, a monthly representation of the variables and a weekly representation of the variables. It is important to mention that the data for Bitcoin price, for both monthly and weekly data sets, have zero value from the inception of Bitcoin to July 18th, 2010, and the reason for this is because Bitcoin was worth fractions of a penny which makes those values are insignificant. The monthly and weekly data sets for Bitcoin and the rest of the variables were pulled from *Investing.com*.<sup>18</sup>

The techniques utilized within this research include descriptive statistics, outlier, correlation, and regression. The statistical programs utilized for this research include Excel and SPSS.

## **METHODOLOGY**

Table 1 shows the *monthly* descriptive statistics for *prices* involving variables including Bitcoin, indexes or commodities.

<b>Monthly Data, Descriptive Statistics, n =136</b>					
<b>July 18, 2010, to 2021 Dec 12, 2021</b>					
	Bitcoin	Nasdaq	S&P	DJIA	Russell
Mean	7,043.33	5,919.16	2,333.63	20,327.09	1,297.91
Median	631.5	4,621.05	2,104.17	17,970.34	1,226.75

<sup>18</sup> Investing.com. 2021. *Bitcoin Historical Data - Investing.com*. [online] Available at: <<https://www.investing.com/crypto/bitcoin/historical-data>> [Accessed 24 December 2021].

St. Dev	13,577.79	3,622.48	871.02	6,702.86	411.14
CV	1.93	0.61	0.37	0.33	0.32
Kurtosis	6.36	0.86	0.20	-0.60	0.15
Skewness	2.65	1.26	0.83	0.57	0.71

<b>Monthly Data, Descriptive Statistics, n =136</b>					
<b>July 18, 2010, to 2021 Dec 12, 2021</b>					
	Nikkei	Gold	Oil	VIX	Euro
Mean	17,916.30	1,470.17	68.97	18.14	1.21
Median	18913.14	1,390.2	64.32	16.31	0.009
St. Dev	5854.0	217.45	22.91	6.85	0.11
CV	0.32	0.15	0.33	0.38	0.09
Kurtosis	-0.80	-0.67	-1.18	6.25	-0.93
Skewness	0.002		0.17	2.11	0.52

**Table 1, Descriptive Statistics**

To detect outliers in our monthly data, all variables are within three standard deviations of the mean with some exception. Regarding the Bitcoin prices, several outliers were detected amongst the monthly Bitcoin prices. These four outliers occurred in 2021 as follow:

Nov 2021, \$56,882,

Oct 2021, \$61,309.60,

April 2021, \$57,720.30,

March 2021, \$58,763.

Reasons pertaining to the recent outliers can be hypothesized to be attributed to recent volatility within the economic environment. VIX prices had three outliers throughout the last 11 years all above three standard deviations of the mean.

Now, we concentrate on the weekly data for all of our variables.

<b>Weekly Data, Descriptive Statistics, n=596</b>					
<b>July 18, 2010 to 2021 Dec 12, 2021</b>					
	Bitcoin	Nasdaq	S&P	DJIA	Russell
Mean	6,804.22	5,813.69	2,308.19	20,157.63	1,286.38
Median	615.55	4,534.43	2,101.78	18,007.22	1218.66
St. Dev	13,412.49	3,562.95	867.85	6743.75	417.75
CV	1.93	0.61	0.38	0.33	0.32
Kurtosis	6.89	0.85	0.14	-0.61	0.16
Skewness	2.74	1.26	0.81	0.57	0.71

<b>Weekly Data, Descriptive Statistics, n=596</b>					
<b>July 18, 2010 to 2021 Dec 12, 2021</b>					
	Nikkei	Gold	Oil	VIX	Euro
Mean	17,741.38	1,466.64	69.94	17.62	1.21

Median	18,403.65	1,384.45	63.74	15.86	1.18
St. Dev	5,928.14	216.88	22.71	6.98	0.11
CV	0.33	0.15	0.61	0.38	0.33
Kurtosis	-0.80	-0.68	-1.19	10.36	-1.04
Skewness	0.06	0.67	0.16	2.52	0.45

Table 2 shows the *weekly* descriptive statistics for *prices* involving variables including Bitcoin, indexes and commodities.

Similarly, to the monthly findings, all variables within the weekly data are within three standard deviations of the mean with some exceptions. Bitcoin, Nasdaq 100 and VIX contained outliers within their data. Bitcoin had 28 outliers within the last 4 years, Nasdaq 100 had one outlier in the amount of \$16, 573.34 (August 2021) which is slightly above three standard deviations of the mean, the upper limit being \$16,502.56. VIX had 10 outliers within its data, 7 of which were consecutive and above three standard deviations from the mean, ranging from 40.11-66.04. The remaining 3 outliers occurred within August 2011. Analyzing these outliers can be an interesting issue which can be studied in the future research.

In order to create an analytical model, it would be useful to examine the correlation among our variables for monthly and weekly data. Table 3 shows the *monthly correlation* involving variables including Bitcoin price and all indexes and commodities for our monthly data.

<u>Table 3, Monthly Data</u>	<u>Partial of Correlation Matrix</u>
	<i>Bitcoin Price</i>
<b>Bitcoin Price</b>	1
<b>Nasdaq Price</b>	<b>0.885516635</b>
<b>S&amp;P 500 Price</b>	<b>0.845070597</b>
<b>Dow Jones Price</b>	<b>0.80189546</b>
<b>Russell 2000 Price</b>	<b>0.832664285</b>
<b>Nikkei 225 Price</b>	<b>0.721738458</b>
<b>Gold Price</b>	<b>0.542107271</b>

<b>Oil Price</b>	-0.159412152
<b>VIX Price</b>	0.175976956
<b>Euro Xchange Rate</b>	
<b>Price</b>	-0.209551315

Results highlighted in green show significant correlation between Bitcoin and some of our indexes and commodities. The strongest correlation is between Bitcoin price and Nasdaq 100 price (.88). The second highest correlation is between the Bitcoin price and S&P 500 (.84). Some other indexes such as Russell 200 price, Dow Jones price and Nikkei 225 price also have a significant relationship with Bitcoin price (at least 0.72). The commodity that shows a relatively large correlation with Bitcoin price is the price of gold, maintaining a correlation of (0.54). We intend to include these highly correlated variables in our analytical model initially.

Table 4 shows the *weekly correlation* involving variables including Bitcoin price, all indexes, and commodities.

**Table 4**      **Partial Correlation Matrix**

	<i>Bitcoin Price</i>
<b>Bitcoin Price</b>	1
<b>Nasdaq Price</b>	<b>0.873711535</b>
<b>S&amp;P 500 Price</b>	<b>0.831042265</b>
<b>Dow Jones Price</b>	<b>0.790557268</b>
<b>Russell 2000 Price</b>	<b>0.824310524</b>
<b>Nikkei 225 Price</b>	<b>0.720660664</b>
<b>Gold Price</b>	<b>0.540206775</b>
<b>Oil Price</b>	-0.150797891
<b>VIX Price</b>	0.10637435
<b>Euro Xchange Rate</b>	
<b>Price</b>	-0.201310607

Results highlighted in green show significant correlation between Bitcoin and some of our indexes and commodities. The strongest correlation is relationship between Bitcoin price and Nasdaq 100 price, maintaining a correlation of 0.87. Following this relationship, Bitcoin price and S&P 500 also maintain a high correlation of 0.83. In addition, other indexes such as Russel 2000 price, Dow Jones price, and Nikkei 225 price have high correlation (above 0.72). Once again, gold price is the only commodity showing a relatively large relationship with Bitcoin price, maintaining a correlation of 0.54. This is consistent thus far with monthly data.

Now, we use an analytical model for predicting the price of Bitcoin based on those variables which are highly correlated to the price of Bitcoin. Figure 4 shows the regression results for the *monthly* data by using the Statistical Package for the Social Sciences (SPSS).

**Figure 4**      **Regression Analysis**

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.949 <sup>a</sup>	.901	.897	4361.343354000

a. Predictors: (Constant), Oil Price , Russell 2000 Price , Nasdaq Price, Nikkei 225 Price, Dow Jones Price

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22415348660.000	5	4483069732.000	235.687	.000 <sup>b</sup>
	Residual	2472771060.000	130	19021315.850		
	Total	24888119720.000	135			

a. Dependent Variable: Bitcoin Price

b. Predictors: (Constant), Oil Price , Russell 2000 Price , Nasdaq Price, Nikkei 225 Price, Dow Jones Price

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-12092.922	3503.052		-3.452	.001
	Nasdaq Price	4.863	.391	1.298	12.430	.000
	Dow Jones Price	-2.167	.337	-1.070	-6.426	.000
	Russell 2000 Price	39.096	6.317	1.184	6.189	.000
	Nikkei 225 Price	-1.155	.376	-.498	-3.072	.003
	Oil Price	62.972	29.060	.106	2.167	.032

a. Dependent Variable: Bitcoin Price



The Coefficients table explains the following information pertaining to the relationship between bitcoin price and its associated variables: For every unit increase in Nasdaq price (\$1), Bitcoin price will increase by 4.863. For every unit increase in Dow Jones Price, Bitcoin price will decrease by 2.167. For every unit increase in Russell 2000 price, Bitcoin price will increase by 39.096. For every unit increase in Nikkei 225 price, Bitcoin price will decrease by 1.155. For every unit increase in Oil price, Bitcoin price will increase by 62.972.

Figure 5 shows the regression results for the *weekly* data by using the Statistical Package for The Social Sciences (SPSS).

**Figure 5      Regression Analysis**

**Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.941 <sup>a</sup>	.885	.884	4568.519561000

a. Predictors: (Constant), VIX Price, Dow Jones Price, Oil Price , Nikkei 225 Price, Nasdaq Price, Russell 2000 Price

**ANOVA<sup>a</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	94744276170.000	6	15790712700.000	756.573	.000 <sup>b</sup>
	Residual	12293237500.000	589	20871370.980		
	Total	107037513700.000	595			

a. Dependent Variable: Bitcoin Price

b. Predictors: (Constant), VIX Price, Dow Jones Price, Oil Price , Nikkei 225 Price, Nasdaq Price, Russell 2000 Price

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-19159.474	2315.947		-8.273	.000
	Nasdaq Price	4.422	.256	1.175	17.288	.000
	Dow Jones Price	-2.213	.166	-1.113	-13.327	.000
	Russell 2000 Price	40.464	3.293	1.260	12.287	.000
	Nikkei 225 Price	-.903	.178	-.399	-5.078	.000
	Oil Price	85.699	13.943	.145	6.147	.000
	VIX Price	166.182	38.655	.087	4.299	.000

a. Dependent Variable: Bitcoin Price

The Coefficients table explains the following information pertaining to the relationship between Bitcoin price and its associated variables: For every unit increase in Nasdaq price (\$1), Bitcoin price will increase by 4.422. For every unit increase in Dow Jones price, Bitcoin price will decrease by 2.213. For every unit increase in Russell 2000 price, Bitcoin price will increase by 40.464. For every unit increase in Nikkei 225 price, Bitcoin price will decrease by 0.903. For every unit increase in Oil price, Bitcoin price will increase by 85.699. For every unit increase in VIX price, Bitcoin price will increase by 166.182.

These results suggest that for the monthly prices of indexes and commodities the following variables are significant at the 5% level: **Nasdaq Price, Oil Price, Dow Jones Price, Russell 2000 Price, Nikkei 225 Price**. While the following variables are not significant at the 5% level: S&P 500, Gold, VIX, and Euro Exchange Rate. On the other hand, our results suggest that for the weekly prices of indexes and commodities the following variables are significant at the 5% level: **Nasdaq Price, Oil Price, Dow Jones price, Russell 2000 Price, Nikkei 225 Price, and VIX price**. While the following variables are not significant at the 5% level: S&P 500, Gold, and Euro Exchange Rate. It must be noted that some of the explanatory variables (for example our indexes) are correlated with each other and consequently created multi-collinearity. Indeed, the negative sign of a couple indexes in our regression equation support this conjecture. However, in this study we are just interested in forecasting and prediction of the price of Bitcoin.

## **CONCLUSION**

This article analyzed variables categorized as financial indexes, commodities, and VIX in efforts to better understand the behavior of Bitcoin price. We have examined their relationship and interpreted their measures based on a model structured by two divisions; monthly and weekly data sets, in efforts to identify significance amongst their individual as well as collective relationships. In conclusion, we have determined that there is some significance between Bitcoin price and financial indexes, especially Nasdaq, Dow Jones Price, Russell 2000 Price, and Nikkei. however, it must be mentioned that Bitcoin behaves as a speculative asset and other factors also must be examined carefully. For example, paying attention to the overall economic stance of financial markets in addition to attentive effort towards digital markets and medias could be a method to predict Bitcoin price more accurately.

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CHAC-olate: A Machine Learning Approach to Understanding the Effects of Rainfall on Cacao  
Trees During the Mayan Era

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ABSTRACT

Climate change has been a persistent topic of interest for eons. The Mayans of the Yucatan Peninsula in Mexico applied their Traditional Ecological Knowledge (TEK) for weather forecasting knowledge in order to be prepared for their coming seasons [5]. As the Olmecs/Mayans are often credited as being the initiators of chocolate, the Mayan rain god, Chac, had a profound influence on the Mayan culture, society, and love of chocolate. Chocolate was used as currency, ritual ingredient, and a pleasurable drink, as well as being considered as sacred as maize during those times. The Goddess of Chocolate, IxCacao, was even worshipped during those times. This ongoing research project explores how rainfall affected cacao trees during the Mayan times in the Yucatan Peninsula in Mexico, and what might be predicted, through machine learning models, for the near term with today's remaining Mayan generation.

1.0. Introduction

As the Mayans greatly worshipped Chac, the rain God, it seems likely that the Mayans, during their Classic Period of 300-900 A.D., vanished as a thriving civilization due to climate



change and persistent droughts. As we are now in the midst of global climate/warming conversations, our research tries to seek answers, using a machine learning model, as to how the effects of rainfall may influence the future production and use of chocolate for Mayan use in the coming years. A retrospective analysis is discussed, as well as using machine learning techniques to forecast the precipitation and temperature in the Yucatan Peninsula in Mexico in the near future.

Rainfall is the most important environmental factor influencing cacao yields. We can often learn from the past to predict the future [3]. During the Mayan times, the lack of rainfall and climate change are often attributed to the Mayan civilization's collapse [1]. As the Mayans (and the Olmecs) are recognized as the pioneers of chocolate, it would be helpful to learn, through a retrospective analysis, how rainfall affected the cacao trees during the Mayan times and specifically, using an AI machine learning approach, predicting how we may learn from these experiences for the future growth of cocoa farming [2,4].

This machine learning approach, using both descriptive and predictive analytics, is quite novel for use in this application. From this research, students, climatologists, and chocolate historians can learn more about the Mayan civilization, rainfall effects on past and future cacao trees/cocoa farming, and the more far-reaching implications on the effect of global warming/climate change, especially per the chocolate context. Chac, as the Mayan Rain God, was revered, as well as chocolate during those times. The hope is to provide insight, through machine learning, to allow students, educators, practitioners, and others to better understand

why the role of the Mayans and rainfall are so important in the history of chocolate (or as we like to say for this project title, CHAC-olate)!

## 2.0 Literature Review

The literature review explores various publications regarding the collapse of the Mayan civilization and how rainfall affected cacao trees during that time. Due to extreme weather conditions such as continual droughts, research has shown that this society did not stay alive. However, some research contradicts rainfall as the reason for the Mayan decline and instead considers the increase in summer temperatures to be the main driver (Collard et al., 2021). This information is shown through supporting distribution and regression analysis (Collard et al., 2021). With climate change becoming a more popular discussion today, machine learning models are an advantageous way to predict the impact of rainfall on cacao trees during the Mayan civilization. The challenging aspect that researchers have discussed is not predicting short-term rainfall, but rather long-term rainfall and the irregular rainfall that can have disastrous effects on farmland (Moulana et al., 2020). Among the various methods for rainfall, forecasting includes different regression analyses, model output statistics technique (MOS), artificial neural networks, solar radiation forecasting, among others (Sanders, 2005).

### 2.1 The Mayan Civilization and its Collapse

The Classic Mayan civilization (ca 200-950 A.D.) had its downfall from various events including rainfall, temperature, and overall management of this society. Its peak occurred “around AD 750 and disintegrated during the Terminal Classic period (AD 750–1000)” (Marx et

al., 2017). It is observed that when political leadership fails, it is up to the individuals, families, and communities to adapt to a changing environment to survive, unlike the Mayans (Lucero et al., 2011). When this is put in the mindset of present-day with the increased awareness of climate change, there is a lesson to be learned. In addition, due to over-reliance on technology, people are less likely to adjust to change which has been a recurring pattern in pre-Hispanic, southwest United States, at the end of the western Roman Empire, and in the Maya Lowlands (Lucero et al., 2011). Intriguingly, Mayan farmers had their traditional way of weather forecasting. In part, astronomy and mathematics were important and used by Mayan priests to predict the agricultural rainy seasons where they would also pray to the rain god, Chac. Rain is essentially significant to this group of people as it symbolizes fertility (Camacho-Villa, 2021).

As stated previously, climate changes in the environment greatly impacted the Maya civilization. The study, *Climate Over the Past Two Millennia*, investigates both proxy climate data and theoretical climate model simulations. These methods were then used to reconstruct past climate, past surface temperature, and atmospheric circulation, and drought. Paleoclimate proxy data falls into two categories. The first consists of “annually or perhaps decadal resolved high-resolution proxy records, such as tree rings, corals, ice cores, laminated sediments, and historical documentary proxy information” (Mann, 2007). However, the second category is not explained in this way as the records are “less well-resolved in time, have less precise age models, or both” (Mann, 2007). In addition, the research assessment looked at the role of solar and volcanic radiative forcing and “dynamical modes of climate variability” which includes the North Atlantic Oscillation (NAO) and El Niño/Southern Oscillation (ENSO) (Mann, 2007). At the end of this study, it was concluded that the increase in temperatures during the

twentieth century is unparalleled and that its only reasonable explanation would be through contemporary human-caused actions.

Mexico sits between tropics and subtropics and is between two zones called the Trade Winds and sub-tropical pressure belt. Therefore, the weather conditions fluctuate which impacts a society's living environment. Severe drought and dry conditions were still happening in the early 1970s, but in 1981, Mexico experienced ample precipitation (Metcalf, 1987). There is evidence that shows that the droughts that persisted for many years in the Yucatan Peninsula were caused by severe coldness and dryness in Greenland (Richardson, 2007). This resulted in the Maya abandonment in fifty-year increments starting at A.D. 760 (Richardson, 2007). When observing the variability in the climate over the last 2,000 years, high-resolution titanium (Ti) data has been collected by "using an ITRAX XRF core scanner from a laminated sediment core from the Laguna de Juanacatlán, western central Mexico" (Metcalf, 2010). This study wanted to find the relationship between Ti and precipitation by "comparing Ti data against instrumental meteorological record" and "against historical information which related to periods of major drought, where we would expect to see lower values of Ti reflecting reduced runoff" (Metcalf, 2010). As a result, it was concluded that their analysis "of the last 2,000 years of the Juanacatlán Ti record, demonstrates that the full, 7,000-year sequence, will provide an unparalleled, high-resolution reconstruction of precipitation/run-off variability on the east Pacific margin of Mexico." (Metcalf, 2010).

Since it has been confirmed by many studies that the Classic Mayan Civilization collapse is related to a decrease in precipitation, the degree of harshness has been the puzzling part. One study used a "quantitative view of the four best-dated and best-resolved paleoclimate

records from the Yucatan Peninsula (YP)” (Medina-Elizalde et al., 2012). Two different tests were conducted that looked at Terminal Classical Period (TCP) droughts for the summer seasons shift and observed the isotope mass balance model replicates the progress of Lake Chichanacanab as a function of lower distresses in summer precipitation. The overall findings were “that droughts occurring during the disintegration of the Maya civilization represented up to 40% reduction in annual precipitation, probably due to a reduction in summer season tropical storm frequency and intensity” (Medina-Elizalde et al., 2012). Another research article used reconstruction methods in the Northwest Yucatan Peninsula to observe the last 3,800 years of rainfall. Since the Maya collapse happened between 800 to 860 A.D., they found that the reduction of precipitation was at 18% and drought in the Pre-classic period appeared to be a 21% reduction. Specifically, the methods used were called the “calibration of pollen rain data and precipitation”, “modern pollen-precipitation relationship”, and “model of the transfer function” (Carrillo-Bastos et al., 2013). The study concluded that the better predictive and consistent model was the “calibration of modern fossil pollen.”

## 2.2 Cacao Trees

Cocoa (*Theobroma cacao*) is one of the world’s “most studied commodities” and produces a well-consumed product, chocolate. One study investigates cacao traceability and reported on two main stages in the production of chocolate. Stage one is to “identify cacao trees genotype composition” and Stage 2 is to determine “where fermentation of cacao beans occurs” (Pedro, 2021). In order for cacao trees to flourish, they need approximately 1,500 to 2,000 mm of rain per year. When this condition is met, the cacao trees will produce pods for

the year as in the previous times in South American tropical forests. Climate change poses a threat to the production of cacao trees and this plant does not thrive in warmer temperatures. Therefore, a plethora of research in different regions including Indonesia, Ghana, Costa Rica, Brazil, and West Africa has shown the correlation between rainfall and the increasing global temperature on the production of cacao (Santosa, 2018); (Hutchina, 2015); (Gateau-Rey, 2015-16); (Schroth, 2016). The focus is to provide recommendations around climate change strategies so that the production of cocoa may continue. Some research, for instance, revolves around gathering “a data set of the distribution of cocoa production in Indonesia and used it to develop a suitability zoning model using Random Forest (RF) machine learning” (Bunn, 2017). Other research looked to review the physiological responses of cacao to different climate elements. They found the following: “water limitation causes significant yield reduction in cacao, but when genotypic variation in sensitivity is evident, cacao experiences higher temperatures than is often reported in the literature; the complexity of the cacao/shade tree interaction can lead to contradictory results, and elevated CO<sub>2</sub> may alleviate some negative effects of climate change; implementation of mitigation strategies can help reduce environmental stress, and significant gaps in research need addressing...” (Lahive, et al, 2018).

### 2.3 Machine Learning for Weather and Crop Prediction

To predict and forecast rainfall and crop yield, many studies have been conducted using machine learning techniques. In Shooks’ et. al. (2021) article, they utilize deep learning to “build a Long Short-Term Memory (LSTM) – Recurrent Neural Network based model that leverages pedigree relatedness measures along with weekly weather parameters to dissect and predict

genotype response in multiple environments” (Shooks et. al., 2021). They found that deep learning (DL) can integrate additional data flawlessly but shows issues in the ML community when it comes to correctly understanding DL-based model outcomes. Another study conducted by Narejo et. al. (2021), also used deep learning as their method for rainfall forecasting. They used a Temporal Deep Belief Network (DBN) which was shown to have performed better than the Convolutional Neural Network (CNN). The DBN models should be used “for capturing complex representations mostly from static and stationary data such as image classification and object recognition” as they lack “dynamic modeling and are not accurately adequate for non-stationary environments based on time-variant features” (Narejo et. al., 2021).

As the above discusses deep learning models for predicting crop yield and rainfall, Lamos-Diaz et. al. (2020) researched machine learning models for forecasting specifically cacao crops and other influencing components. The various models used in this study included linear regression models, support vector machines (SVM), and ensemble learning models (random forest, and gradient boosting). Then, they compared SVM and ensemble learning models against least absolute shrinkage and selection operator (LASSO) regression models. The study showed that “on average, the performance of gradient boosting is higher than the other algorithms...” (Lamos-Diaz et. al., 2020). This study concluded by being able to use ML to predict crop yields. Cocoa was also investigated in another study through ML to detect cocoa diseases. This is important to prevent losing crops as farmers do not have the resources to detect diseases early-on. Different methods such as analyzing histograms of oriented gradient (HoG), local binary pattern (LBP), and Support Vector Machines (SVM) were used and found



SVM, Random Forest, and ANN's to be an even more accurate measure if there was a larger dataset (Rodriguez et. al., 2021).

Several studies centered around rainfall prediction in different areas (i.e., Tenerife Island, Germany, and South America) show that machine learning can be used as an accurate method (Aguasca-Colomo, 2019); (Kreklow, 2019); (Anochi, 2021). Flood forecasting is another topic that will show great benefits to communities as a warning can then be released before the occurrence (Dazzi et. al., 2021). The flood prediction was based on the Parma River in Italy and Support Vector Regression (SVR), Multilayer Perception (MLP), and Long Short-term Memory (LSTM) were compared, and they found LSTM to be appropriate and "accurate in predicting peak values, and it should be preferred for setting up an operational forecasting system" (Dazzi et. al., 2021). The TabNet Model was used in the Yan et. al. (2021) research because they wanted to mitigate the error rate of precipitation forecasting. Since rainfall has many "meteorological factors and is a complex nonlinear system", neural networks help with the various parameters and they found their method to perform that best when compared to others such as BP-NN, LSTM, and Lightgbm (Yan et. al., 2021). Some other studies suggest methods such as Genetic Algorithms and Gated Recurrent Unit (GRU) algorithms to be "best suitable as it gave an improved results and more accuracy" as well as better "suited for the research work as it supported time series format" (Kachwala et. al., nd). The issue with rainfall in all the studies is that it is difficult to predict rainfall in the long term as there are uncertainties. In Mohammed et. al. (2020), a linear regression method is used first for early forecast, and the standard deviation and mean will be calculated for "future prediction of crop seasons" (Mohammed et. al., 2020). Again, MLR, SVR, ANN, and others are used to draw

analysis over which approach is better suited. When this was complete, Mohammed et. al.'s (2020) team found that the SVR model returned the best results for this kind of prediction.

The studies demonstrate how machine learning can be an efficient tool for weather predictions because it takes into consideration variables such as solar radiation, temperature, and wind speed (Sanders, 2005). Sanders found that “weather forecast data in the prediction models resulted in a 7.6% reduction in mean absolute error (MAE) for one-hour predictions when compared to using historical observations alone, and a 40.2% reduction in MAE for 24-hour predictions” (Sanders, 2005). For this study, Random Forests were able to have the smallest error rate. Although predicting long term rainfall is challenging, Han et. al.'s (2016) study focused on *nowcasting*, “very short-term convective storm forecasting” (Han et. al., 2016). Han et. al. (2016) used a method called SBOW with the incorporation of real-time VDRAS re-analysis data. Although there was some success in this method, SBOW has restrictions with the convective initiation (CI), “storm that is grown from scratch”, because the training information is inadequate. Therefore, this means that the machine learning method does not have enough data to assess the situation and make the proper decision. It was concluded that there is a need for more VDRAS data to therefore allow the machine to make more informed decisions (Han et. al., 2016).

Gibson et. al. (2021) investigates seasonal forecasting of western US precipitation and uses methods consisting of climate model training data, machine learning predictor variables, observational and re-analysis data, random forests, XGBoost, neural networks, LSTM networks, and interpretable machine learning. When observing their findings, they suggested the Random Forest approach to seasonal predicting is favorable and when “compared to the traditional

approach of training statistical models on observational data, the large sample size enabled by training on large climate model simulations helps overcome sampling issues and allows for nonlinear interactions to be represented” (Gibson et. al., 2021).

Challenges and potential opportunities were investigated in Chantry et. al.’s (2021) study when using machine learning, specifically hard, medium, and soft AI for modeling weather and climate. To begin, an emphasis on the timescale prediction was addressed and includes now-casting (“precipitation right now or with a forecast lead time of a couple of hours”), short-range (“prediction describes forecasts for a day or two ahead”), medium-range rainfall (“timescales of a couple of days out to a couple of weeks”), sub-seasonal (“timescales from two weeks to one season”), seasonal (“depends critically on the coupled dynamics of the atmosphere and ocean and an archetypal phenomenon is the El Nino event in the tropical Pacific Ocean”), and climate-change (“how the statistics of weather changes as the greenhouse gas concentration of the atmosphere increases, on timescales of decades and longer”) (Chantry et. al., 2021).

Zhao (2020) describes the challenges of accurately predicting the future and the events that can occur. To aid in this process, it is advantageous to utilize “predictive analysis techniques from domains such as machine learning, data mining, pattern recognition, statistics, and other computational models” (Zhao, 2016). This article describes the process of event prediction by combining different techniques looking at three different traits: heterogeneous multi-output predictions, complex dependencies among the prediction output, and a real-time stream of prediction (Zhao, 2016). Overall, Zhao’s study is broader than the previous research studies as this one discusses event prediction methods for different industries.

### 3.0 Datasets

For our research, we explored the possible use of the following weather datasets:

- [www.worldclim.org](http://www.worldclim.org)

NOAA:

- <https://library.noaa.gov/Collections/Digital-Docs/Foreign-Climate-Data/Mexico-Climate-Data>
- <https://www.cpc.ncep.noaa.gov/products/precip/realtime/GIS/USMEX/analysis.shtml>
- Global Climate Data Guide data sets: <https://psl.noaa.gov/data/gridded/data.gpcp.html>

Mexico Precipitation/Climate Change data sets in data.world

- Download Precipitation Data (Seasonal or Monthly):

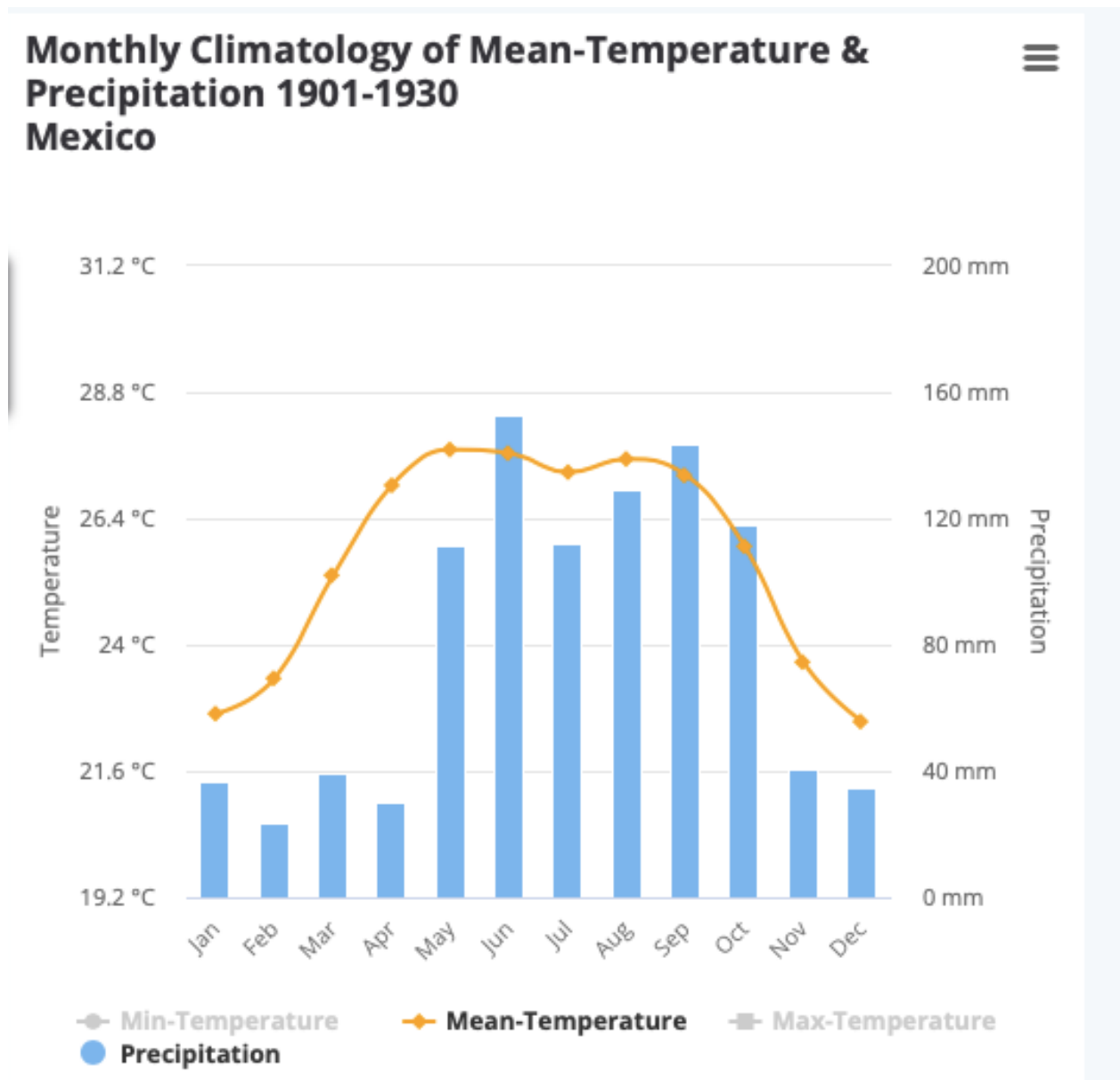
<https://climateknowledgeportal.worldbank.org/download-data>

<https://climateknowledgeportal.worldbank.org/country/mexico/climate-data-historical>

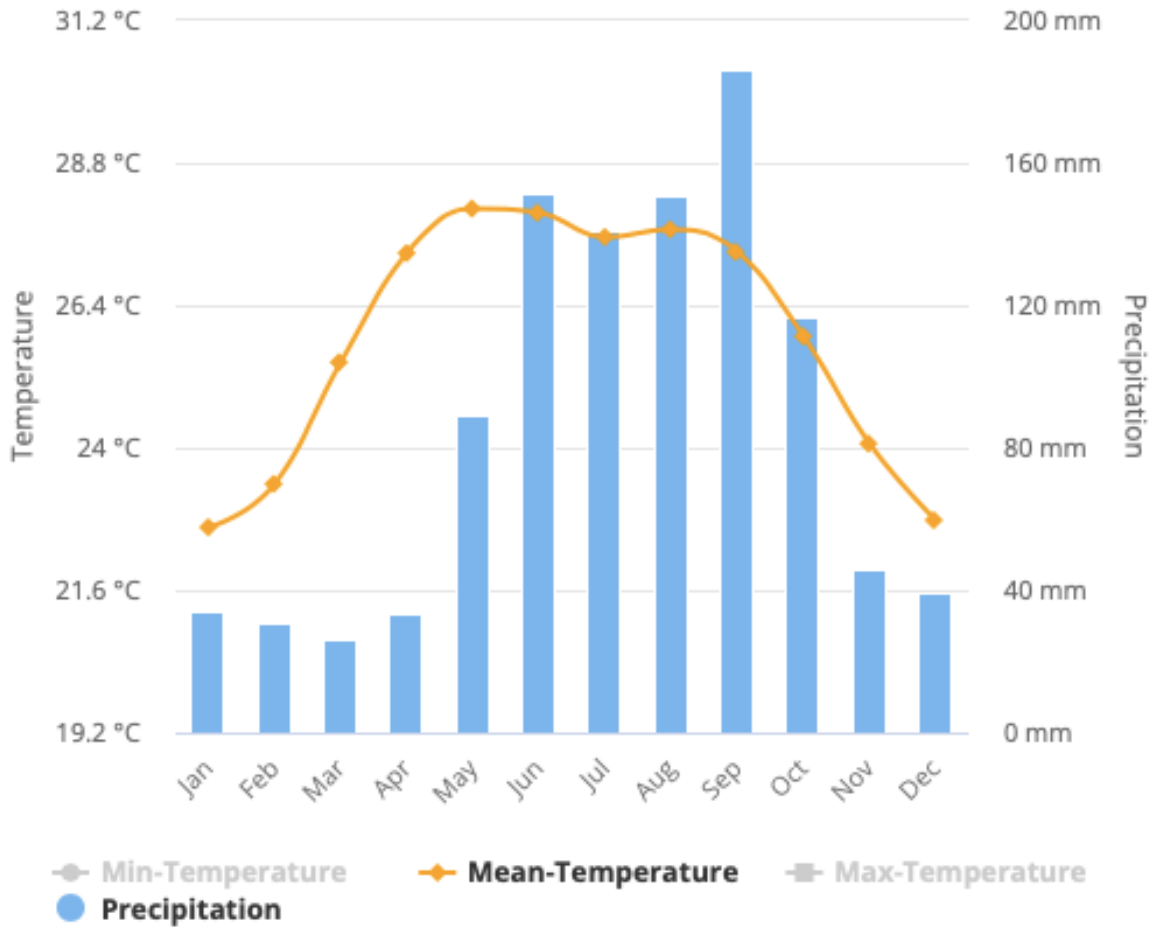
Figures 1-3 (<https://climateknowledgeportal.worldbank.org/download-data><https://climateknowledgeportal.worldbank.org/country/mexico/climate-data-historical>) indicate the mean-temperature & precipitation from 1901 through 2020. The average mean-temperature from 1901-1930 in the Yucatan was 22.69 degrees Celsius. The average mean-temperature from 1961-1990 in the Yucatan is 22.66 degrees Celsius. The average mean-temperature from 1991-2020 in the Yucatan is 23.33 degrees Celsius. Thus, we have seen a rise in average mean-temperature in the Yucatan over the past 100 years or so. As expected, mean monthly precipitation in the Yucatan has also increased over the years: about 71mm (1901-

1930); about 80 mm (1961-1990); about 90 mm (1991-2020). A rise in average temperatures will cause more evaporation to occur which, in turn, will increase overall precipitation.

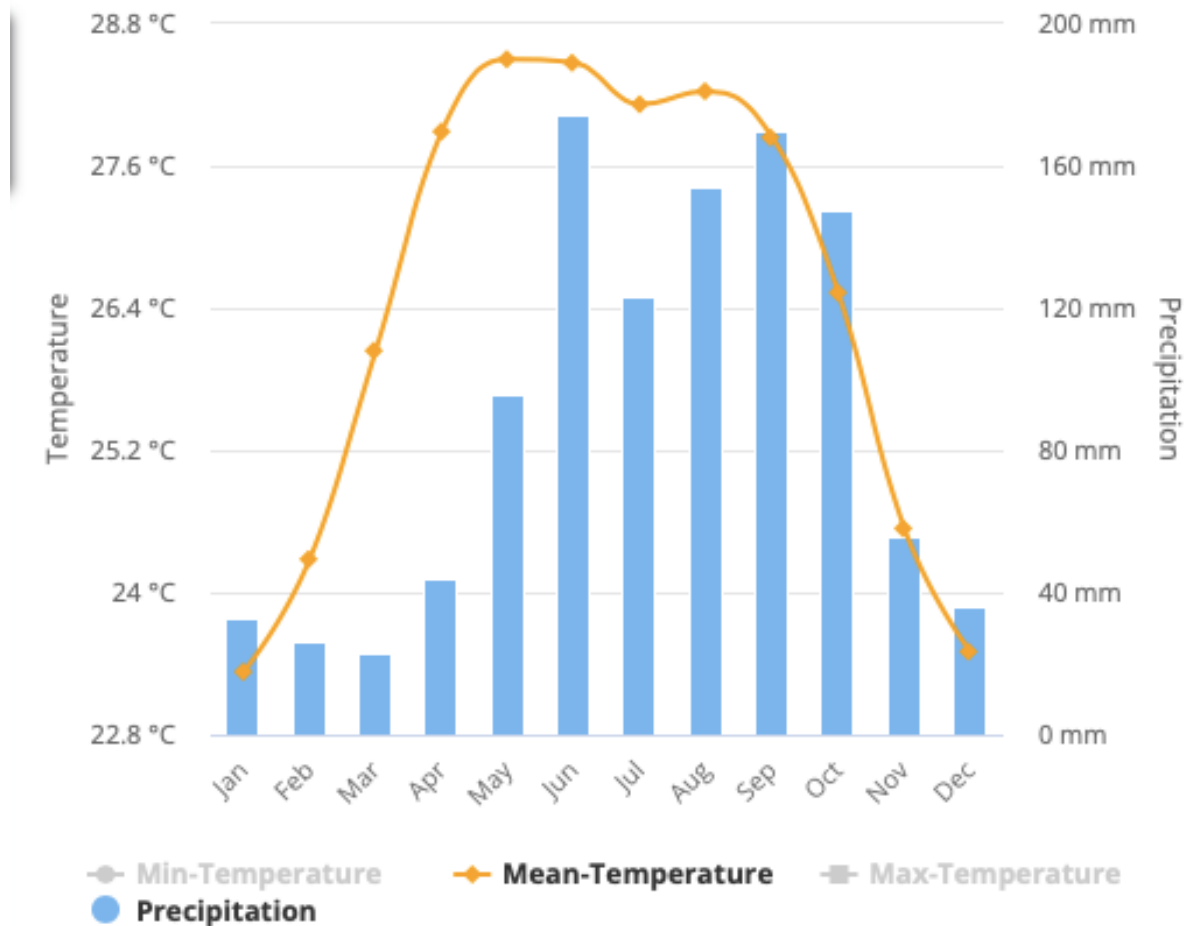
Figures 1 through 3: Monthly Climatology of Mean-Temperature & Precipitation in the Yucatan Peninsula, Mexico from 1901-1930, 1961-1990, and 1991-2020



# Monthly Climatology of Mean-Temperature & Precipitation 1961-1990 Mexico



## Monthly Climatology of Mean-Temperature & Precipitation 1991-2020 Mexico



### 4.0 Machine Learning Application

For the machine learning exercise, we decided to buy the daily precipitation/rainfall in the Yucatan Peninsula (Mexico) dataset from Meteomatics ([www.meteomatics.com](http://www.meteomatics.com)) from July 1, 2014 through October 11, 2021 and use RapidMiner ([www.rapidminer.com](http://www.rapidminer.com)) as our machine learning toolkit. The methods that were used below were created through RapidMiner using



their Auto Model capability. Before importing the data into the Auto Model, Turbo Prep was used to review and cleanse the data. Since the daily precipitation data was heavily skewed right, the data normalization method that was then selected was standardization. This was used on the continuous data for precipitation and temperature, the dependent and independent variables, respectively. After the data was standardized, it was imported into Auto Model where different models were run. They included a generalized linear model (regression), deep learning, decision tree, random forest, gradient boosted trees, and support vector machine. The results provided the model with the fastest scoring time, fastest total time, and best performance.

Table 1.1 and Table 1.2 show the results from the RapidMiner Auto Model using the different types of models, with associated correlations and root mean squared errors. The orange ribbon represents the “Best Performance” model, the purple running person represents the “Fastest Scoring Time” and the blue person running represents the “Fastest Total Time”. The decision tree model received both the fastest scoring time and the fastest total time, and the gradient boosted trees was classified as best performing.

*Table 1.1: RapidMiner Auto Model on Our Weather Data – Correlation*




Correlation ▾	Model	Correlation
	<a href="#">Generalized Linear Model</a>	0.174
	<a href="#">Deep Learning</a>	0.404
	<a href="#">Decision Tree</a>  	0
	<a href="#">Random Forest</a>	0.467
	<a href="#">Gradient Boosted Trees</a> 	0.606
	<a href="#">Support Vector Machine</a>	0.373

Table 1.2: Overview of RapidMiner Auto Model on Our Weather Data



Model	Root Mean Squared Error
<a href="#">Generalized Linear Model</a>	0.926
<a href="#">Deep Learning</a>	0.759
<a href="#">Decision Tree</a> 	0.825
<a href="#">Random Forest</a>	0.866
<a href="#">Gradient Boosted Trees</a> 	0.691
<a href="#">Support Vector Machine</a>	0.812

Table 1.3 depicts an overview of the results from the Auto Model that the RapidMiner software ran. As the table shows, the generalized linear model had a root mean squared error (RMSE) of 0.926 +/- 0.372, an absolute error of 0.491 +/- 0.090, a correlation of 0.174, and a squared error of 0.967 +/- 0.785. The linear relationship with this approach can be considered weak as it is just about 0.20 and below 0.50.

Table 1.3 - Overview of the Six Models and Results

Model	Root Mean Squared Error	Absolute Error	Relative Error	Squared Error	Correlation
Generalized Linear Model	0.926 +/- 0.372	0.491 +/- 0.090	91.6%	0.967 +/- 0.785	0.174
Deep Learning	0.759 +/- 0.189	0.445 +/- 0.039	83.0%	0.605 +/- 0.315	0.404
Decision Tree	0.825 +/- 0.219	0.486 +/- 0.043	100.4%	0.718 +/- 0.392	0
Random Forest	0.866 +/- 0.345	0.461 +/- 0.085	86.9%	0.845 +/- 0.675	0.467
Gradient Boosted Trees	0.691 +/- 0.229	0.403 +/- 0.084	67.8%	0.519 +/- 0.385	0.606
Support Vector Machine	0.812 +/- 0.226	0.347 +/- 0.047	55.0%	0.700 +/- 0.401	0.373

Following the generalized linear model was the deep learning method. As described by IBM, deep learning “is a subset of machine learning, which is essentially a neural network with three or more layers. These neural networks attempt to simulate the behavior of the human brain—albeit far from matching its ability—allowing it to “learn” from large amounts of data”

(<https://www.ibm.com/cloud/learn/deep-learning>). The RMSE under this approach was 0.759

+/- 0.189, an absolute error of 0.445 +/- 0.039, a correlation of 0.404, and a squared error of 0.605 +/- 0.315. For the decision tree model, the target variable used in this model was precipitation. This decision tree had a root mean squared error (RMSE) of 0.825 +/- 0.219, an absolute error of 0.486 +/- 0.043, a correlation of 0, and a squared error of 0.718 +/- 0.392. Overall, these errors are high, and the correlation shows that there is no linear relationship. The random forest model had a root mean squared error (RMSE) of 0.866 +/- 0.345, an absolute error of 0.461 +/- 0.085, a correlation of 0.467, and a squared error of 0.845 +/- 0.675. The linear relationship with this approach is between weak and moderate. The gradient boosted trees model had a root mean squared error (RMSE) of 0.691 +/- 0.229, an absolute error of 0.403 +/- 0.084, a correlation of 0.606, and a squared error of 0.519 +/- 0.385. The linear relationship with this approach can be considered moderate as it is above 0.50. The last approach that was used is the Support Vector Machine. The calculations of accuracy under this model included an RMSE of 0.812 +/- 0.226, an absolute error of 0.347 +/- 0.047, a correlation of 0.373, and a squared error of 0.700 +/- 0.401. Overall, each of these machine learning algorithms seemed to produce high error rates and low correlations. A combination of approaches may be warranted in the future as suggested by the literature review.

Seeing that we wanted to improve our predictive modeling results, we also tried using the Holt-Winters Time Series Forecasting model for this application. Under Holt-Winters, the time series attribute used was the daily precipitation variable. To run the model, it was indicated that the indices attribute was the date/time variable. When applying the forecast, the forecast horizon was set at 365 for a one-year forecast. When the next year's worth of precipitation values was summed (October 12, 2021-October 11, 2022), the total was 2654.55

mm which is far above the cacao tree requirement range. We also question the accuracy of this approach, as there seemed to be some exponential growth when forecasting 3 and 5 year horizons.

### 5.0 Findings & Conclusions

The original daily weather data provided three variables – date, precipitation in millimeters (mm), and temperature in Celsius from January 1, 2014 through October 11, 2021 from the Yucatan Peninsula. As discussed in the literature review, cacao trees require 1,500 to 2,000 mm of rainfall per year to flourish properly. Table 1.4 provides a summary of the daily historical rainfall data by giving the total rainfall per year and whether that amount meets the precipitation needed for cacao trees. When analyzing the given data over the last several years, there was only one year, 2020, that met the needed precipitation to produce cacao trees optimally (perhaps some COVID-related effects). The average total rainfall based on the data, excluding 2020, was 882.04 mm which is significantly below the required range. Even when we applied our machine learning algorithms to predict the anticipated rainfall in the Yucatan for the following year, we also saw that expected annual precipitation will fall below our threshold.

Therefore, this expresses concern on whether the future of cacao production in the Yucatan Peninsula is viable due to the risk of precipitation issues. Being that precipitation levels are correlated to the many climate change variables, this can raise even further concerns for the other areas in the world that mainly produce cacao, such as West Africa and Asia/Oceania

*Table 1.4 – Summary of Total Rainfall per Year from Yucatan Given Data Jan 2014- Oct 2021.*

<b>YEAR</b>	<b>TOTAL RAINFALL PER YEAR (IN MM)</b>	<b>MET CACAO TREE REQUIREMENT RANGE (1500- 2000 MM)</b>
<b>2014</b>	989.16	No
<b>2015</b>	864.78	No
<b>2016</b>	805.26	No
<b>2017</b>	1028.06	No
<b>2018</b>	863.72	No
<b>2019</b>	762	No
<b>2020</b>	1587.74	Yes
<b>2021*</b>	861.28	No
<b>* YEAR 2021 IS NOT A FULL YEAR. IT IS FROM JANUARY 1, 2021 TO OCTOBER 11, 2021</b>		

In furthering our research, The World Cocoa Foundation (WCF) has three focus areas that include “Prosperous Farmers, Empowered Communities, and Healthy Planet” (<https://www.worldcocoafoundation.org/>). Under Prosperous Farmers, the WCF strives to “improve the livelihoods of cocoa farmers around the world”. It helps Empower Communities by committing themselves to fight “child labor in the cocoa supply chain”. Finally, to accomplish its goal of creating a healthy planet, the WCF is “committed to ending cocoa-related deforestation and taking climate action” (<https://www.worldcocoafoundation.org/>). Therefore, many factors and challenges that contribute to the production of cocoa demonstrate how important this Foundation is as well as forecasting the future of cocoa production. When cacao trees are receiving the proper rainfall, they can last up to 100 years, but they are normally most productive in the first 25 to 30 years.

Although this research was specific to the Yucatan Peninsula, other areas in the world are producers of large percentages of cocoa output to the world. In West Africa, for instance, Ghana Community Development Manager Hamidu Isaka, works to improve the cocoa yield in this area without increasing the amount of land

[\(https://www.worldcocoafoundation.org/blog/increasing-cocoa-yield-with-the-same-amount-of-land-is-possible/\)](https://www.worldcocoafoundation.org/blog/increasing-cocoa-yield-with-the-same-amount-of-land-is-possible/). Isaka's method is to map the farms as it is a crucial part to stopping deforestation because it can detect whether "a farm is located in a protected forest area or near a protected area" (Isaka, 2021). Not only is this a way to end deforestation but also it protects the farmers in that their land is safe and helps bring farming communities together knowing that these actions have positive results.

Overall, this research tries to predict the future of cocoa production in the Yucatan in the near term, but it can also act as an aid for the cocoa supply chain in general. More machine learning applications, with additional data variables and embedded techniques, should help in better understanding this issue, along with similar issues with other crops. As related to our direct research, the data from 2014-2021 show that for most of the years, there has not been enough rainfall for flourishing cacao trees in the Yucatan. This may be a good reason why countries like the Ivory Coast have been a key producer of cocoa production. Perhaps, the Mayan Rain G-d, Chac, will be kinder to the Mayans and Yucatan Peninsula to improve the yield of the cacao trees, so that we may call "Chocolate", Chac-olate!

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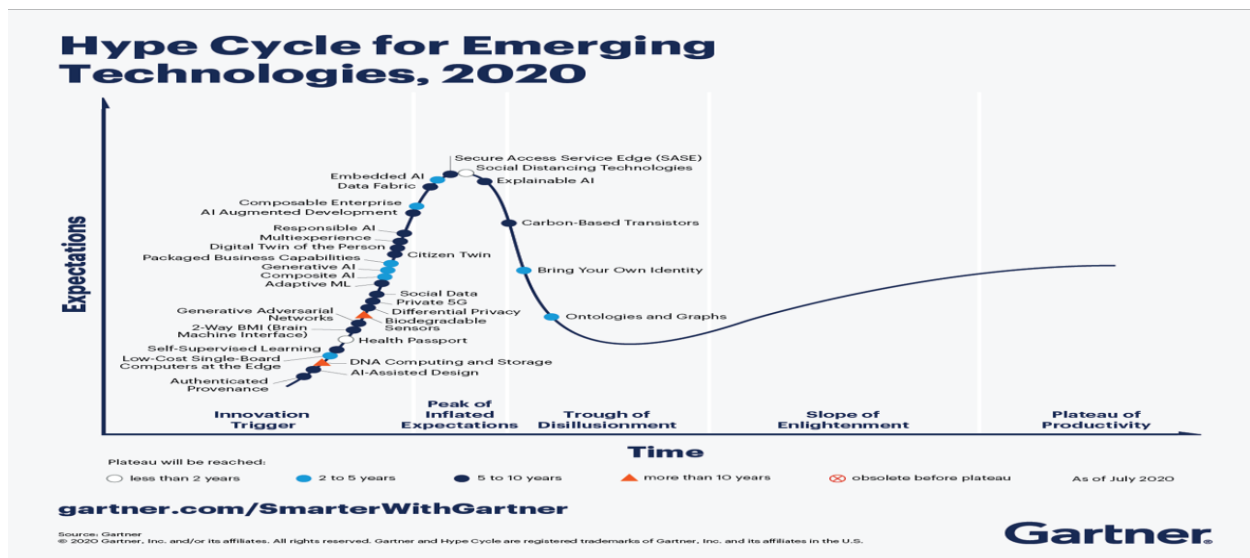
## Developing Story in Analytics course

Anil Aggarwal

University of Baltimore

AS technology is developing data visualization is becoming an important area of study. Organizations are demanding graduates who can understand, manage and make sense of data in visual format. This paper is an attempt in that direction. Developing a course and updating always creates challenges and opportunities. Visualization typically has two parts. Exploration and Explanation. The first part deals with data analysis and modeling, and the second part deals with data validation and story building. These parts are not mutually exclusive. One important part of the course is the use of real life data to develop story line. This is challenging since students and faculty need to understand how “story” is developed, what are the support documents needed to tell the story which can be effective. This paper will address issues related to implementation of such data analytics.

Data is being generated at unprecedented rate. This maybe big data, corporate data or government data. It needs to be analyzed and explored in form which is useful to users. According to Gartner hype cycle AI based technology and social data are part of emerging technologies



Developing story is an art itself. It requires competency in several disciplines. Following competencies maybe required

- Statistics/OR
- Database skills

- Programming skills
- Soft skills
- Logic skills
- 

As evidenced from above several/different skills are required to develop a story. If, we think in terms of TV series, movies and other shows, it is clear a story must make sense and be logical in sequence and frames. These topics need to be included in the new course geared towards building a story. Story building requires cross referencing to allow users to get detailed explanation (drill down) from various frames.

A story should be connected between various frames and should allow for cross referencing for more details. For example, One of the earliest story building example was of cholera break in UK. John snow was able to diagnose cause of cholera by using analytics.

These skills need to be included in a visual analytics course

## Lessons Learned

Once the course was designed the next step was to deliver it online. Story building was incorporated. There were challenges and following important lessons were learned..

- Highlight important stuff
  - Titles
  - Labels
  - Captions
- Be accessible to different users
- Not all data is important
- Provide statistics, if details not required
- Avoid clutter

## Conclusion

This new phenomenon merges two fields visualization and BI. It is important that our students understand the combined approach instead of existing isolated concepts of visualization and story building. There will always be challenges due to business background of students. This, however, should not be a drawback but an opportunity to develop new skills. As technology is improving it is allowing us to incorporate various analytical techniques in a visual environment. This will allow professors to concentrate on data visualization and resulting story to ‘discover’ opportunities in the classroom.

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Tableau 9: The Official Guide / Edition 2, ISBN:9780071843294

**DECISION SCIENCES INSTITUTE**  
**Opportunities and Challenges of Implementing Real-Time Data Warehousing in Higher Education**

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**ABSTRACT**

Higher education institutions are using information management systems for all the core activities ranging from admission, registration, course management, alumni, graduate, to academy operations. A real-time data warehousing approach supports generating, analyzing, and updating data to drive efficient decision-making processes. This paper presents a literature review focused on the implementation of, and the opportunities and challenges associated with real-time data warehousing in administrative and academic management processes and teaching performance systems. The paper concludes with future directions related to data warehousing in the higher education domain.

KEYWORDS: Real-time Data Warehousing, Higher Education, Knowledge, ETL, Decision Support/Evaluation Systems, Learning Analytics

**INTRODUCTION**

Data warehousing is the process of storing, monitoring, and analyzing large amounts of history and summary data that are extracted from multiple disparate data sources into a single multi-dimensional depository aiming to provide insights into the performance with an organization and improve its decision-making process (Moscoso-Zea et al., 2018). Real-time data warehousing literally is a system that reflects the state of the data warehouse in real time. If a query is running to learn a particular aspect of the business or entity described by the warehouse, the answer displays the state of that business or entity at the time the query was run (Mohania et al., 2009). Most data warehouses have data that are concealed or state the business at a point in the past. A real-time data warehouse has low undiscovered data and provides current data by using different technologies to acquire, cleanse, transform, store, and disseminate information in real time. Sayad (2017) identified three types of processing for real-time data mining: 1) on-line analytical processing: through mobile devices etc. 2) distributed processing: separately processing distributed data or segments of large data and integrating the results to obtain a single model, and 3) parallel processing: processing rapidly from multiple conventional processing units such as multi-threads, multi-processors, or a specialized chip (see Table 1). Data warehousing is in the center of analytics processing ensuring information extracted, transformed, and loaded meets the quality standards and results in a quality output in the generation of organizational knowledge (Moscoso-Zea et al., 2018). Real-time analytics, consisting of dynamic analysis and immediate reporting that enables users to access all available data to improve performance and quality of service (Mohania et al., 2009).

Three Types of Real-Time Data Mining Processing	Features
On-line analytical processing	via in-situ, such as mobile devices, satellites
Distributed processing	Process distributed data separately and generate into a single model
Parallel processing	Rapid processing from multiple units

Table 1: Three types of real-time data mining processing (Source: Sayad, 2017)

Knowledge is the key resource that can strengthen the positioning of an organization and is normally defined as experience, facts, know-how, processes, and beliefs that increase organizational or individual capabilities (Karemente et al., 2009, as cited in Moscoso-Zea et al., 2018). The components of analysis rules constitute the knowledge model of a real-time data warehouse, that determines what an analyst needs to consider when specifying an active rule to automate a routine decision task. The analysis graph and decision-making phases stand for the knowledge for multidimensional analysis and decision-making (Mohania et al., 2009). A centralized data collector enables gathering information from institutions, transporting those data to its servers and data processing centers, and then analyzing, visualizing, and circulating the data to capture knowledge and decision-making practices (Williamson, 2018). Data analysis aims to generate knowledge and draw conclusions from the information in data warehousing by processing data and using technological and statistical tools. The creation of knowledge involves shaping information from people, processes, and technology, and establishing mechanisms for data analysis (Moscoso-Zea et al., 2018). Summarized as shown in Figure 1.

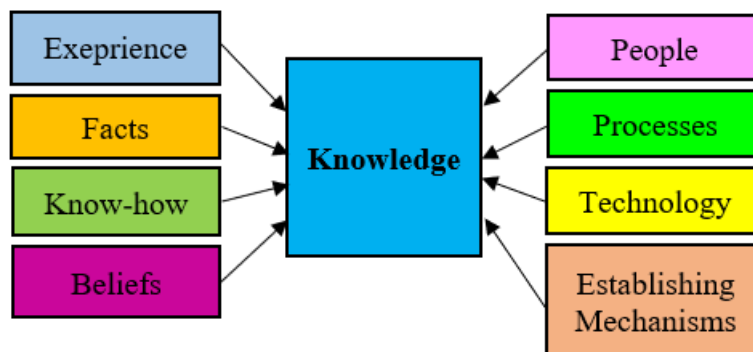


Figure 1: The creation of knowledge (Source: Moscoso-Zea et al, 2018)

In the higher education domain, students, faculty, and staff all contribute to the diverse sources of data available for analysis. The data stored in the universities' information systems are valuable for decision-making, compliance, assessment, and performance evaluation (Jim & Chang, 2018). Real time systems allow the consumption of data to occur in time periods that can vary from a few seconds to a few minutes (Mohania et al., 2009). The digital higher education sector has data-driven universities operating within a smart and connected environment, where institutions can self-monitor; policymakers can analyze sectoral data; and users can measure their progress in real-time (Williamson, 2018). Sensor networks, real-time business intelligence, and real-time cloud applications are becoming more popular along with the development of real-time data warehousing (Cuzzocrea et al., 2020). Moscoso-Zea et al.



(2018) states that the higher education institutes are facing challenges in business intelligence and data analysis tasks along with the adoption of the internet of things and cloud computing as a large amount of information is generated every day along with various administrative and academic applications and devices. Due to these factors, the complexity to store, process, and analyze data in these institutions increases. To address this complexity, the implementation of a real-time data warehouse along with supporting business intelligence tools can improve the efficiency of processing and understanding the volume of available data.

## IMPLEMENTATION

The adoption of digital technologies for record management may free up physical space but require continuous investment to upgrade the advancing hardware and software. Technology infrastructure, large-scale databases, and demands for timely data are employed to support decision making involving all levels of college leadership and operations (Picciano, 2012, as cited by Jim & Chang, 2018). Maintaining information technology (IT) and business processes while improving teaching and learning performance for faculty, students, and staff are tasks that are not easy to achieve. Data resolutions in higher education institutions based on cloud computing centralized structure and machine learning processes need quality data to produce an accurate and precise solution, which also require lots of real-time data to offer a decent service (Amo et al., 2021). The blending of academia and business processes in higher education and the digitalization within universities demand an organizational and communicable structure to monitor data and information for the benefits and goals of the organizations and their stakeholders (Jim & Chang, 2018).

Rezgui et al. (2017) introduced the definitions of “first level” knowledge and “advanced-level” knowledge which offer end-users knowledge without or with decision information including evaluation, responsibility, decision time, and affected field to indicate the applications of decision evaluation systems in higher education domain. He also proposed an approach based on Key Performance Indicator (KPI) and called the KPI-based decision evaluation system to integrate technologies, processes, and architectures of quality management systems and decision support systems to help higher education institutes maintain a high level of quality by following standards and guidelines and to support the coordination activities in the organization to manage and improve efficiency and effectiveness of its performance. The data was extracted, transformed, and loaded, and then stored in the target data warehouse to be available for query processing (Cuzzocrea et al., 2020). Data warehousing is used to gather KPI lists and their values and changes over time. The decision support systems will give a real-time situation of KPIs and help the management team in the higher education institutes to visualize the key performance indicators over time and the achievements of targets. Six dimensions are usually utilized to analyze the insights of real-time data warehousing: schema proposal, user requirements, business requirements, effectiveness, implementation, and data analysis and many institutions have upgraded their infrastructures to a hybrid model (Moscoso-Zea et al., 2018). Real-time data warehousing enables the integration of operational information with historical records; manages real-time scalability to increase numbers of users; and incorporates active alert mechanisms into user interfaces such as electronic dashboards (March & Hevner, 2007).

Cuzzocrea et al. (2020) brought up a proposed approach based on intelligent manipulation of SQL statements of input queries. The queries are decomposed in suitable sub-queries and

submitted as final input queries to a necessary component responsible for the cooperative query answering through a parallel query processing method. This method prompts a novel data warehousing framework in which the static data is separated from the dynamic data with the purpose of achieving the real-time processing features. The dynamic data warehouse contains the light real-time data integration component, whereas the static data warehouse holds the bulk of data and all the indexing and summarizing components on less recent data. The processing is parallel so that each data channel can analyze and transport data separately and rapidly, and then merge together for a generated report in a real-time manner. Real-time stream processing is referred as in-memory processing of massive data that can significantly reduce execution time when input completely fits into memory and can be generally required into two types of applications: One is organizing data to reach a decision, and the second is to generate a certain reaction on real-time database with low latency (Mehmood & Anees, 2020). From the above, it can be summarized as in Figure 2.

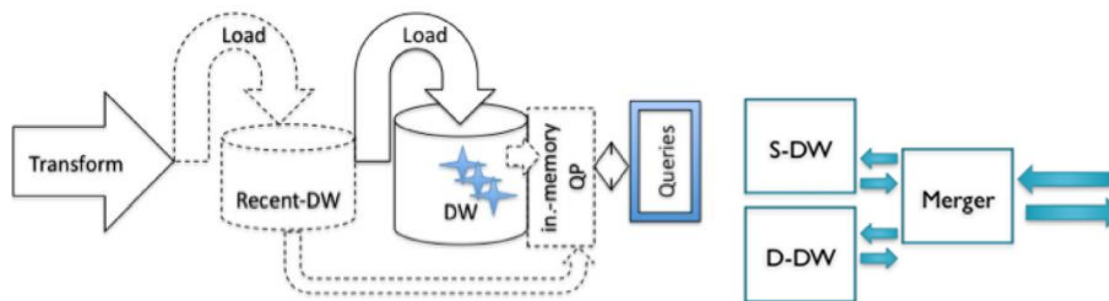


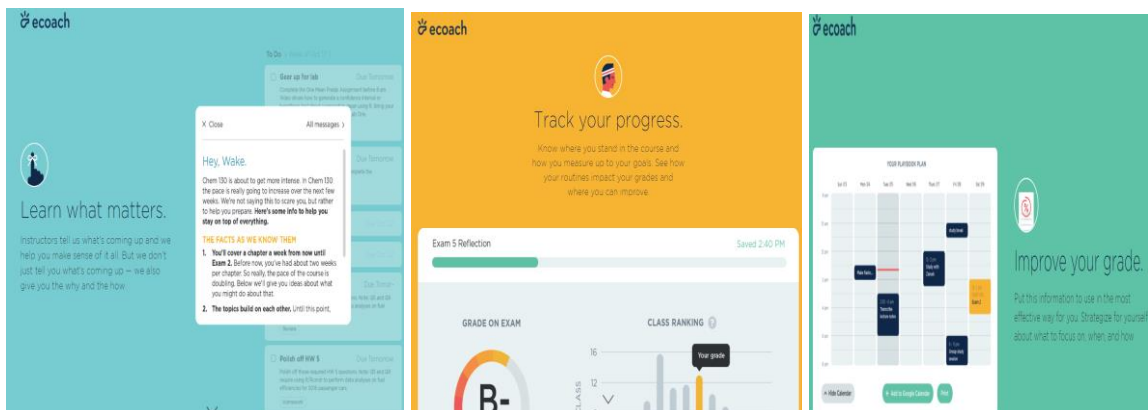
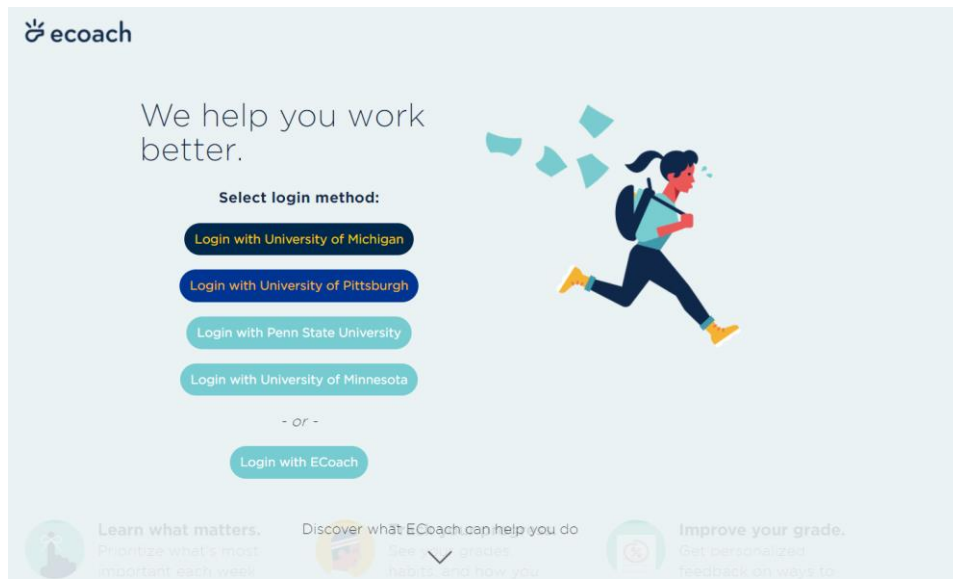
Figure 2: The proposed real-time data warehousing architecture and conceptual model (Source: Cuzzocrea et al., 2020)

For many universities, their business and instructional processes supported by information technology have become entangled (Jim & Chang, 2018). The ongoing cycle of data analytics provides information for performance, accountability, and other educational objectives such as student learning outcomes; therefore, data-driven decision-making is a widely adopted approach to cope with these concerns (Hora et al., 2017). Administrative records, financial records, enrollment data, student information, and faculty records are internal datasets maintained and processed in-house. External data are referred to third-party applications such as a learning management system, curriculum and instructional tools, digital library resources, and social media data. Research data is between internal and external and is managed according to the institution's data management policy as well as the funding agency's expectations (Jim & Chang, 2018). Universities must consider their benefits when using data and information and protecting data as an asset.

### Case Examples

Mattingly et al. (2012) discussed that learning and academic analytics in higher education aim to predict student success by evaluating students' study and support from academic programs and institutions. The key performance indicators of student success stem from the standards and decisions at institutional levels, which are used to produce operations reports and make decisions. Data can be extracted in real-time from learning management systems, content management systems, or learning content management systems that integrate with Student

Information Systems, which may store additional information and demographics as well as historical and background records about students. These data may be stored at different locations on campus, such as financial aid, residential life, registration, IT help desk, and the learning center. The underlying algorithms and parameters related to data collection and reporting can be modified based on the strategy focus. For example, the University of Michigan established ECoach (see Figure 3), a student support and intervention system that provides a model to identify strengths, weaknesses, and performance trends that impact student success in completing their degrees. ECoach provides the interface between students and the resources available to them by offering customized recommendations of study habits and practice assignments and giving feedback on progress as well as encouragement in their efforts to maximize each student's success. University of Pittsburg, Penn State University, and University of Minnesota joined in this ECoach club as well. It includes three sections: learn what matters, track your progress, and improve your grade. The students can receive what's coming up from the instructors and learn the why and the how from the ECoach. The software also displays dashboards of the student's Grades, Class Ranking, and Your Playbook Plan to visualize their progress in the course and then instruct them how to improve their tasks, goals, and grades. At present 104, 418 students are using ECoach to improve their grades.



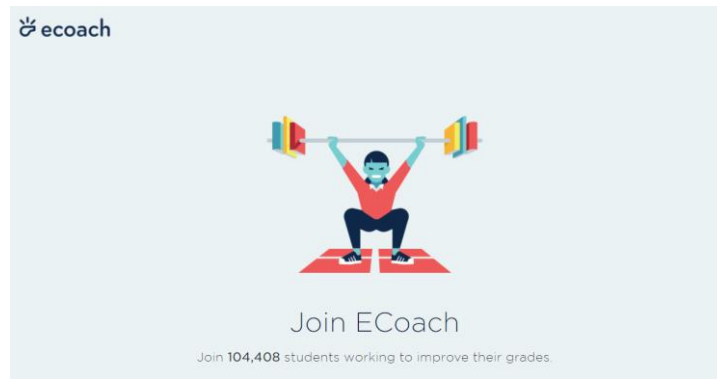


Figure 3. ECoach home page (Source: <https://ecoach.ai.umich.edu/Welcome/>)

Penn State is using iTwo system as the Institution Insight System (see Figure 4). It is a user-friendly tool with dragging and dropping functions and provides access to dashboards of LionPATH, a platform for students to select and enroll courses, academic schedule, pay tuitions, check financial statements and status, view grades, request unofficial and official transcripts etc., according to roles and responsibilities. Notification emails will be sent out to the users when new dashboards are available. Accesses to dashboards of graduate and undergraduate admissions, class meeting patterns, as well as student and instruction require requests for authorization to approve. Because the data is updated nightly, there is a delay for the servers and systems to generate data and reports. Online training is providing a way to learn how to be familiar with accessing and generating reports. After a security access to iTwo, all the dashboards and reports including both old and new reports in the existing data warehouse are accessible. Users also can create their own reports; however, the old values and new values cannot be blended in a single report. The Reporting or Data Warehouse team will work with each department to ensure they can access to the resources needed. Departments need to develop their specific reports and make them available for the Reporting and Data Warehouse team to replace the old ones. Accessing and running PeopleSoft (PS) Queries in LionPATH are certain roles' jobs but not everyone's. Every PS Query will be developed, reviewed, and tested through a process before it is launched in the production database. Real-time queries will take place in the LionPATH system (see Figure 5). Drop-down selection boxes are created through PS Queries which can help filter customizable results (The Penn State University website).

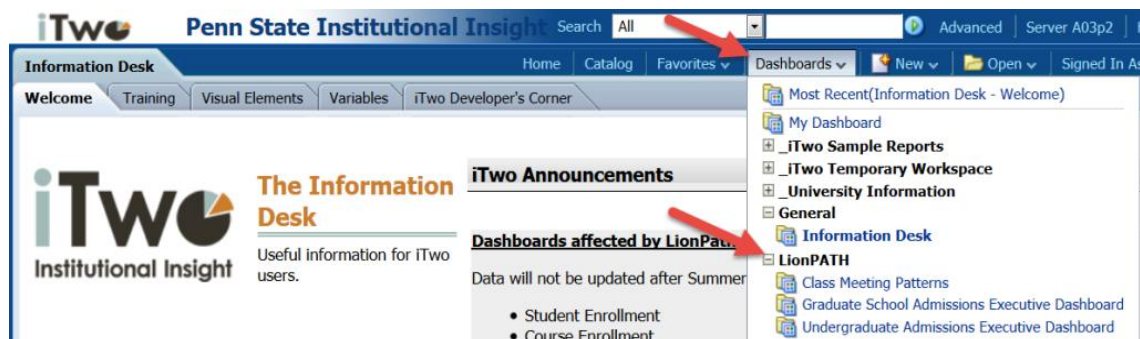


Figure 4. iTwo Institutional Insight webpage at Penn State University (Source: <https://lionpathsupport.psu.edu/faqs/facultystaff-faqs/data-warehouseitwo/#160>)

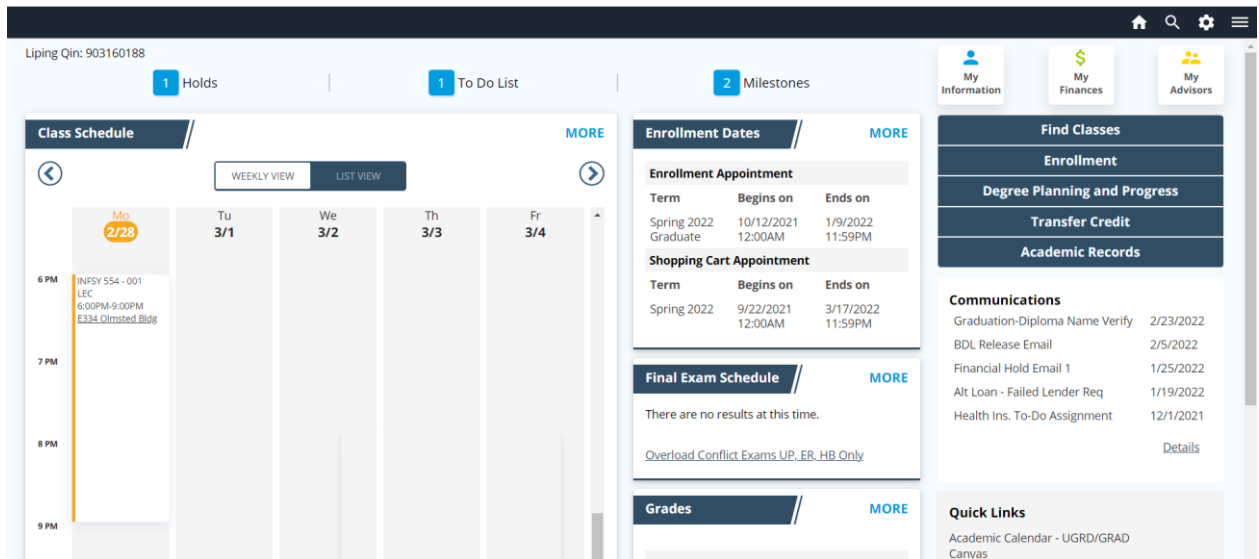


Figure 5. LionPATH dashboard for students at Penn State University

(Source: [https://www.lionpath.psu.edu/psc/CSPRD/EMPLOYEE/SA/c/PE\\_UI018\\_HB\\_STDNT.PE\\_UI018\\_HB\\_STDNT.GBL?Page=PE\\_UI018\\_HB\\_STDNT&Action=U](https://www.lionpath.psu.edu/psc/CSPRD/EMPLOYEE/SA/c/PE_UI018_HB_STDNT.PE_UI018_HB_STDNT.GBL?Page=PE_UI018_HB_STDNT&Action=U))

Additionally, Chatbots, Siri, and Alexa are examples of artificial intelligence systems that users can interact with to provide real-time support at an unprecedented scale (Larkan-Skinner & Shedd, 2021). It also could be used to answer easy questions or questions that students may feel uncomfortable to ask. For instance, Georgia State University applied a chatbot named “Pounce” to answer questions for new students. Timely information plays an important role in the management of academic analytics, which can provide timely access to data, make information broadly accessible, and ease the users with friendly technology tools (Mattingly et al., 2012). Martha, an AI-driven chatbot, was introduced to the George Washington University in 2018 as a pilot project and generated more than 4000 chats within one month. It will become a permanent member in the campus community. The Live Chat Benchmark Report 2020 indicates that the use of the bots is dramatically increasing in broad scopes due to the way they comprehend the natural human language. This technology brings revolutions to the education domain. Some of the popular chatbots are Martha, Botsify, CourseQ, and Miao, who can converse to students, parents, and tutors with overwhelming messages (see Figure 6). These provide real-time information access, simplify administrative procedures, make online learning easier, support career counseling, and eventually increase student’s engagement and participation (Karmick Solutions website, 2021).

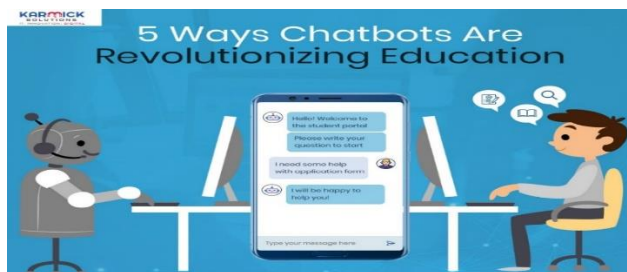


Figure 6. A sample display of chatbots (Source: <https://karmicksolutions.com/blog/5-ways-chatbots-are-revolutionizing-education/>)



The upgrading of software helps data warehousing adopt advanced systems for data integration. For example, the University of Pittsburg uses Oracle-based database to access data of student, financial, and employee that is initiated in several university systems such as Student Information System – PeopleSoft, PRISM, and PantherExpress (purchase orders). Data and information from the existing and new systems are updated daily from Monday to Saturday in the data marts to align with new reporting and analytics needs. Tools like Cognos and Tableau, a SQL client are deployed to support accessing the university data warehouse. Security is managed by a federal authorization process (The University of Pittsburg website, see Figure 7).

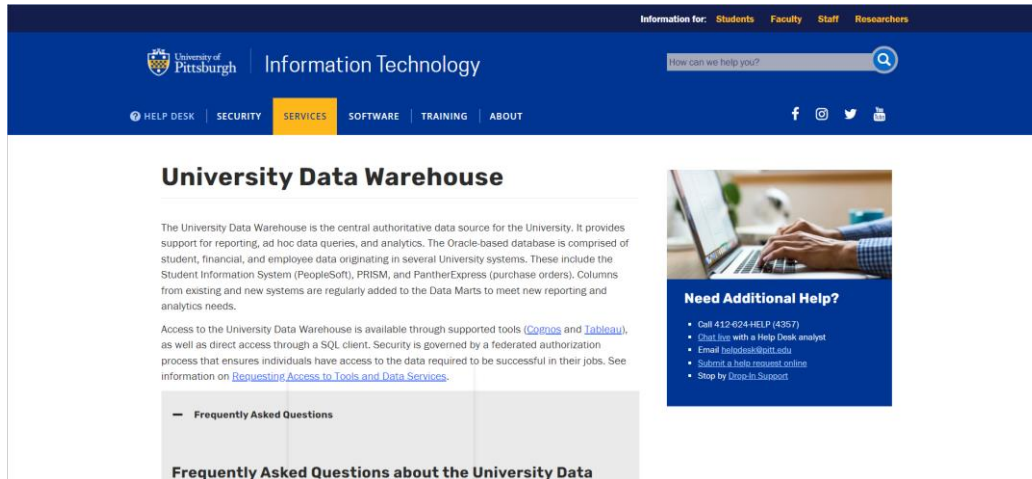


Figure 7. University Data Warehouse at University of Pittsburg (Source: <https://www.technology.pitt.edu/services/university-data-warehouse>)

Princeton University hosted first Global Accessibility Awareness Day (GAAD) event in April 2017. The keynote speaker Haben Girma who is the first deafblind Harvard Law School graduate and a Forbes 30 under 30 honoree received real-time audience feedback for the first time via a unique haptic feedback device created by a pair of Princeton undergraduate students, which was a profound example of technology's ability and power (The Princeton University Office of Information Technology Annual Report 2016-2017, see Figure 8).



Figure 8. Haben Girma an international disability-rights advocate attended GAAD at Princeton University in 2017 (Source: [https://oit.princeton.edu/sites/oit/files/ar\\_16-17.pdf](https://oit.princeton.edu/sites/oit/files/ar_16-17.pdf))

The Princeton University applies the User Experience Office (UXO) to promoting inclusive and user-centered design by using software and websites and running UX process including design and services, documents, business processes, and even physical spaces for all the departments getting involved in the work netting. The IT services encompass 8 major categories in infrastructure, administrative and business, communications and collaboration, security and identity/access service, teaching and learning, research computing, IT professional services, and client computing (see Figure 9). The Envision framework is used for outreach, education, and training. Tableau is applied to data analytics and reporting. A system administrator joins Research Computing and academic departments to share best practices in system management, fill in gaps, and reinforce existing departmental knowledge and information. In the future, the university will focus on Infrastructure as a Service (IaaS) and shift towards code-based or virtualized IT to encompass scalable technology and evolve in conjunction with the University’s real-time requirements (The Princeton University website).

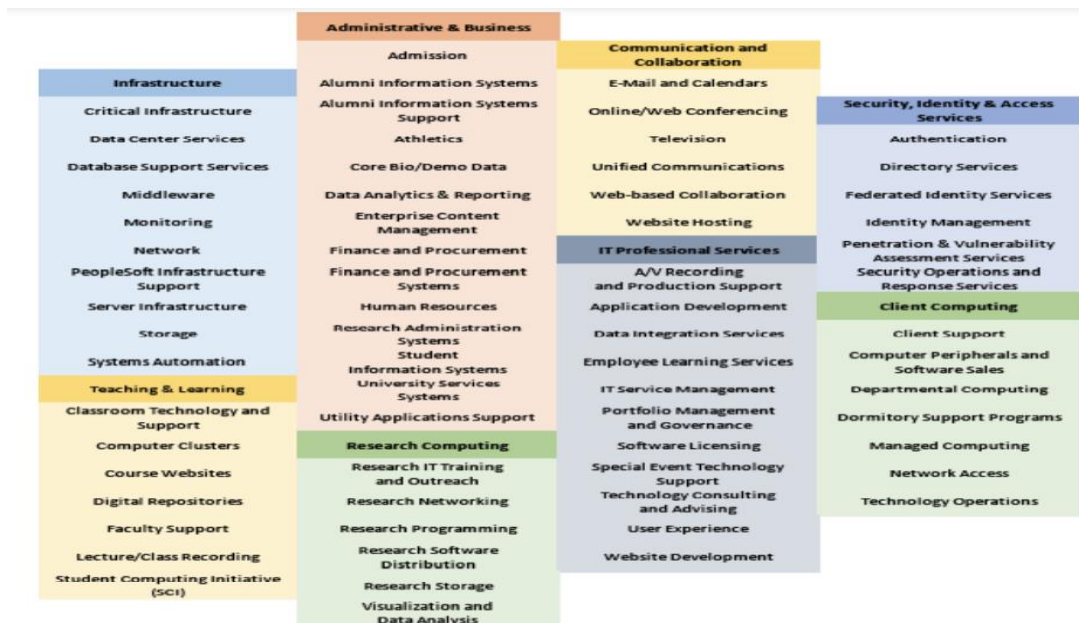


Figure 9. 8 major IT service categories provided by the Office of Information Technology at Princeton University (Source: [https://oit.princeton.edu/sites/oit/files/ar\\_16-17.pdf](https://oit.princeton.edu/sites/oit/files/ar_16-17.pdf))

According to the webpage of Information Services and Technology, New Jersey Institute of Technology released Windows 11 on October 5<sup>th</sup>, 2021, and transited data protection to Rubrik cloud platform. The university is partnering with Amazon Web Services (AWS) to host service platform including Canvas, Maxient, Chrome River for Expenses, Admin pages, etc. E-learning tools are used to enhance courses online or in-person. Public access infrastructure for High Performance Computing as part of the Lochness HPC cluster has faster inter-node networking, a newer operation system, and a freshly updated data management system. They use Hadoop, SAS, SPSS, R to deal with big data and analytics. Tools like MySQL, Oracle, Tartan, and Tomcat are on the list too with purpose of leveraging the efficacy of data management systems that support several APIs, applications, and security protocols (The New Jersey Institute of Technology website, see Figure 10).

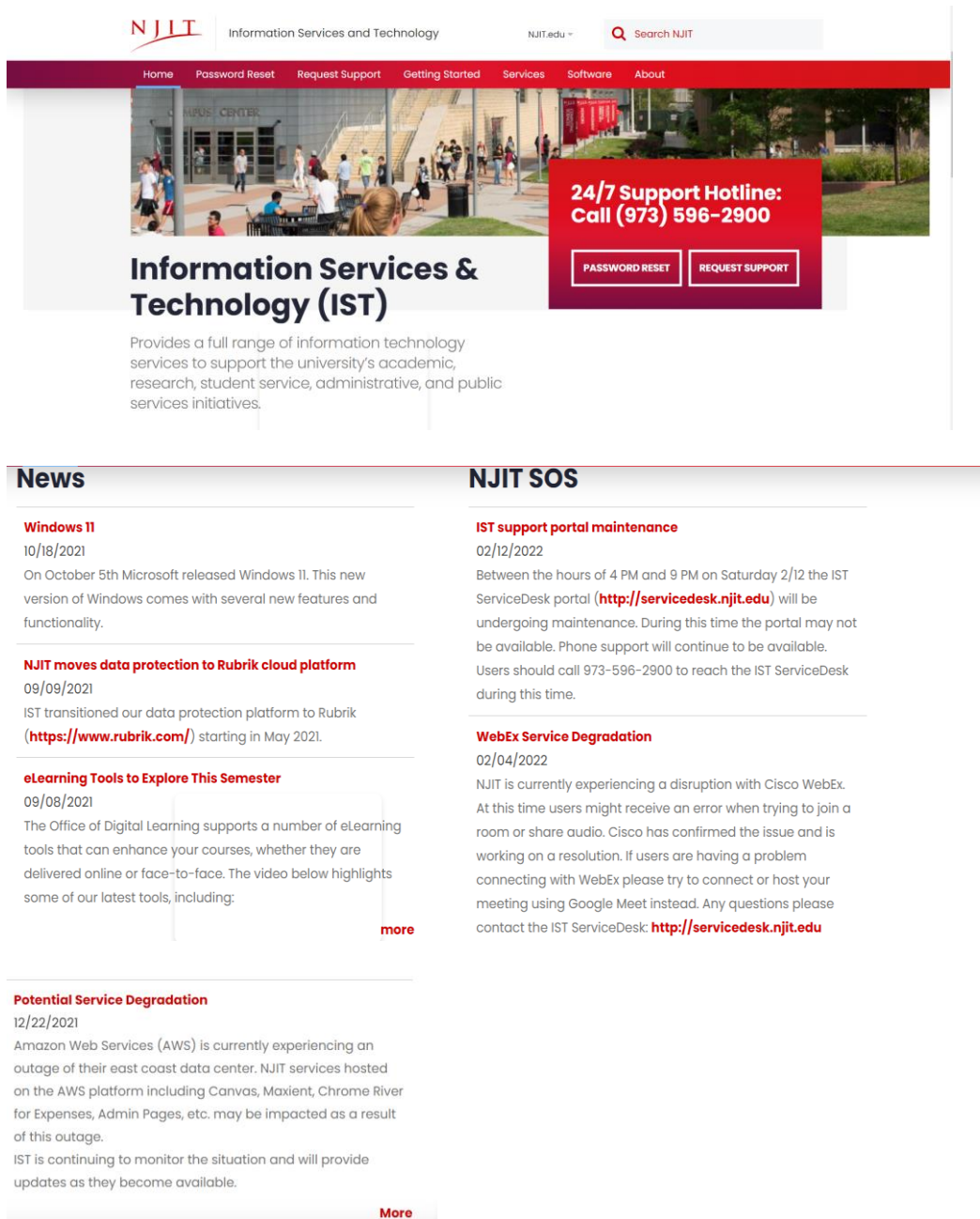


Figure 10. Information Services and Technology (IST) webpage at New Jersey Institute of Technology (Source: <https://ist.njit.edu>)

## DISCUSSION AND IMPLICATIONS

Real-time data warehousing allows users to access data as soon as it is collected and is immediately available, which is crucial for supporting live and in-the-moment decision making. This type of data is virtually penetrating in every aspect of lives and powering everything including bank transactions, GPS, COVID-19 maps, administration and learning management



systems in higher education institutes. One of the most valuable applications is to help monitor and maintain IT infrastructure and to enable organizations gaining more comprehensive advantages and insights into the performance of their networks. The higher educational institutions implement real-time data warehousing and technologies aiming to improve the information management and decision-making, as well as prompt university operations smarter (Williamson, 2018).

The real-time capability of these systems permits universities to leverage market conditions, follow trends related to the education industry, boost quality assurance, enhance academic performance, and optimize data analysis (Pérez-Pérez et al., 2018). Data governance mechanisms can help protect privacy, academic freedom, intellectual property, and information security and compliance at universities (Borgman, 2018). Data governance associated with data, IT, business, information, security etc. is necessary for steering and accelerating information technology, data processes, and decision-making, and eventually supporting the higher education institutes to accomplish their tasks and reach their goals. A theoretical target operating model for higher education is proposed as a single central data warehouse based on cloud storage, where all student data could flow consistently between higher education providers, and enables real-time analytics to be realized (Williamson, 2018).

If information analysis is performed without a proper data preprocessing and transformation, that will lead to an inconsistent analysis and erroneous decisions for the management teams (Moscoso-Zea et al., 2018). The higher education institutes have challenges in aligning their information technology (IT) efforts with business processes to reach the organizational goals. Data analysis that does not meet quality standards cannot produce quality reports and explicit knowledge (Moscoso-Zea et al., 2018). Seven criteria of data governance are mentioned by Jim & Chang (2018): data governance body (stakeholders); data quality; data access or restriction; data security; data stewardship, ownership, and roles; metadata documentation and organization; and business process integration. Each criterion is developed to minimize overlapping data and information and to allow analysis of the existing online data and information. Specific software programs, standards, and private sector organizations coordinate live data and real-time metrics as well as combine with political reforms to build a marketized and smarter universities (Williamson, 2018). The data warehousing should only be available to who is in the roles as problems arise to avoid that data are misused for unauthorized purposes. Sometimes people do not have permissions and do not understand the data. Some people access the data with improper intentions. Furthermore, face-to-face training and on-demand training should be developed for different levels of users who are regularly involved in upgrading the systems and changing the reporting structures (Mattingly et al., 2012).

According to Mehmood & Anees (2020), the primary challenges for real-time data warehousing identified include in-memory computing, distributing computing, support to semi-structure data, low latency, effective resource allocation, fast disk input/output operation, platform independence, scalability, lock-free concurrent update for moving objects, fault tolerance, implementation of machine learning algorithm on un-structured big data, as well as real-time processing of spatiotemporal data streams. Tools and technologies developed as real-time stream processing solutions have Hadoop, Apache Spark, Apache Storm, SplunkStream, Yahoo!S4, Apache Samza, GridGain, MapReduce, HPCC, Flink, Kafka Streams, IBM Streams, Mesa, Stream Cube, CAIDC, RT-SBD, MLG-join etc. These challenges create opportunities for new processing technologies and tools emerge substantially.

## FUTURE DIRECTIONS

The real-time data warehousing and big data streaming have become the ubiquitous trends in all application fields (Mehmood & Anees, 2020). The future of data is related to build data architecture, define language and standards, establish relevant practices of real-time analytics and visualization, and provide the space to involve other emerging big data technologies as an infrastructural substance. Data future is a strategic intervention to make big data ready and to design standards and systems in place, which will allow institutional self-monitoring, assist policymaking, develop intervention, as well as enable users to access real-time information on progress and available resources at any time they need (Williamson, 2018).

Technology continues to shape the future of the higher education institutes. With the implementation of artificial intelligence, instructors can be efficient and effective on routine tasks, such as grading and scheduling, and students can receive personalized instruction with smart technologies (Bouchrika, 2020). For example, essay-grading software called Gradescope can assist instructors to assess homework and exams and give grades quickly and accurately. In addition, the higher education institutes may carry on adopting virtual learning in the post-COVID-19 period. Administrators can have more timely access to critical data that impacts decision making, compliance, accreditation and other key components that comprise tertiary education environments.

## CONCLUSION

Automated methods will be used to assess metadata about experience, motivation, and learning among key stakeholders in an academic organization who are faculty, students, executive officers, student affairs staff, institutional research staff, and information technology staff (Mattingly et al., 2012). Each group can be impacted by these data analytics, learning insight into behaviors, and recommended interventions to support student success and decision making. A model of continuous improvement seeking balance between objectives and outcomes for programs, courses, and activities is the direction of each higher education institute.

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# **Cyber Security, IT, and Emerging Technologies**

## **Effects of IT-enabled dynamic capabilities on organizational agility in innovation: empirical research in the context of developing economy**

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### **ABSTRACT**

Researchers and practitioners question how information technology (IT) can help firms to build dynamic capabilities and leverage innovation organizational agility in developing countries. This empirical research examined the relationship between IT-enabled dynamic capabilities (ITDC) and organizational agility in innovation (OAI) to address this issue. The survey data from 108 Brazilian firms were used to test the proposed model. The findings demonstrated the positive and different effects of IT-enabled dynamic capabilities on organizational agility in innovation through the dimensions of proactiveness (OAPRO), radicalness (OARAD), responsiveness (OARES), and adaptiveness (OAADA).

**KEYWORDS:** IT-enabled dynamic capabilities, Organizational agility in innovation, Developing economy.

### **INTRODUCTION**

In today's, organizations in developing economies must be able to build dynamic capabilities to survive in the competitive business environment. In the volatile and fast turbulence environment, organizations treat unprecedented threats, and emerging opportunities can be captured in their market (Mikalef et al., 2020).

Past studies by the lens of the resource-based view (RBV) have asserted that organizations that have a strong IT capability can influence competitive advantage to attend market needs (Bharadwaj, 2000; Kim et al., 2011; Kohli & Grover, 2008; Lu & Ramamurthy, 2011).

However, RBV has some restrictions to attend to the rise in uncertainty facing firms through the global competition, trade wars, fickle consumers, due to volatile prices, and other such external factors (Tallon et al., 2019). Hence, the dynamic capabilities view (DCV) as an extension of RBV, which arises to attend to these challenges building a firm's capabilities to effect changes to its resource base (Teece, 2018).

Prior studies indicated that IT-enabled dynamic capabilities can positively influence corporate performance by the dimensions of balance scored card (BSC) (Yoshikuni & Albertin, 2017), and competitive performance by enabling the organization to sense and seize arising opportunities to attend swiftly market requirements under uncertain environments (Mikalef & Pateli, 2017).

This empirical research aims to examine how IT-enabled capabilities as a second-order construct of the first-order construct through the dimensions of sensing, coordinating, learning, integrating, and reconfiguring can help firms to build develop organizational agility of proactiveness (OAPRO), radicalness (OARAD), responsiveness (OARES), and adaptiveness (OAADA) in the context of a developing economy.

Hence, this study increases the theoretical clarity of the role of IT of dynamic capabilities in business-level strategy and elucidates the impact of different dimensions of organizational agility in innovation. Covering gaps of the link between IT and organizational agility, mentioned as future research to investigate in more detail how IT capabilities can help firms better build capabilities so that sensing is accurate, timely, and responds to market requirements (Tallon et al., 2019). Moreover, according to Mikalef and Pateli (2017), the literature is vague and there is limited empirical evidence to show that IT-enabled dynamic capabilities can potentially promote the proclivity of firms to radical market-changing innovations, such as organizational agility of proactiveness and radicalness. And finally, the study also contributes to the literature of dynamic capabilities enabled by IT, because scholars have recommended investigating how IT capabilities as higher-order dynamic capabilities enable the firm-level and inter-organizational dynamic capabilities to facilitate firm-level sensing, seizing, and reconfiguration capabilities, even more in developing economy, such as Brazil, as recommended by Li and Chan (2019).

Thus, this study proposes the two research questions:

**RQ1.** What is the effect of the IT-enabled dynamic capabilities on organizational agility in terms of proactiveness, radicalness, responsiveness, and adaptiveness in the context of a developing economy?

And

**RQ2.** Is there a different impact of IT-enabled dynamic capabilities on organizational agility in terms of proactiveness, radicalness, responsiveness, and adaptiveness?

## **LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT**

### **IT-enabled dynamic capabilities (ITDC)**

The Dynamic Capabilities View (DCV) is a recent and relevant theoretical perspective in strategic management (Schilke, 2014; Teece, 2018), where dynamic capabilities enable organizations to build, integrate and reconfigure resources and competencies in the face of changing business environments (Teece et al., 1997). Dynamic capabilities also help organizations to sustain evolutionary fitness (Rowe et al., 2017), to sense and seize emerging business opportunities (Mikalef & Pateli, 2017), even as they innovate and adapt to changing market and environmental conditions (Dixon et al., 2014; Yoshikuni et al., 2021).

Thus, dynamic capabilities are conceptualized as strategic options that allow organizations to adapt their operation mode when the opportunity or need arises (Mikalef et al., 2020; Pavlou & El Sawy, 2006).

Based on the DCV, prior studies have defined the IT-enabled dynamic capabilities (ITDC) construct as an organization's ability to leverage its IT resources and IT competencies, in combination with other resources and capabilities, to address rapidly changing business environments (Mikalef et al., 2020; Mikalef & Pateli, 2017). These previous studies defined that ITDC construct can be divided into the following five dimensions, complementary in nature and empowers synergies, adapts the way the organization operates and competes and resulting in



competitive performance gains: sensing, coordinating, learning, integrating, and reconfiguring capabilities (Mikalef et al., 2020; Mikalef & Pateli, 2017).

The IT-enabled sensing capability contributes to ensuring that customers and competitors are closely monitored to receive and analyze sufficient feedback to subsidize strategic decisions (Roberts & Grover, 2012), as well as it can help organizations to detect gaps in functional areas (Yoshikuni et al., 2021), supply chain activities or business processes and take corrective efficiency actions (Estampe et al., 2013). The IT-enabled capabilities of coordination and learning contribute to increasing the efficiency of generating, disseminating, and responding to market demands (Wamba et al., 2020), introducing products that fit better to changing customer demands and simultaneously reduces response time (Mikalef & Pateli, 2017; Swafford et al., 2008). In the case of IT-enabled integration and reconfiguration capabilities, they allow organizations to improve collaboration with business partners and to be able to efficiently adapt to inter-organizational relationships whenever necessary (Mikalef et al., 2020; Wamba et al., 2020), especially when operating in uncertain environments, where organizations need to engage and disengage in partnerships while maintaining a strongly connected exchange of information with other parts (Gunasekaran et al., 2017; Rai & Tang, 2010).

In IS literature, recent studies have demonstrated that instead of developing rare and non-substitutable IT resources, embedding IT in organizational capabilities could be the source of significant and sustained competitive returns (Kohli & Grover, 2008; Mikalef et al., 2020; Tallon et al., 2019). So, IT capabilities should be measured and analyzed in terms of the organizational processes they enable or help to improve (Bharadwaj et al., 2013; Kohli & Grover, 2008; Melville et al., 2004) and IT can be considered the new means to create organizational capabilities or improve existing ones (Mikalef et al., 2020) to leverage innovation (Yoshikuni et al., 2021).

Under the ITDC perspective, by digitizing organizational capabilities through IT resources, organizations can further generate business value (Benitez et al., 2018; Gable, 2020). Besides, a recent study has demonstrated that IT support for core capabilities has a positive impact on organizational strategic flexibility, which also results in performance gains (Chen et al., 2017; Li & Chan, 2019). Moreover, the requirement of developing ITDC has been intensified and is more relevant now, considering the dynamics and turbulence of the external environment, which demands frequent and abrupt changes in organizational operations and IT resources and capacities (Mikalef et al., 2020; Yoshikuni & Albertin, 2017).

### **Organizational agility through IT-enabled dynamic capabilities**

Organizational agility is a significant business capability (Lee et al., 2015) and, in an actual competitive business context, is becoming vital for competitive success by innovation (Tallon et al., 2019), considering that it represents an organization's ability to continually sense and respond to market changes (D'Aveni et al., 2010; Mikalef et al., 2020). Organizational agility is conceptualized as an organization's higher-order dynamic capability to detect opportunities and threats (Lu & Ramamurthy, 2011), aggregate the needed assets and capabilities to launch an appropriate response, evaluate the benefits and risks and execute actions with efficiency and competitiveness (Sambamurthy, V et al., 2003; Tallon et al., 2019)

The organizational agility in innovation (OAI) can be represented by four dimensions (first-order), to effectively and efficiently sense and respond to various market conditions (Bharadwaj & Sambamurthy, 2005; Lee et al., 2015; Lu & Ramamurthy, 2011): proactiveness (OAPRO), radicalness (OARAD), responsiveness (OARES) and adaptiveness (OAADA). Thus, proactiveness is the ability to capture new opportunities before of competitors, by anticipating and responding proactively (Lumpkin & Dess, 1996; Miller & Friesen, 1983; Yoshikuni & Albertin, 2018). The radicalness construct is represented by driving radical strategic movements and implementing new business models to join new markets (Lee et al., 2015). In the case of responsiveness, it is the ability to rapidly respond to market emerging opportunities caused by

changes in customer preferences or the environment (Mikalef et al., 2020; Yoshikuni et al., 2021). The adaptiveness construct consists of the ability to adapt business models according to emerging industry best practices (Lee et al., 2015; Subramani & Youndt, 2005).

Digitized platforms of business processes and knowledge allow an organization to rapidly monitor and detect changing needs, flexibly change their market strategies, and efficiently react to customers' changing requirements (Li & Chan, 2019; Sambamurthy, V et al., 2003). Therefore, an organization's capability to manage and utilize IT resources is vital for organizational agility (Lee et al., 2015) and ITs' capabilities are considered an enabler of organization agility (Chakravarthy et al., 2013; Lu & Ramamurthy, 2011; Tallon et al., 2019). Besides, according to prior studies, IT-enabled dynamic capabilities can positively affect an organization's competitive performance, by allowing the organization to sense and seize emerging opportunities to address rapidly changing external environments (Drnevich & Kriauciunas, 2011; Mikalef et al., 2020; Mikalef & Pateli, 2017). Thus, this study hypothesizes that IT-enabled dynamic capabilities should be positively associated with organizational agility's dimensions: proactiveness, radicalness, responsiveness, and adaptiveness.

IT-enabled dynamic capabilities can generate competitive performance gains by enhancing an organization's ability to innovate (Mikalef et al., 2020; Yoshikuni & Albertin, 2017) and contribute to identifying emerging technological opportunities and assessing how they might be leveraged for the productions of new products and services before competitors (Teece, 2007). Thus, this study hypothesizes that:

**H1:** IT-enabled dynamic capabilities should be positively associated with organizational agility's proactiveness.

Organizations can redirect their partnerships and establish joint ventures or strategic alliances (Wamba et al., 2017) to complement their resources and knowledge and drive strategic changes efficiently (Mikalef et al., 2020; Tafti et al., 2013). Besides, even having enough organizational capabilities, to make a significant difference in their operations and competitive response, these capabilities should be enhanced by IT (El Sawy et al., 2010; Rai et al., 2006; Yoshikuni, 2021). In this sense, this study proposes that:

**H2:** IT-enabled dynamic capabilities should be positively associated with organizational agility's radicalness.

IT-enabled dynamic capabilities can extend information sharing through coordination and promote collaboration (Yoshikuni, 2021) by integrating and mapping different knowledge sets to incorporate new knowledge (Joshi et al., 2010; Mikalef et al., 2020). The increased knowledge can enhance an organization's innovation capacity and, consequently, its competitive performance and its response capacity to rapidly changing market demands and opportunities (Malhotra et al., 2005; Mikalef et al., 2019; Roberts et al., 2012). Therefore, this study hypothesizes that:

**H3:** IT-enabled dynamic capabilities should be positively associated with organizational agility's responsiveness.

Through IT-enabled dynamic capabilities, some synergies are developed, mainly through integration and coordination capabilities (Li & Chan, 2019), which provide the necessary resources for communication and cooperation (Enkel & Heil, 2014; Yoshikuni & Albertin, 2017), enhance the organization's ability to transform and apply new knowledge into new products, services, and processes and adapt the business model according to industry needs (Mikalef et al., 2020; Setia & Patel, 2013). In addition, the capacity to reconfigure IT-based processes contributes to innovating, and adapting to new business characteristics, considering partners and market best practices (Hanseth & Lyytinen, 2010; Tallon et al., 2019).



**H4:** IT-enabled dynamic capabilities should be positively associated with organizational agility's adaptiveness.

### **Difference effects of Organizational agility in innovation through IT-enabled dynamic capabilities**

The strategic management literature has demonstrated that firms adopt different typologies of generic strategies to leverage competitive advantages and improve corporate performance (Miller & Friesen, 1983; Mintzberg et al., 2009; Porter, 1998; Wolf & Floyd, 2017). Previous studies of IS demonstrated that orientation strategy can be influence in different effects the relationship between IT resources and capabilities on proximate and distal outcomes (Chan et al., 2006; Sabherwal & Chan, 2001; Yayla & Hu, 2012; Yoshikuni & Albertin, 2018). According to Lee, Tallon, and colleagues (Lee et al., 2015; Tallon et al., 2019) IT resources and practices can contribute in a different way to improve organizational agility through the dimensions (proactiveness, radicalness, responsiveness, and adaptiveness) to effectively and efficiently sense and respond to the market requirements.

Thus, firms can adopt specific orientation strategies to build competitive advantage, and it is supposed that IT dynamic capabilities can contribute in different ways to organizational agility in innovation. Hence, this study proposes the following hypotheses:

**H5a:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of proactiveness and radicalness.

**H5b:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of proactiveness and responsiveness.

**H5c:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of proactiveness and adaptiveness.

**H5d:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of radicalness and responsiveness.

**H5e:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of radicalness and adaptiveness.

**H5f:** There is a different impact of IT-enabled dynamic capabilities on organizational agility in terms of responsiveness and adaptiveness

## **METHODS**

### **Sample**

It was developed and administered, a survey instrument to examine the hypothesis. In line with studies of Information Systems, the convenience sample data was adopted, and the first author contact Brazilian firms across different industries. The respondent's positions included senior and executive managers, and middle and first-line managers. The final sample was 108 cases that attend the PLS-PM literature mandates that indicate the final sample corresponds to 10 times the number of structural paths that predict a given endogenous variable.

## Construct measurement

The empirical study is composed of five constructs and control variables. The respondents were asked to assess the degree to which they agree/disagree (Likert scale 1-7) with the assertive items of each first-order construct.

The constructs were adopted by current literature that has been previously validated. IT-Enabled Dynamic Capabilities (ITDC) was a second-order construct by the dimension of sensing (ITDCS), coordinating (ITDCC), learning (ITDCL), integrating (ITDCI), and reconfiguring (ITDCR) routines (Mikalef et al., 2020; Mikalef & Pateli, 2017). Organization agility (OA) was composed through four first-order latent reflexive constructs by the dimensions of Proactiveness (OAPRO), Radicalness (OARAD), Responsiveness (OARES), and Adaptiveness (OAADA) (Lee et al., 2015). The study included control variables of firm size, firm age, sector to examine their potential impact on dependent variables of organizational agility, as recommended by Melville and colleagues (Melville et al., 2004). Appendix A shows de assertive items.

## Statistical techniques

The partial least squares structural equation modeling (PLS-SEM), by the SmartPLS software package 3.3 was used to analyze the data using. Because PLS-SEM is an advanced statistic technique of variance-based, allowing: (i) no assumptions in respect of multivariate normality, (ii) flexibility to use both reflective and formative variables, (iii) the capacity to examine models using smaller samples, as mentioned by Hair and colleagues (Hair et al., 2017).

## RESULTS

### Measurement model

The first-order reflexive latent variables of organizational agility were analyzed through reliability, convergent validity, and discriminant validity. Construct reliability was examined by composite reliability (CR) and Cronbach's alpha ( $\alpha$ ) and all values were the thresholds of 0.70, indicating acceptable construct (Hair et al., 2017), see Table 1. The construct-to-item loading showed a threshold above 0.50, all items are above 0.70, just OAPRO1 is 0.627, was indicating indicator reliability (Bido & Silva, 2019), see Appendix B.

Table 1: Assessment of reliability, convergent and discriminant validity of reflective constructs

Constructs	1	2	3	4	5	6	7	8	9
1-ITDCC	<b>0,877</b>								
2-ITDCI	0,709	<b>0,893</b>							
3-ITDCL	0,782	0,685	<b>0,908</b>						
4-ITDCR	0,759	0,669	0,812	<b>0,851</b>					
5-ITDCS	0,741	0,678	0,774	0,729	<b>0,874</b>				
6-OAADP	0,585	0,384	0,521	0,564	0,542	<b>0,901</b>			
7-OAPRO	0,599	0,516	0,607	0,532	0,590	0,734	<b>0,812</b>		
8-OARAD	0,450	0,312	0,414	0,382	0,461	0,757	0,735	<b>0,871</b>	
9-OARES	0,438	0,312	0,444	0,408	0,505	0,817	0,730	0,744	<b>0,892</b>
CA	0,899	0,915	0,929	0,873	0,897	0,883	0,732	0,842	0,869
Rho_A	0,900	0,925	0,930	0,873	0,900	0,886	0,784	0,866	0,887

CR	0,930	0,940	0,949	0,913	0,928	0,928	0,850	0,904	0,921
AVE	0,768	0,797	0,824	0,724	0,764	0,812	0,659	0,759	0,796

Note: IT-enabled dynamic capabilities (ITDC); ITDCC - Coordinating, ITDCI - Integrating, ITDCL - Learning, ITDCR - Reconfiguring, ITDCS - Sensing, Organizational Agility (AO), OAADA - Adaptiveness, OAPRO - Proactiveness, OARAD - Radicalness, OARES - Responsiveness, CA - Cronbach's Alpha, CR - Composite Reliability, AVE - Average Variance Extracted.

The average variance extracted (AVE) was assessed by examining if each construct exceeded the lower limit of 0.50, and indicating convergent validity. Discriminant validity was examined: (i) by Fornell-Larcker criterion (Fornell & Larcker, 1981) if each construct's AVE square root is greater than its higher correlation with any other construct, see Table 1, (ii) whether each indicator's outer loadings on its assigned construct were greater than its cross-loadings with other constructs, and (iii) the heterotrait-monotrait ratio (HTMT) measured the correlation between constructs, indicating that they were perfectly measured, as recommended by Hair, Henseler, and colleagues (Hair et al., 2017; Henseler et al., 2015). Hence, the outcomes of first-order reflective measures suggest reliable and valid, indicating that all items are appropriate to measure their respective latent variables.

The IT-enabled dynamic capabilities as a second-order construct (reflective-formative type) was measured using the repeating indicator approach to obtain latent variable scores for the first-order constructs by higher-order construct, as recommended by Hair et al. (2017). Additionally, the variance inflation factors (VIF) was assessed and all the threshold were below 4, indicating low multicollinearity (Bido & Silva, 2019), see Table 2.

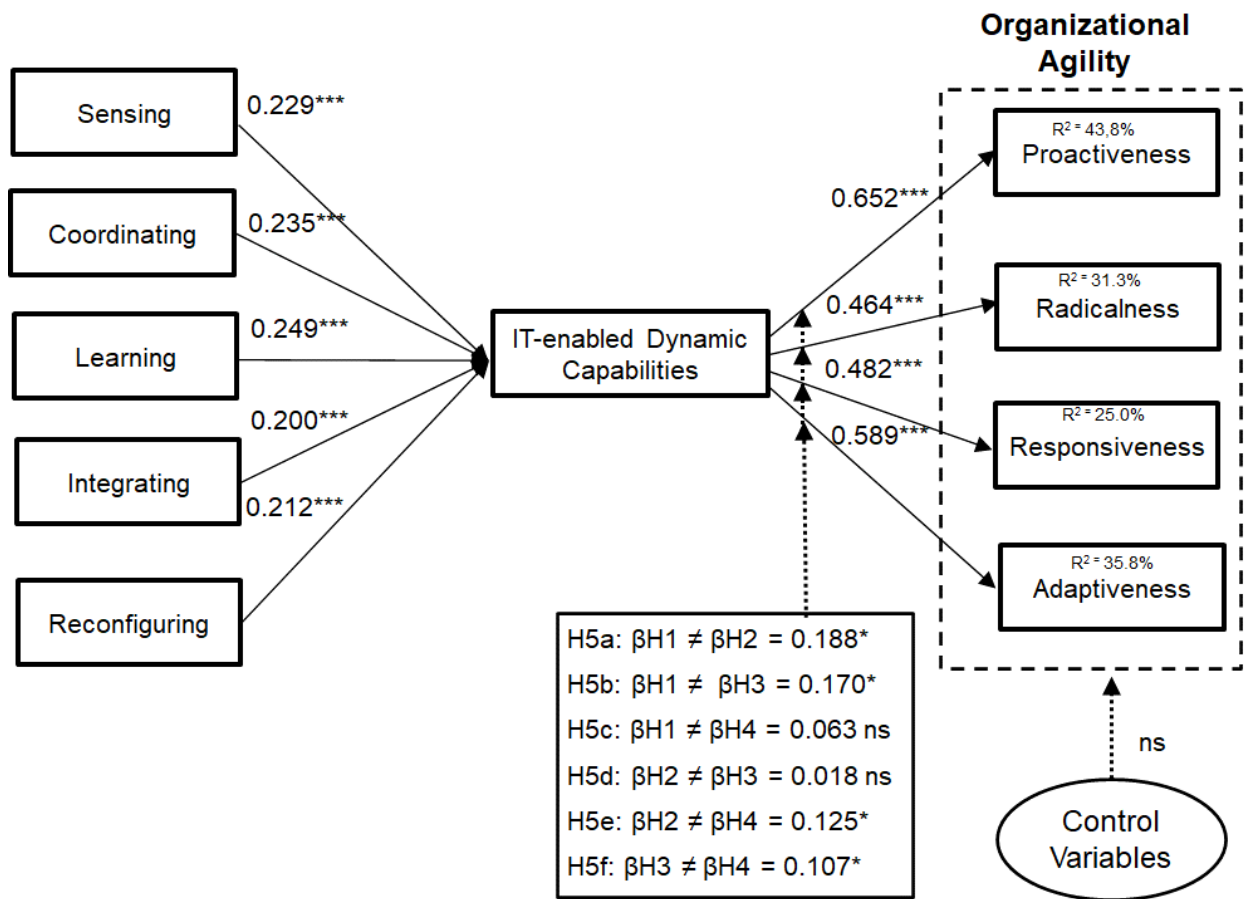
Table 2: Multicollinearity diagnostics, t-value, p-value and path weights of first-order constructs on second-order construct of IT-enabled dynamic capability (ITDC)

Construct	Weight	T-value	P-Values	VIF
Sensing (ITDCS)	0.229	19.770	0.000	3.044
Coordinating (ITDCC)	0.235	18.011	0.000	3.394
Learning (ITDCL)	0.249	14.906	0.000	4.125
Integrating (ITDCI)	0.200	12.600	0.000	2.343
Reconfiguring (ITDCR)	0.212	17.539	0.000	3.511

**Structural model assessment**

Figure 1 summarized the structural model from the PLS analysis, explaining the variance of endogenous variables ( $R^2$ ) and the standardized path coefficients ( $\beta$ ) by performing a bootstrap analysis with 5000 resamples were obtained the significance of estimates (t-statistics).

Figure 1: Outcomes of the structural model



Note:  $p < 0.05^*$ ,  $p < 0.01^{**}$ ,  $p < 0.001^{***}$ , ns: no significance

All four direct hypotheses were confirmed. The H1 showed a positive relationship between a firms' level of IT-enabled dynamic capabilities on organizational agility of proactiveness (H1,  $\beta = 0.652$ ,  $t = 12.331$ ,  $p < 0.001$ ). The H2 demonstrated a positive relationship between a firms' level of IT-enabled dynamic capabilities on organizational agility of radicalness (H2,  $\beta = 0.464$ ,  $t = 5.506$ ,  $p < 0.001$ ). The H3 was supported, indicating a positive effect in the relationship between a firms' level of IT-enabled dynamic capabilities on organizational agility of responsiveness (H3,  $\beta = 0.482$ ,  $t = 5.737$ ,  $p < 0.001$ ). The H4 was supported, demonstrating a positive effect in the relationship between a firms' level of IT-enabled dynamic capabilities on organizational agility of adaptiveness (H4,  $\beta = 0.589$ ,  $t = 7.122$ ,  $p < 0.001$ ).

The control variables didn't show any effect on the dependent variables.

To analyze hypothesis H5 (a, b, c, d, e, and f) whether there are differences in path effects in the relationship between IT-enabled dynamic capabilities and organizational agility variables, it was used the methodological framework was to test differences between path coefficients following Rodríguez-Entrena and colleagues (Rodríguez-Entrena et al., 2018). The 95% confidence interval and 5,000 subsamples by bootstrap were performed to analyze the statistical significance. The tests were accessed Standard/ Student's t confidence interval, percentile bootstrap, and standard bootstrap, and values between the confidence intervals are less than zero, demonstrating a lack of statistical significance ( $p$ -value  $> 0.05$ ) to hypothesis H5c:  $\beta_{H1} \neq \beta_{H4}$ , and H5d:  $\beta_{H2} \neq \beta_{H3}$ , indicating no supporting to H5c and H5d. However, to hypothesis H5a:  $\beta_{H1} \neq \beta_{H2}$ , H5b:  $\beta_{H1} \neq \beta_{H3}$ , H5e:  $\beta_{H2} \neq \beta_{H4}$ , and H5f:  $\beta_{H3} \neq \beta_{H4}$ , showing statistical significance

difference ( $p$ -value < 0.05), supporting H5a, H5b, H5e, and H5f with respectively difference path coefficients. The analysis was summarized in Table 3.

Table 3: Difference of path coefficients by PLS-PM

Type of confidence interval (α=5%)	Hypothesis											
	H5a:		H5b:		H5c:		H5d:		H5e:		H5f:	
	$\beta_{H1} \neq \beta_{H2}$	$\beta_{H1} \neq \beta_{H3}$	$\beta_{H1} \neq \beta_{H4}$	$\beta_{H2} \neq \beta_{H3}$	$\beta_{H2} \neq \beta_{H4}$	$\beta_{H3} \neq \beta_{H4}$	LB	UB	LB	UB	LB	UB
Standard	0.16	0.18	0.15	0.17	0.06	0.08	0.04	0.04	0.11	0.13	0.10	0.11
Percentile	0.07	0.34	0.04	0.32	0.00	0.23	0.00	0.12	0.02	0.23	0.02	0.22
Basic	0.04	0.31	0.03	0.30	-0.07	0.15	-0.04	0.08	0.02	0.23	0.00	0.20
Difference of $\beta$	0,188		0,170		0,063		0,018		0,125		0,107	
P-value < 0.05	Yes		Yes		No		No		Yes		Yes	

Note: LB - lower bound, UB - upper bound

### DISCUSSION AND CONCLUSIONS

This study's findings indicate that the impact of IT-enabled dynamic capabilities on organizational agility in innovation by different effects in terms of proactiveness, radicalness, responsiveness, and adaptiveness, in the context of a developing economy. The current empirical study presents six key findings.

First, in contrast to past studies of IT capabilities on the RBV, this study measured IT capabilities by the underlying routines in terms of sensing, coordinating, learning, integrating, and reconfiguring described in the dynamic capabilities view as a higher-order construct, and extend the knowledge of the literature of IT capabilities (Mikalef et al., 2020; Mikalef & Pateli, 2017).

Second, the study finds empirical support for hypothesis H1 that IT-enabled dynamic capabilities positively influence organizational agility in terms of proactiveness. This outcome demonstrates the role of IT digitally enabling the underlying routines that jointly comprise dynamic capabilities and indicates that the IT strategic use can leverage significant organizational agility by business processes to capture new opportunities by anticipating and responding ahead of competitors.

Third, the results indicate support for H2 that IT-enabled dynamic capabilities have positive effects on organizational agility in terms of radicalness. This finding confirms that IT can be embedded in the core capabilities to ability business processes to implement new business models to penetrate new markets by radical strategic movements.

Fourth, hypothesis H3 was supported, indicating the relationship between IT-enabled dynamic capabilities has a positive impact on organizational agility in terms of responsiveness. Thus, in the answer to changes in customer preferences, firm IT capabilities can ability dynamic capabilities in the business processes to rapidly respond to emerging opportunities in the marketplace.

Fifth, the outcome demonstrated that IT-enabled dynamic capabilities have a positive effect on organizational agility in terms of adaptiveness. This means that IT capabilities ability organizations to adapt business models and keep up with emerging industry best practices.

The empirical outcomes of hypotheses H1, H2, H3, and H4 provide support for the argument that the impact of IT-enabled dynamic capabilities on organizational agility in innovation can be in different dimensions of strategy orientation. So, this suggests that the IT resources cannot by themselves be a source to enable organizational agility; rather, IT capabilities enabled organizational routines to contribute to the ability of agilely reconfiguring protectiveness, radicalness, responsiveness, and adaptiveness to leverage innovation. While the past empirical

study has demonstrated that IT-enabled dynamic capabilities can leverage the ability to market capitalizing agility and operational adjustment agility to gain competitive advantage (Mikalef & Pateli, 2017). Thus, this study contributes to extending the literature on dynamic capabilities and IT capabilities and respond the issue mentioned by Tallon and colleagues (Tallon et al., 2019) that is necessary to investigate with more detail how IT build capabilities to be agile in business processes to enhance the success of the business strategy adopted.

Sixth, the value of IT-enabled dynamic capabilities on organizational agility in innovation is more apparent in terms of proactiveness and adaptiveness than radicalness and responsiveness. This outcome denotes that strong IT-enabled dynamic capabilities support existing business processes, and adopt best practices used by other firms through adapting business models, and anticipating and seeking opportunities to attend to future market needs. Thus, compared to previous research, this empirical research raises the importance of IT business value to anticipate and adapt organizational routines, such as proactiveness and adaptiveness to build innovation by strong IT-enabled dynamic capabilities result in increased organizational agility. Moreover, previous studies of IT-enabled dynamic capabilities (by sensing, coordinating, learning, integrating, and reconfiguring) and organizational agility (by proactiveness, radicalness, responsiveness, and adaptiveness) have been realized in the developed economies. Thus, this empirical study contributes to extending the knowledge of IT capabilities and strategic management literature in the novel context of developing economies, such as Brazil.

## **PRACTICAL IMPLICATIONS**

The findings of this empirical study provide several implications for managers. Executives should be aware of the value of investing in the five dimensions of IT-enabled dynamic capabilities comprise to leverage organizational agility in innovation. Therefore, as in previous research (Mikalef et al., 2020; Mikalef & Pateli, 2017; Yoshikuni, 2021; Yoshikuni & Albertin, 2017), this study demonstrated that IT alone cannot guarantee success, i.e., IT resources and other practices associated with embedded in the business processes can leverage firms to fulfill their business objectives by dynamic capabilities, as mentioned by Li and Chan (Li & Chan, 2019).

## **FUTURE RESEARCH**

This study shows important contributions, but it has also some limitations and further research can be addressed. For example, this study adopted IT-enabled dynamic capabilities (Mikalef et al., 2020; Mikalef & Pateli, 2017) with directed towards five dimensions of IT-based are embedded in dynamic capabilities, there are opportunities for future research to investigate other dimensions related to emerging technologies and strategy knowledge as an alternative to enable dynamic capabilities to leverage innovation, ambidexterity, advantage competitive, corporate performance and other distal outcomes.

The dynamic capability's view theorizes that environmental factors can influence the antecedents and precedents constructs of IT-enabled dynamic capabilities. Once, there is limited empirical evidence to support this claim among IT-enabled dynamic capabilities and organizational agility in innovation. Future research can examine how external factors, such as uncertainty and turbulence factors, can influence this kind of relationship.

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**APPENDIX A - Questionnaire items**

Organizational Agility (AO) in innovation was adopted by Lee and colleagues (Lee et al., 2015)

Please indicate the ability of your firm to create innovation relative to other firms of:	Means	S.D.
Organizational Agility in terms of Proactiveness (AOPRO) to:		
[OAPRO1] Anticipate new business opportunities	5.32	1.27
[OAPRO2] Seek new business opportunities	5.14	1.46
[OAPRO3] Seek novel approaches to future market needs	5.22	1.38
Organizational Agility in terms of Radicalness (OARAD) to:		
[OARAD1] Seek high-risk projects with chances of high return	5.06	1.57
[OARAD2] Support business experimentation despite uncertain returns	4.72	1.62
[OARAD3] Commit resources to radical changes that can potentially transform markets and competition	4.50	1.40
Organizational Agility in terms of Responsiveness (OARES) to:		
[OARES1] Rapidly react to emerging opportunities in customer needs	4.28	1.64
[OARES2] Rapidly react to emerging opportunities in markets	5.16	1.40
[OARES3] Rapidly react to emerging environmental opportunities (e.g., new regulations, globalization)	5.15	1.51
Organizational Agility in terms of Adaptiveness (AOADA) to:		
[OAADA1] Adapt existing business models	5.18	1.42
[OAADA2] Adapt existing business processes	5.23	1.26
[OAADA3] Quickly adopt best practices used by others	5.14	1.23

IT-enabled dynamic capabilities (ITDC) was adopted by Mikalef and colleagues (Mikalef et al., 2020; Mikalef & Pateli, 2017)

Please indicate how effective your company is in using IT systems for the following purposes:	Means	S.D.
IT-enabled dynamic capabilities in sensing (ITDCS)		
[ITDCS1] Scanning the environment and identifying new business opportunities	5.23	1.43
[ITDCS2] Reviewing our product development efforts to ensure they are in line with what the customers want	5.24	1.41
[ITDCS3] Implementing ideas for new products and improving existing products or services	5.16	1.47
[ITDCS4] Anticipating discontinuities arising in our business domain by developing greater reactive and proactive strength	4.94	1.50
IT-enabled dynamic capabilities in coordinating (ITDCC)		
[ITDCC1] Providing more effective coordination among different functional activities	4.96	1.34
[ITDCC2] Providing more effective coordination with customers, business partners, and distributors	5.22	1.20
[ITDCC3] Ensuring that the output of work is synchronized with the work of other functional units or business partners	4.89	1.36
[ITDCC4] Reducing redundant tasks, or overlapping activities performed by different operational units	4.44	1.52

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IT-enabled dynamic capabilities in learning (ITDCL)		
[ITDCL1] Identify, evaluate, and import new information and knowledge	5.22	1.38
[ITDCL2] Transform existing information into new knowledge	5.14	1.42
[ITDCL3] Assimilate new information and knowledge	5.16	1.38
[ITDCL4] Use accumulated information and knowledge to assist decision making	5.35	1.46
IT-enabled dynamic capabilities in integrating (ITDCI)		
[ITDCI1] Easily accessing data and other valuable resources in real-time from business partners	4.77	1.89
[ITDCI2] Aggregating relevant information from business partners, suppliers, and customers. (e.g. operating information, business customer performance)	5.19	1.62
[ITDCI3] Collaborating in demand forecasting and planning between our firm and our business partners	4.95	1.76
[ITDCI4] Streamlining business processes with suppliers, distributors, and customers	4.83	1.62
IT-enabled dynamic capabilities in reconfiguring (ITDCR)		
[ITDCR1] Adjusting for and responding to unexpected changes easily	4.64	1.57
[ITDCR2] Easily adding an eligible new partner that you want to do business with or removing ones that you have terminated your partnership	4.89	1.52
[ITDCR3] Adjusting our business processes in response to shifts in our business priorities	5.12	1.34
[ITDCR4] Reconfiguring our business processes to come up with new productive assets	4.97	1.36

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**APPENDIX B - Measurement model statistics**

Latent Variable	Indicators	1	2	3	4	5	6	7	8	9	p-value
1-Sensing (ITDCS)	ITDCS1	<b>0.853</b>	0.651	0.714	0.623	0.619	0.531	0.432	0.425	0.443	0.001
	ITDCS2	<b>0.889</b>	0.634	0.637	0.603	0.653	0.506	0.382	0.492	0.494	0.001
	ITDCS3	<b>0.849</b>	0.562	0.615	0.514	0.557	0.485	0.385	0.445	0.450	0.001
	ITDCS4	<b>0.904</b>	0.732	0.732	0.624	0.710	0.539	0.411	0.410	0.505	0.001
2-Coordinating (ITDCC)	ITDCC1	0.688	<b>0.862</b>	0.677	0.591	0.591	0.510	0.398	0.301	0.501	0.001
	ITDCC2	0.660	<b>0.926</b>	0.681	0.671	0.678	0.585	0.426	0.436	0.578	0.001
	ITDCC3	0.665	<b>0.898</b>	0.642	0.681	0.684	0.495	0.354	0.371	0.470	0.001
	ITDCC4	0.585	<b>0.816</b>	0.741	0.539	0.708	0.505	0.400	0.424	0.498	0.001
3-Learning (ITDCL)	ITDCL1	0.701	0.726	<b>0.897</b>	0.644	0.698	0.515	0.381	0.429	0.461	0.001
	ITDCL2	0.702	0.716	<b>0.907</b>	0.564	0.767	0.533	0.340	0.352	0.445	0.001
	ITDCL3	0.735	0.730	<b>0.944</b>	0.648	0.756	0.610	0.395	0.440	0.515	0.001
	ITDCL4	0.670	0.666	<b>0.882</b>	0.632	0.728	0.544	0.387	0.389	0.470	0.001
4-Intergrating (ITDCI)	ITDCI1	0.488	0.550	0.524	<b>0.833</b>	0.519	0.454	0.252	0.261	0.312	0.001
	ITDCI2	0.552	0.607	0.578	<b>0.914</b>	0.572	0.410	0.210	0.202	0.249	0.001
	ITDCI3	0.664	0.686	0.649	<b>0.930</b>	0.637	0.534	0.345	0.337	0.418	0.001
	ITDCI4	0.689	0.673	0.677	<b>0.890</b>	0.643	0.435	0.292	0.300	0.374	0.001
5-Reconfiguring (ITDCR)	ITDCR1	0.690	0.679	0.728	0.568	<b>0.822</b>	0.426	0.292	0.394	0.463	0.001
	ITDCR2	0.471	0.584	0.597	0.510	<b>0.813</b>	0.564	0.442	0.415	0.499	0.001
	ITDCR3	0.625	0.650	0.705	0.632	<b>0.884</b>	0.405	0.275	0.314	0.489	0.001
	ITDCR4	0.685	0.667	0.727	0.563	<b>0.883</b>	0.421	0.299	0.271	0.469	0.001
6-Proactiveness (OAPRO)	OAPRO1	0.281	0.396	0.449	0.337	0.440	<b>0.627</b>	0.326	0.451	0.413	0.001
	OAPRO2	0.483	0.450	0.431	0.380	0.335	<b>0.873</b>	0.741	0.672	0.682	0.001
	OAPRO3	0.620	0.594	0.595	0.521	0.529	<b>0.906</b>	0.664	0.635	0.659	0.001
7-Radicalness (OARAD)	OARAD1	0.501	0.505	0.424	0.315	0.426	0.755	<b>0.889</b>	0.704	0.752	0.001
	OARAD2	0.348	0.335	0.316	0.255	0.288	0.582	<b>0.909</b>	0.641	0.642	0.001
	OARAD3	0.326	0.305	0.325	0.234	0.257	0.552	<b>0.813</b>	0.586	0.557	0.001
8-Responsiveness (OARES)	OARES1	0.373	0.372	0.294	0.220	0.246	0.533	0.710	<b>0.791</b>	0.590	0.001
	OARES2	0.483	0.358	0.418	0.255	0.388	0.687	0.646	<b>0.936</b>	0.770	0.001

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	OARES3	0.487	0.442	0.461	0.350	0.440	0.720	0.652	<b>0.942</b>	0.809	0.001
9-	OAADA1	0.444	0.460	0.439	0.333	0.471	0.556	0.678	0.792	<b>0.844</b>	0.001
Adaptativeness (OAADA)	OAADA2	0.526	0.534	0.478	0.328	0.538	0.698	0.718	0.723	<b>0.940</b>	0.001
	OAADA3	0.491	0.584	0.492	0.379	0.514	0.723	0.651	0.699	<b>0.917</b>	0.001

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# **Decision Making: Public Administration and Policy**

## AN OVERVIEW OF CHINESE JOINT VENTURES AND “MADE IN CHINA 2025” PLAN

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### **Abstract**

Chinese Joint Ventures take advantages from their foreign partners to reach Chinese government’s “Made in China 2025” goals. This paper is an overview of Chinese Joint Ventures and “Made in China 2025” plan.

### **1. Introduction**

A joint venture (hereafter JV) is a business entity created by two or more parties, generally characterized by shared ownership, shared returns and risks, and shared governance. [1]

JVs are widely used for various purposes such as sharing risk, penetrating a new market, and transferring “know how” or a technology. The spread of JVs among potential competing companies and countries has been one of the most important business phenomena of recent years. More and more mutually competing business companies participate in various international JVs. This phenomenon leads people to think about what roles JVs may play among the competing companies and countries.

Chinese JVs have been taking advantage of their foreign partners to reach the Chinese government’s “Made in China 2025” goals. This paper is an overview of Chinese JVs and the “Made in China 2025” plan.

### **2. Equity JVs and Co-operative JVs in China**

There are two types of Chinese JVs:

- 1) China-Foreign Equity Joint Ventures (EJVs) and
- 2) China-Foreign Co-operative Joint Ventures (CJVs),

The EJV is formed between a Chinese partner and a foreign company. Prior to China's entry into WTO in December 2001, EJVs predominated in China.

Co-operative enterprises are also called Contractual Operative Enterprises. The foreign investor provides the majority of funds and technology, and the Chinese partner provides land, buildings, equipment, etc. In addition, the foreign partner is also a minority shareholder. [2]

Since the 1990's foreign companies, including American manufacturers, gained valuable access to rapidly expanding Chinese markets, while Chinese companies benefitted from the inflow of capital and exposure to technology from international sources. The joint venture policy has raised questions of whether Chinese firms have unjustly taken certain technologies and intellectual property from its American partners, as tensions over trade have recently escalated between the United States and China. The US trade deficit with China reached \$375.2bn in 2018. To narrow trade gap between US and China, America was looking for at least \$200bn to be narrowed by 2020. To reach the goal, America wanted 1) Import more US goods to China, 2) Tariffs on imports Chinese products, and 3) Other financial penalties to China.

Recent economic studies indicated that the Chinese partners in these ventures benefited enormously from the unequal arrangements due to their access to

leading American technology. Republican lawmakers have proposed a legislation that would subject future joint ventures with Chinese firms to be reviewed by the Committee on Foreign Investment in the United States. [3]

The tables in next page shows “Transnational Corporations and the Internationalization of R&D” data of Foreign Direct Investment related to China since 1985.

### **3. Events Crucial to Chinese JVs**

On September 3, 2016, the 12<sup>th</sup> National People’s Congress Standing Committee of China passed amendments to the current four main foreign-investment laws in China. The Amendments officially mark China’s nationwide shift from its existing “case-by-case approval” system (the “Existing Approval System”) to a simplified and standardized approval system. [4]

A confidential US Department of Defense report given to policymakers in 2017 concluded that the U.S. must increase its screening of Chinese investments in U.S. technology companies to protect U.S. economic well-being and national security.

On September 13, 2017, then President Trump blocked a private equity firm backed by Chinese investors from acquiring U.S. Lattice Semiconductor Corporation. This was only the fourth time a U.S. president has blocked a transaction through the Committee on Foreign Investment in the United States (CFIUS).

In November 2017, members of the U.S. House and Senate introduced a legislation that would update the national security review process of CFIUS. The legislation entitled Foreign Investment Risk Review Modernization Act of 2017 (FIRRMA) and based on the Defense Production Act of 1950, key Section 721 as amended.

On January 3, 2018, Ant Financial, the Chinese payment systems of Alibaba, terminated its attempt to acquire U.S. money transfer company MoneyGram International Inc. after CFIUS rejected the companies’ proposed mitigation measures designed to address CFIUS concerns over the safety of data that may be used to identify U.S. citizens. [5]

In March 2018, then President Donald Trump blocked Broadcom Ltd.’s takeover of Qualcomm.inc, sending a signal that any deal that could give China an edge in critical technology would be knocked down in the name of national security. Trump’s message with Broadcom block was that U.S. tech is not for sale!

The potential threat of technological stealing has deterred some companies from entering the Chinese market altogether. Tesla Motors is an example; it talks with Chinese officials to build an integrated "Gigafactory" in Shanghai producing batteries and automobiles have progressed to the final stage. It wants to build a wholly owned factory in stand of a JV because a concern of losing control of its technology [6]. However, Tesla has entered China’s market late but is in trouble now.

IBM spent more than \$5.3 million lobbying the U.S. government last year, including on CFIUS issues.

US trade policy makers and academic scholars addressed their concern about trade war cost and death to US economy. Samm Sacks, a senior fellow specializing on tech policy at the Washington based research firm Centre for Strategic & International Studies, said: “The challenge is that the US’s and Chinese technology developments, supply chains, commercial markets are tightly intertwined.” [7]

**Transnational Corporations and the Internationalization of R&D**

**Country fact sheet: China**

**EMBARGO**

The content of this fact sheet, released in conjunction with *WIROS*, must not be quoted, or summarized in the press, radio, or on television before:  
**17:00 hrs GMT on 29 September 2005.**

**FDI overview, selected years**  
(Millions of dollars and per cent)

FDI flows	1985-1995 (Annual average)					as a percentage of gross fixed capital formation 1985-1995 (Annual average)				
	1985-1995 (Annual average)	2001	2002	2003	2004	1985-1995 (Annual average)	2001	2002	2003	2004
<b>China</b>										
Inward	11 715	46 878	52 743	53 505	60 630	6.0	10.5	10.4	8.6	8.2
Outward	1 687	6 885	2 518	- 152	1 805	0.9	1.5	-	-	-
Memorandum										
Singapore										
Inward	4 529	14 122	5 822	9 331	16 060	32.9	55.5	25.6	41.7	62.7
Outward	1 505	22 711	4 095	3 705	10 667	8.3	89.3	18.0	16.5	41.6
United States										
Inward	44 109	159 461	71 331	56 834	95 859	4.2	8.1	3.7	2.8	4.2
Outward	43 102	124 873	134 946	119 406	229 294	3.5	6.3	7.0	5.9	10.1
East Asia										
Inward	17 582	78 654	67 282	72 060	105 037	4.8	11.5	8.9	8.1	10.1
Outward	13 372	26 145	27 555	14 442	53 521	3.8	3.8	3.7	1.6	5.1
Asia and Oceania										
Inward	31 609	108 688	92 042	101 424	147 611	4.4	9.9	7.7	7.3	9.1
Outward	16 712	52 027	35 998	17 239	69 423	2.4	4.9	3.1	1.3	4.4
Developing economies										
Inward	49 868	217 845	155 528	166 337	233 227	4.6	12.9	9.5	8.8	10.5
Outward	21 580	78 571	47 775	29 016	83 190	1.9	3.7	2.8	1.6	4.2
World										
Inward	182 438	825 925	716 128	632 599	648 146	3.8	12.0	10.6	8.3	7.5
Outward	203 256	743 465	652 181	616 923	730 257	4.3	10.8	9.7	8.2	8.7

as a percentage of gross domestic product

WIR 2017 factsheet - China - Google Chrome  
 unctad.org/sections/dita\_dir/docs/wir2017/wir17\_fs\_cn\_en.pdf

**Country fact sheet: China**

**Foreign direct investment (FDI) overview, selected years**  
 (Millions of dollars and per cent)

FDI flows	2005–2007	2013	2014	2015	2016	as a percentage of gross fixed capital formation			
	(Pre-crisis annual average)					2005–2007	2014	2015	2016
	(Pre-crisis annual average)					(Pre-crisis annual average)			
<b>China</b>									
<b>Inward</b>	<b>76 214</b>	<b>123 911</b>	<b>128 500</b>	<b>135 610</b>	<b>133 700</b>	<b>6.7</b>	<b>2.7</b>	<b>2.8</b>	<b>2.8</b>
<b>Outward</b>	<b>18 800</b>	<b>107 844</b>	<b>123 120</b>	<b>127 560</b>	<b>183 100</b>	<b>1.7</b>	<b>2.6</b>	<b>2.6</b>	<b>3.8</b>
<b>Memorandum</b>									
<b>India</b>									
Inward	17 766	28 199	34 582	44 064	44 486	5.6	5.6	7.2	7.0
Outward	11 501	1 679	11 783	7 572	5 120	3.6	1.9	1.2	0.8
<b>United States</b>									
Inward	185 953	201 393	171 601	348 402	391 104	6.0	5.0	9.7	10.8
Outward	211 035	303 432	292 283	303 177	299 003	6.8	8.6	8.5	8.2
<b>East Asia</b>									
Inward	139 077	221 275	257 487	317 796	260 033	8.8	4.8	5.8	4.8
Outward	86 847	232 976	288 750	237 176	291 243	5.5	5.4	4.4	5.4
<b>Asia and Oceania</b>									
Inward	293 036	424 193	462 608	525 435	444 586	10.8	6.0	6.8	5.8
Outward	159 120	364 860	413 734	339 723	364 506	5.8	5.4	4.4	4.7
<b>Developing economies *</b>									
Inward	429 927	674 658	703 780	752 329	646 030	11.9	7.4	8.1	7.1
Outward	203 745	432 766	472 745	389 267	383 429	5.6	5.0	4.2	4.2
<b>World *</b>									

Josh Kallmer of the Information Technology Industry Council said that “The companies that are engaged both in the production of goods and supply of services have really complex global supply chains that cannot just be picked up and moved...Supply cannot just be rendered from another market. It takes years to renegotiate contracts. It takes years to move physical equipment.” [7]

JP Morgan found that “reshuffling and relocating production lines to either the US or other major tech-exporting countries would involve a significant amount of resources and capital and be a rather time-consuming process”. [7]

Then President Donald Trump seeks to limit China’s ambitions in the tech sector by denying the country access to U.S. markets and acquisition of U.S. intellectual property. The US legislation aims to strengthen CFIUS and expands its scope in particular to prevent the Chinese from obtaining sensitive U.S. technologies. Moreover, the legislation reflects concern about technology transfers to unfriendly countries such as China. [6]

Under then President Donald Trump, a series aggressive protective practices are put in places including a) require “thousand talent plan” scholars report to FBI regularly; b) investigate Huawei supporting research centers in American universities; and c) discharge US army officers with immigrate background.

#### **4. “Made in China 2025” Plan**

The Chinese government has established China’s national guidelines for the development and promotion of the semiconductor industry. China’s 2014 policy for expanding the local semiconductor industry set ambitious targets through 2030, with specific goals for various horizons, is shown in the link below:

[https://www.mckinsey.com/~media/McKinsey/Featured\\_Insights/Asia\\_Pacific/A\\_new\\_world\\_under\\_construction\\_China\\_and\\_semiconductors/SVGZ\\_A\\_new\\_world\\_under\\_construction\\_ex4.ashx](https://www.mckinsey.com/~media/McKinsey/Featured_Insights/Asia_Pacific/A_new_world_under_construction_China_and_semiconductors/SVGZ_A_new_world_under_construction_ex4.ashx)

Billions of dollars have been poured into semiconductor industry for R&D and acquisition, in domestic and on the abroad, by the Chinese government. Before its semiconductor plan was announced in June 2014, China’s outbound investment in the semiconductor industry never exceed \$1 billion. But by 2015, Chinese companies made oversea acquisition offers worth \$35 billion. The government invested 40 times higher than previous targets and hopes the industry will receive about \$100 billion to \$150 billion from all sources, including state-owned enterprises and other investors. As the trade war with the US increasingly intensified, a government backup fund designed for the semiconductor industry will distribute \$31.5 billion to the industry in the second half of 2018. [9]

China’s State Council announced its “Made in China 2025” plan, also known as MIC 2025, in May 2015. China’s chief strategic objective is to become a global leader in manufacturing high-quality and high-technology products. The ten priority sectors identified in the plan are as follows:

1. Next-generation information technology
2. High-end numerical control machinery and robotics
3. Aerospace and aviation equipment
4. Maritime engineering equipment and high-tech maritime vessel manufacturing

5. Advanced rail equipment
6. Energy-saving and new energy vehicles
7. Electrical equipment
8. New materials
9. Biomedicine and high-performance medical devices
10. Agricultural machinery and equipment

MIC 2025 identifies several industries—AI, robots, large aircraft, aircraft engines, new energy vehicles, smart grids, and high-end medical devices—as areas to improve indigenous R&D for doubling self-sufficiency rates for core infrastructure components and key infrastructure materials. Furthermore, it sets a goal to achieve significant growth in market share of indigenous intellectual property for high value equipment.

In a report titled “Made in China 2025: Global Ambitions Built on Local Protections”, the US Chamber of Commerce has criticized China’s 10-year plan illustrating the state’s intent to leverage China’s legal and regulatory systems to favor domestic Chinese companies over foreign ones in targeted sectors because of 2.2 trillion-yuan (US \$318 billion) worth of state-directed capital and a bundle of national security regulations associated with the program. For example, “forecasting China’s strong demand for new energy vehicles or NEVs, a number of foreign companies opened battery factories in China in 2015.” Then “one year later, Beijing issued a list of companies allowed to supply the domestic market; no foreign company was included on the list.” [9]

#### **5. Negative Comments on 2025 plan from the US**

- “Beijing's grand plan to upgrade its manufacturing base has riled governments around the world, confirming their suspicion that China is not looking for a 'win-win' in trade relations as its overseas emissaries often insist”.
- “The real existential threat to U.S. technological leadership.”
- “China’s intention through Made in China 2025 is not so much to join the ranks of hi-tech economies like Germany, the United States, South Korea, and Japan, as much as replace them altogether.”
- “The plan lays out targets for achieving 70% ‘self-sufficiency’ in core components and basic materials in industries like aerospace equipment and telecommunication equipment by 2025. That could devastate countries like South Korea and Germany, where hi-tech sectors constitute a large share of industrial output and exports. That could be a problem for countries that rely on exporting high-tech products or the global supply chain for high-tech components.”
- “The supply chains for hi-tech products usually span across many borders, with highly specialized components often produced in one country and modified or assembled somewhere else. Rather than abiding by the free market and rule-based trade, China is intent on subsuming the entire global hi-tech supply chain through subsidizing domestic industry and mercantilist industrial policies.” [9]

In China government’s “Amazing China” documentary television programs from March 2 to April 19, 2019, the documentaries show world-class successes and breakthroughs China has accomplished in high tech and strategical industries since 2012. Chinese viewers are excited and proud. But foreign viewers are stunned and terrified. They don’t believe that China will rise peacefully. It stirs unwanted attention



and fear. As the world scrutinizes messages in the documentary, unexpected unfriendly trade policies and practices are unfolding. China has to regain a trust worldwide with extra efforts and time. But how much? What if we didn't ring the wake-up calls mentioned above?

As a response to "Made in China 2025" plan of Chinese government, the US took the following actions toward China:

1. Stopped selling core tech parts
2. Stopped selling core US business (such as Qualcomm to Broadcom)
3. Ended JV in core tech developments (such as Tesla)
4. Discontinued sharing any tech crucial to the 2025 plan

## **6. Chinese JVs Crises**

Chinese JVs now are facing following crises:

1. Lacking core tech capacity
2. Restricted accessing to high tech foreigner partners
3. Tensions with international trading partners
4. Negative global image

Chines JVs need to answer following questions now:

1. China's JV ownership rate—a better model?
2. China's right to advance its IT and manufacturing industries—a better approach?
3. State capital using—a better way to support a free competition and a market-economy?
4. Winer takes all or win-win for all—a better trade practice and a proper team-player within global supply-chain network?
5. Balance of technological dependence and independence in a global economy—any better way?
6. Innovation fostering—when, where, and how?
7. Finding state owned enterprise economy's place in global market economy

Chinese government needs to do following things to ease tension in trade war:

1. Acknowledge global market economy
2. Progressively abandon state enterprise and state capital structures
3. Respect intellectual property and change current JV ownership rate
4. Acknowledge China's role and responsibility as a member of global supply-chain network
5. Explain to the world community that China's right to develop high tech for better quality of manufacturing. But don't forget to emphasize that China will be straying in the current WTO system and do better as a cooperative member in global economy.

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## REENGINEERING BUREAUCRACY IN PUBLIC ADMINISTRATION FOR BETTER DECISION MAKING

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### ABSTRACT

*The benefits of computerizing existing bureaucratic systems have been well researched. E-Government initiatives have been around for quite a while in developed and developing countries. However, literature on how information technology can improve decision making is comparatively sparse. Usable knowledge can be harnessed more effectively and efficiently by automated systems to yield better alternatives to decision makers. The benefits of network form of bureaucracy as opposed to hierarchical form are studied. In this paper, we study those features of e-governance that go beyond automating citizen-government interactions. We analyze how reengineering the bureaucracy can improve the effectiveness of e-governance regarding citizen-centric decisions for complex problems.*

**Keywords:** bureaucracy, decision making, e-governance, network structure.

### INTRODUCTION

The nature and quality of government-to-constituent transactions all over the world have been dramatically influenced by recent innovations in information technology (IT). E-Government initiatives have been around for quite a while in developed and developing countries. The benefits of computerizing existing bureaucratic systems have been well researched. However, the underlying structural, organizational and institutional components upon which technological innovation is superimposed are as widely divergent as the cultures from which they derive. As a result, the successes of such implementations are widely divergent, and the means by which their effectiveness can be assessed are as of yet in nascent form. Electronic government (e-government) can be defined as the use of information and communication technologies (ICT) by government to deliver information and services to its constituents. Gronlund (2005) states that while government organizations have succeeded in achieving more efficient operations and

better services at the national level, progress is slow to emerge at the local level. In spite of the considerable literature on digital or e-government, there is no general agreement on good measures for digital government or what we should be measuring (Carbo, 2004). Usable knowledge can be harnessed more effectively and efficiently by automated systems to yield better alternatives to decision makers. In this paper, we study those features of e-governance that go beyond automating citizen-government interactions. We analyse how reengineering the bureaucracy can improve the effectiveness of e-governance regarding citizen-centric decisions for complex problems.

Some studies have focused on availability, cost, and quality of ICT networks and equipment. Another stream of research looks at digital government as a special case of ICT-enabled business process change (Scholl, 2003). Factors such as societal readiness for e-government have also to be taken into account in tandem with countless assessments of e-readiness as undertaken by various international organizations specialized in “ICT for development” work (Moon, 2005). In addition to the above, a clearer understanding of the organizational and structural changes that precede the transformation to e-governance is necessary; such analysis is heretofore largely lacking. With this as a main objective, we take a bottom-up approach and analyse the actual transactions that occur between entities in an e-governance context.

The term ‘e-government’ refers to the application of Information and Communication Technology (ICT) by government agencies. In this paper, we prefer to use the term “e-governance” in a broader sense to include a deeper understanding of the way ICTs impact the existing (and potential future) interactions between a government and its constituents. In other words, e-governance goes beyond the ‘what’ of an e-government interaction that presumably delivers service to a constituent - and includes rather an analysis of the ‘how’ and ‘why’.

Sometimes the terms ‘digitization’ and ‘digitalization’ are used interchangeably. But there is a critical difference between the two. Digitization describes the pure analog-to-digital conversion of existing data and documents. Digitalization moves beyond digitization, leveraging digital information technology to entirely transform a business’ processes — evaluating, reengineering and reimagining the way you do business. In the context of digital government, digitization refers to make the government documents easily available to citizens by appropriate automating

of citizen to government interactions. There is a considerable amount of literature on this topic. Digitalization goes further and seeks to leverage innovations in digital information technology to improve and reengineer the process digital government.

This paper is organized as follows. First, we present a brief summary of research regarding how information technology has influenced bureaucracy in this digital age. Next, we propose a holistic framework for improving bureaucracy that will yield more effective e-governance. Conclusions form the last section.

### **BUREAUCRACY AND INFORMATION TECHNOLOGY**

Bureaucracy, as it is understood nowadays, emerged in western society during the second half of the nineteenth century. According to Max Weber, in this new type of organization, leadership and authority were derived from a more rational framework than was the case before (Waters, 2015). Previously, authority was derived from either charisma or tradition. In the case of charismatic authority, followers obeyed gifted leaders out of devotion, loyalty and respect. Traditional authority existed due to historical reasons and people obeyed a person in power for the simple reason that the person was in a position of traditional power. Weber believed that authority in the new, bureaucratic organizational form was more rational because leaders were recognized and obeyed for subscribing to values of logic, efficiency, and reason (Jain, 2004). Max Weber's bureaucratic approach worked as a solution to problems of traditional administrative systems. But it was not the perfect or "close to perfect" solution.

Some of the shortcomings of the bureaucratic management approach are listed below (Waters, 2015):

- The emphasis is only on rules and regulations. There will be unnecessary delays in decision-making due to formalities and rules of Bureaucratic Organization. Coordination and communication hampered because of too much formality and rules.
- Bureaucracy involves a lot of paperwork and has just too much level of authority which results in a lot of wastage of time, effort and money. Not ideal for efficiency.
- Too much importance is given to the technical qualifications of the employees for promotion and transfers. Dedication and commitment of the employee are not considered.

- The rules and levels of authority are just too much. It gives a greater sense of security to the employees. But bureaucratic management gives a window for “red-tapism.”

E-government has resulted in improvements in the following areas (Cucciniello, 2012):

- Better access to information,
- Better access to government services,
- Better customer service,
- Better value derived from government services.

Some of the deficiencies of bureaucracy that have not been fully addressed by e-government initiatives pertain to the quality of decisions made by the government that affect the general public. Decisions made by government departments at federal state, and local levels affect all citizens. Some of these decisions can be quite complex. For example, consider a situation in which a new renewable generation facility is needed for a region. Many people may want the facility near their area with the expectation that it will bring jobs and economic growth to their area. Others may not want it near them because of concerns about environmental impacts and increased traffic (Morgan, 2019). There can be conflict between local and statewide goals. In such situations, optimal decisions have to be taken using techniques such as multiple criteria decision making.

Bureaucracy as a means of implementing public administration is undergoing momentous changes due to innovations in Information and Communication Technologies (ICTs). These changes have to be examined with reference to political, managerial, and professional domains responsible for policy, administration, and service (Cordella, 2007). Typically, in a bureaucracy, discretion is structured by rules and standard operating procedures, and it does allow civil servants to take into consideration contextual variations and act according to other norms. It has to be ensured that the uniquely human ability to act on broader societal norms is retained after ICT intervention in bureaucratic practices.

The interactions between information technology (IT) and organizations in general can also be studied in four stages as stated by Hurbean (2008). In the first stage called ‘Islands of

Automation,’ organizations continue to function as before having just automated a small fraction of their processes. In the second stage called ‘Automated Process Chains,’ organizations produce the same services as before but with changes in the way the organization functions, with a minimum of reengineering due to the intervention of information technology. In the third stage, termed as ‘Reengineering through Information Technology.’ organizations produce the same services as before but in a completely innovative way that affects all internal functions information flows and structures. The fourth stage is called ‘Total Reinvention.’ In this stage, we envisage a scenario where organizations restructure the meaning of their existence and all their internal and external relations.

### **A FRAMEWORK FOR REENGINEERING BUREAUCRACY**

Information technology (IT) can play a critical role in improving bureaucracy resulting in better user experience. Automating existing bureaucratic procedures *per se* will not yield the expected results. As Michael Hammer, a well-known business consultant who championed business process reengineering, wrote an article in *Harvard Business Review* titled “Don’t Automate, Obliterate.” He stresses the importance of simplifying processes, eliminating non-value-added tasks, and innovating to improve speed, quality, and service. No meaningful improvements can be expected by simply automating the existing inefficient processes.

We propose a framework to improve bureaucracy. This framework consists of five stages. In the first stage, existing government-constituent interactions are examined. The number of interactions is indeed very large as evidenced by the three stakeholder groups of constituents (citizen, business, and government). In the second stage, processes are made free from accountability dysfunctions. In the third stage, processes are restructured to make them more effective and efficient. In the fourth stage, the hierarchical structure is converted into a network structure. In the fifth and final stage, restructured interactions (processes) are automated in the modules of the networked bureaucracy



## Stage I

In the first stage, we select the processes that need to be reengineered so that the citizen will have a better interaction with the government. In order to reengineer bureaucracy, we need to address these questions (Ramaswamy and Selian, 2007):

- How can we make e-Government truly citizen-centric?
- Do we have objectives that are correct and realistic?
- How well are we achieving these objectives fully and cost effectively?
- Are these objectives jointly determined and agreed upon by the citizens and the government agencies?

We need better models of the processes used to plan, fund, develop, implement, operate, and evaluate successful e-Government in various political and social, cultural, and economic contexts (Allison, 2002).

Some of the above concerns are addressed by the e-Governance cube. Ramaswamy and Selian (2007) propose the formation of an e-Governance cube with the following three axes: *entity type* on the x-axis, *processing complexity* on the y-axis, and *perceived value* on the z-axis. The e-governance cube provides a means of evaluating an extensive (if not comprehensive) series of government-constituent interactions. Depending upon which of the 27 sub-cubes contains the given transaction of interest, we are now able to make inferences on the potential of that transaction for its ease of conversion to e-governance. This naturally opens up a wide arena of analysis, particularly for others who wish to specialize and focus specifically on the dynamics and characteristics of specific e-governance transactions. In the context of the e-governance cube model, the further one moves away from the origin, the more resistance one encounters. From the e-inclusion view point, the processes that are valued high on the z-axis (perceived value) need to be addresses first. At the end of the first stage, we will have a prioritized list of processes that have to be restructured.

## Stage II

In the second stage, socio-technical factors are considered. Sociotechnical factors pertain to exacerbated accountability dysfunctions that can occur as a consequence of automation. According to Bovens (2005) the major categories of dysfunctions are: Rule-obsession, Proceduralism, Rigidity, and Scapegoating. Before manual procedures are automated, it has to be ensured that there are no problems such as rule-obsession and proceduralism. Not only will this help towards efficiency and effectiveness, but it will also make acceptance by constituents easier.

Rule-obsession refers to the focus on outcomes over process. This focus on outcomes over process takes the rule-obsession dysfunction and transmutes into an equally dysfunctional outcome-obsession where the outcome of the computer process cannot be questioned (Smith, 2010). 'Proceduralism' refers to increased emphasis on procedures to avoid responsibility and accountability. Strict adherence to procedures can render the bureaucracy to lose the ability to balance procedures with public values. Relying heavily on encoded computer procedures can undermine the effectiveness of public sector organizations. Bureaucracy defines roles and positions with assigned responsibilities and practices, including discretion. As the operating procedures are embedded in the system, they can become more rigid than supervisors could be (Fountain, 2001).

The ability to take contextual variations into account is affected by the encoding of procedures which actually results in encoding rigidity. After developing a system, the embedded rigidity can make it difficult to modify as part of organizational learning. As a result of the introduction of ICTs in the public sector, there has been a displacement of accountability from bureaucrat to software engineer. When things go wrong, the tendency is to use the computer as a scapegoat. It is important to consider these socio-technical factors while building e-government systems in order that the citizens can have confidence in automated systems. At the end of the second stage, we will have a set of modified processes that do not exhibit exacerbated accountability dysfunctions.

### **Stage III**

In the third stage, the selected processes are restructured. Automating legacy procedures that afforded plenty of opportunities for inefficiency will not yield results. At this stage, the results of data analytics are used to modify processes (Passerini, 2012). The main objective of restructuring various processes before transforming them into digital interactions is to improve the effectiveness as a system. It is to be noted that placing an IT layer over and automating a faulty bureaucratic system may yield a more efficient system, but will certainly not be one desired by or responsive to its core constituents.

Business process reengineering (BPR) has now become a well-established approach in the restructuring efforts of public sector organizations. Frederick Taylor suggested in the 1880s that managers use process reengineering methods to discover the best processes for performing work, and these processes be reengineered for optimal performance. Hammer and Champy (1993) define BPR as ‘the fundamental rethinking and radical design of business processes to achieve dramatic improvement in critical measures of performance such as cost, quality, service and speed.’ Davenport (1993) describes ‘business process redesign’ as the analysis and design of workflows and processes within and between organizations.

Redesign, retooling, and re-orchestrating form the key components of Business Process Reengineering (BPR) that are essential for an organization to focus on the outcome that it needs to achieve. In the first stage, the focus is on redesigning the processes. At this stage, we have to look at simplifying and standardizing the existing processes. If there is any need for reorganization, it is done at this stage. The metrics to measure the effectiveness of the process is also determined at this stage. The retooling stage the available IT infrastructure such as networks, intranets, and extranets are examined. In addition, workflow of the processes is accurately mapped. In the final stage, re-orchestration of the processes is implemented.

The entire technological, human, and organizational dimensions can be changed by using the BPR technique. Information technology plays a major role in business process reengineering as it provides office automation, it allows the business to be conducted in different locations, provides

flexibility in manufacturing, permits quicker delivery to customers and supports rapid and paperless transactions (Bogdanoiu, 2014; Wu, 2005). The concept of 'Business Process Engineering' can be successfully applied to improve the decision-making aspect of bureaucracy, which in turn results in better outcome to citizens. The BPR technique implements organizational change based on rapid change, employee empowerment, and training and support by information technology. In order to implement BPR to public administration, the following key actions need to take place:

- Selection of the strategic processes for redesign,
- Simplify new processes – minimize steps – optimize efficiency – modeling,
- Organize a team of employees for each process,
- Organize the workflow – document transfer and control,
- Assign responsibilities and roles for each process,
- Automate processes using information technology,
- Train the process team to efficiently operate the new process,
- Introduce the redesigned process into the new organizational structure.

Martin (2006) proposes 'One-Stop Government' to improve e-governance. Here, the front-office corresponds to the web portal the citizen accesses. Back-office refers to the database that links with various governmental authorities. In such a setup, BPR can play an important role in both horizontal and vertical integration of processes. Consider a scenario where there are 'm' processes in each authority and 'n' such authorities. In horizontal integration, the different processes in each authority are redesigned. In vertical integration, many authorities participate in the same process. In this way, from the perspective of the citizen there is no fragmentation of workflow even if any request involves multiple processes in different departments.

The need for effective and efficient governance calls for automated systems. But in developing countries, where there is no culture of established bureaucracy, there is also a concomitant need for accommodating socio-cultural factors. An analysis of the existing bureaucratic practices in transition countries indicates two areas that need attention. The first pertains to the availability of information regarding governmental procedures to the general public. Acquiring such information is quite simple in most western societies. But in some developing countries

government officials, especially at the lower levels, make it harder for the public to execute these transactions so their reliance on the officials who “sell” this information and “facilitate” the required transaction is not diminished. The roots of public sector corruption are found in such opportunities. The second area of concern is the convoluted way in which governmental procedures in general are laid out. In many countries, several layers of authority are embedded in the bureaucratic system. Efforts to build a congruous system to replace it have yet to emerge. This gives an opportunity for government officials to use the system to their advantage. Clearly, the simplification and clarification of procedures has not been their priority (Homburg and Bekkers, 2002). This elucidates the point that process restructuring should also accompany a concomitant improvement in the work and incentive conditions of the government employees delivering public service. This necessitates the emergence of an environment in which all participants have a share in the benefits of modern technology.

The need for integrating business processes and systems increases in one-stop governance. The difficulties can be technical, political, or integration-related. Technical difficulties can arise due to the existence of independent systems. Political difficulties refer to the lack of involvement by the authorities. In order to successfully implement both horizontal and vertical integration, the structure of public agencies has to be agile. The existence of many participants in various processes can add to the complexity. At the end of the third stage, we will have all the processes restructured for better efficiency and better effectiveness.

#### **Stage IV**

After completion of the restructuring stage, we are ready for implementing in the fourth stage. In this critical stage, we attempt to change the hierarchical structure of bureaucracy to a more agile matrix structure. The importance of networking, coordination, and collaboration among different departments of the government cannot be overemphasized (Centeno, 2005). The network administration has technological and organizational aspects which are closely related. In addition, the interoperability of systems and standardization of systems is only possible if the administrative compartmentalization is changed. In order to successfully execute this stage, the top management support is critical. As Hurbean (2008) suggests, an approach based on

enterprise resource planning (ERP) will be helpful. Both horizontal and vertical integrations of processes are made so that the way communications occur both internally and with external entities are integrated.

In the context of public administration, the term ‘network’ refers to the online network among government, citizens and business. A bureaucracy based on this type of network will result in a more transparent, cooperative and beneficial relationship. Further, this has the potential of yielding better technological integration and organizational connectivity. The traditional bureaucratic model described by Weberian theory emerged with the rise of the industrial society that resulted in the growth and expansion of the administrative tasks of the modern State (Welp 2007).

The main objective of Weberian bureaucracy was to seek efficiency and rationality in executing its functions. It was ensured by unified management and the uniformity and the predictability of routines and processes. This model’s rigid hierarchy and the inflexibility of the processes and regulations did not permit the possibility of appropriate responses to the new problems encountered in our current complex environment. The concept of ‘New Public Management’ was put forward by the Anglo-Saxon countries – United States, United Kingdom, Australia, and New Zealand – as an alternative model to Weberian Bureaucracy (Welp, 2007). This alternative model, referred to as ‘New Public Management’ (NPM) seeks to create smaller administrative structures that are decentralized and enable a degree of flexibility. Less hierarchical models were sought, with emphasis being placed on efficiency and effectiveness, and on an orientation towards the citizen (Hughes, 2001). NPM seeks to create an entrepreneurial government that puts service providers in competition with each other and displaces control from bureaucracy to the community.

The increasing number of public, private, and social actors and intermediaries at national, regional, and local levels in the implementation of e-Governance indicates the need for a networked e-Governance (Centeno, 2005). Governments can create considerable amount of public value just by reproducing themselves as networks. The utility of a network depends on the different systems connected to it and the subsequent interoperability. Interoperability can be

defined as the ability of two or more systems to exchange information and to use the information that has been exchanged. Cross-boundary information sharing is dependent on collaborative governance and interoperability. Collaborative governance provides an inter-organizational structure to make decisions and coordinate efforts across organizational boundaries (Gil-Garcia, 2016). In the current type of bureaucracy that is widely practiced today, the structure is still hierarchical. Even though the orientation is essentially administrative, information dissemination is also given importance. Using the web, many forms can be obtained and some transactions can be executed by citizens. The level of decision-making is at top and middle levels. The degree of operational ease is medium and there are few intermediaries between citizens and decision-making authority.

In the networked bureaucracy, the structure will be matrix and the orientation of this bureaucracy is the user. The web services mirror all the services provided in person, by mail, and by telephone. There are no intermediaries and the degree of operational use is high. At the end of the fourth stage, we will have the entire bureaucracy reengineered for optimal utilization.

### **Stage V**

In the fifth and final stage, restructured processes are automated in the modules of the networked bureaucracy. When automated processes result in disintermediation, it is necessary that the relevant entities are on board with new procedures. The degree of automation can vary across a wide range. Smith (2010) introduces a scale of nine degrees of automation starting from the first level where the computer offers no assistance to the ninth level where the computer decides everything. In between these extremes, there are several levels where a varying degree human-computer interaction occurs. The appropriate level of ICT intervention depends on the particular interaction that has to be automated.

## **CONCLUSIONS**

Sangki (2018) suggests a new e-government development model called as “E-Government Maturity Model based on Socio-political Development” that incorporates the level of social



maturity based on e-democracy and the maturity level of civic society with statistical model. The new model classifies e-Government development into four stages: “Bureaucratic model”, “Information management model”, “Participatory model”, and “Governance model.” In the context of this paper, we are examining the critical factors that affect the transformation to governance model from bureaucratic model. Our proposed model is different from the ‘E-Government Maturity Model’ (EGMM) in the following way. EGMM takes an incremental approach whereas our model attempts to change bureaucracy in a more comprehensive way. By our stage wise approach, we attempt to restructure the processes as well as reengineer the hierarchical structure into a network structure.

During the last few decades, countries all over the world have attempted to improve the efficiency and effectiveness of their bureaucracies by leveraging information technology. While there has been much success regarding achieving efficiency, there is still a lot of scope regarding the effectiveness aspect. The basic building blocks of e-governance in public sector bureaucracy consist of digitized versions of interactions between the government and its constituents. In this paper, we have discussed various aspects of bureaucracy and e-governance. The importance of decentralizing the decision-making process by horizontal and vertical integration of the various processes that affect citizens has been analyzed. Restructuring the bureaucratic procedures and then automating them in a systematic way as suggested in this paper affords a practical approach to render transparency and accountability to public sector in addition to making bureaucracies more efficient and effective. Future work in this area focuses on developing a comprehensive framework that will enable policy makers and researchers to point out the potential priority areas that need to be restructured both process wise and integration wise. This will also yield a realistic estimate of resources needed to achieve such transformation. In addition, such an approach will also help in giving a better insight into process restructuring.

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## **Using Data Envelopment Analysis to Measure and Improve Organizational Performance**

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### **Abstract**

Organizations are complex and have many goals while almost all analytical tools measure performance using only one goal. Thus, analysts often rely on multiple analytical tools to produce a bewildering array of performance measures that often lack internal consistency and a clear focus. In this article, we show how DEA builds a performance frontier that measures organizational performance in the presence of multiple organizational measures. DEA uses the frontier to produce target values for each organizational measure based on the observed performance of organizations in the comparison set. In addition, DEA provides factor performance levels for each performance measure for each organization and can detect circumstances in which an organization has a strong overall performance measure but still has weaknesses in one or more measures. We will illustrate this approach with applications to several examples using real data.

Analyzing organizational performance data is critical in the organizational improvement process. The data must directly reflect the organization's goals and the analytical tools used must be appropriate. However, organizations are complex and have many goals while univariate analytical tools measure performance relative to only one goal. Thus, analysts often rely on multiple analytical tools to produce a collection of performance measures, sometimes resulting in a bewildering array of measures that lack focus.

For example, financial analysts are fond of ratios. They define *leverage* as the ratio of the firm's total assets to its total stockholder equity, *asset efficiency* as the ratio of its sales to its total assets, and *profitability* as the ratio of its net income to its sales. Each of these ratios measures the firm's financial performance in its own specific manner. Leverage measures the firm's success in using its investors' money to increase its financial strength; asset efficiency measures its success in using its assets to increase sales; profitability measures its ability to control costs and retain sales revenue. In all cases, higher values are preferred.

Which of these three ratios is most important to a prospective investor or to the firm's directors?

The DuPont Model (Soliman 2008) addresses this question but not entirely satisfactorily. The DuPont Model is the mathematical identity:

$$\text{Return on Equity} = \text{Leverage} * \text{Asset Efficiency} * \text{Profitability}$$

providing us with yet another ratio, Return on Equity.

The DuPont Model is useful, but it overlooks several crucial flaws. First, ratios assume constant returns to scale. Why should we expect that large and small operations should have comparable ratios? Often, this assumption is unwarranted. A small company can achieve a higher return on

equity because it is producing only the most profitable products. Larger firms produce additional products, which are likely to be less profitable than those first few.

Second, ratios lack a natural comparison value. Does a given ratio indicate good performance or bad performance? Analysts sometimes reference the mean value of the ratio among the organizations in a specified comparison set, such as other firms in the same industry. But the mean value indicates *average*, not *best possible*, performance.

Sexton et al. (2008) showed how a three-stage variable returns-to-scale data envelopment analysis (DEA) model would improve the DuPont Model. By removing the assumption of constant returns to scale, this model can admit small and large firms in the model. The larger comparison set means that evaluations will be more robust, that is, less dependent on a small comparison set. Moreover, as described below, DEA measures performance against a “frontier” defined by firms whose performance cannot be exceeded by any other firm (or weighted average of other firms) in the comparison set, thereby replacing average performance with best possible performance.

Traditionally, DEA has been used to measure organizational *efficiency*. The model identifies two distinct sets called *inputs* and *outputs*. Conceptually, it follows the traditional concepts of economic production: inputs are consumed to produce outputs. For example, an automobile may consume a certain amount of gasoline to move a certain distance. We define the efficiency of the automobile as the ratio of miles traveled to gallons consumed, i.e., miles per gallon. This approach fails if multiple inputs are required to produce various amounts of multiple outputs or constant returns to scale is invalid; DEA permits these generalizations.



In this article, we show that DEA can also measure organizational performance. The central idea is that inputs are quantities for which smaller values are preferred, and outputs are quantities for which larger values are preferred; we prefer to use less input and produce more output. We rename inputs as *SIPs* (smaller is preferred) and outputs as *LIPs* (larger is preferred) and then classify each of our organizational measures as either a SIP or a LIP depending on whether we prefer that measure to be smaller or larger. A nursing home, for example, wants patient falls to be smaller (a SIP) and its percentage of staff vaccinated for influenza to be larger (a LIP). *This reconceptualization extends the DEA methodology from efficiency measurement to performance measurement.*

We illustrate how DEA can be applied in a wide variety of circumstances to measure organizational performance in the presence of multiple organizational measures. DEA provides a global performance measure for the organization and factor performance levels for each organizational measure. This allows us to detect circumstances in which an organization has strong overall performance but weaknesses in one or more organizational measures. Finally, DEA produces target values for each organizational measure based on the observed performance of organizations in the comparison set. If an organization were to improve to equal or exceed all its target values, then it would lie on the performance frontier.

We illustrate application of this approach to several settings using real data. Our examples include two applications to hospitals, and one each to nursing homes, rail systems, and global greenhouse emissions. The authors (and others) have published applications to baseball teams, school districts, school transportation funding, blood centers, and banking.

## **Existing Methods**

Multivariate statistical models, such as linear and logistic regression, incorporate many variables but have two distinct shortcomings. First, while such models can include multiple independent variables, they permit only one dependent variable. Therefore, they typically permit us to model only one performance measure at a time. Second, these techniques focus on the average value of the performance measure as a function of the predictor variables. In performance measurement, we want to determine best possible performance. We want the organization to become the best it can be, not to become mediocre.

The primary models for building a frontier are DEA and *stochastic frontier analysis*, or SFA. While DEA is a deterministic model – there are no probabilities involved – SFA explicitly considers the observed data to be the results of random processes. SFA uses an econometric model that explicitly involves random variables with specified probability distributions. It estimates the frontier much the way that linear regression estimates the best fit linear model (Aigner, D.J., Lovell, C.A.K. and Schmidt, P. 1977, Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. and Battese, G.E. 2005, Greene, W. H. 2008, Meeusen, Wim, and Julien van den Broeck. 1977 and Parmeter, C.F. and Kumbhakar, S.C., 2014).

SFA uses a specified nonlinear function that equals or exceeds each value of the dependent variable by as little as possible. It utilizes two distinct error terms: one that measures random noise, and one that measures distance from the frontier. In addition, we need to make assumptions regarding the details of the nonlinear function and the nature of the probability distributions. Like DEA, the methodology requires specialized software.

While there are many published applications of SFA, perhaps its main weakness is that the underlying model, like in linear regression, can typically have only one dependent variable.

Thus, SFA generally models only one performance measure and there is often no obvious best choice among the many possibilities. Therefore, on balance, we prefer DEA.

### **Data Envelopment Analysis**

Data Envelopment Analysis (DEA) is a linear programming-based methodology that is used to measure the relative efficiency of each of several organizations, each of which uses the same set of inputs to produce the same set of outputs. Hospitals, for example, use physician labor, nursing labor, technician labor, beds, and other inputs to produce surgical patients treated, medical patients treated, outpatients treated and other outputs. Since the inputs are shared among the outputs, a model that uses one specific output as the dependent variable would be poorly specified and misleading.

By contrast, DEA measures all hospitals relative to a frontier. For each hospital that does not lie on the frontier, DEA computes the extent to which it needs to increase each output (an *output orientation*), decrease each input (an *input orientation*), or both (a *mixed orientation*), to reach the frontier. Specifically, DEA produces overall performance scores,  $E_0$  and  $\theta_0$ , for the hospital. For hospitals not on the frontier,  $E_0$  represents the extent to which the hospital can reduce each SIP, and  $\theta_0$  represents the extent to which the hospital can increase each LIP. The hospitals that determine the frontier have overall performance scores of 100%.

Potential improvements for each SIP and each LIP are expressed as *factor performance scores*.

Suppose that a hospital has  $E_0 = 0.90$ , meaning that it can decrease every SIP to 90% of its current level. However, it may be possible to decrease one particular SIP to 75% of its current level. Then that SIP would have a factor performance score of 0.75. A similar situation occurs with LIPs. If  $\theta_0 = 1.20$ , then the hospital can increase every LIP by 20%. It may be possible to

increase a particular individual LIP by 30%; the factor performance score for that LIP would be 1.30.

To use DEA, we need to identify a set of comparable organizations that utilize the same SIPs and the same LIPs; we call this the *reference set*. DEA solves one linear program for each organization. The decision variables in the DEA are weights, one for each organization in the reference set. Each weight is nonnegative, and the sum of the weights is one (to assume variable returns to scale). The optimal solution for the organization identifies a hypothetical target organization that has the same or lower value of each SIP and the same or higher value of each LIP. This hypothetical organization lies on the performance frontier and serves as the target organization for the organization.

DEA can also incorporate site characteristics that describe characteristics of the organization that lie beyond the immediate control of its management but are believed to either improve or degrade its performance. In the case of hospitals, we might consider its patient mix (surgical vs. medical) and the average severity index of the cases it treats as site characteristics. Site characteristics ensure that the results of the model are not influenced by factors over which management has no control. The DEA linear program is presented in Figure 1.

$$\begin{aligned} & \text{Min } E_0 \text{ (or Max } \theta_0) \\ & \text{subject to} \end{aligned} \quad (1)$$

$$\sum_{j=1}^n \lambda_j X_{ij} \leq E_0 X_{i0} \text{ for } i = 1, 2, \dots, S \quad (2) \quad \text{Target SIP} \leq E_0(\text{Actual SIP})$$

$$\sum_{j=1}^n \lambda_j Y_{rj} \geq \theta_0 Y_{r0} \text{ for } r = 1, 2, \dots, L \quad (3) \quad \text{Target LIP} \geq \theta_0(\text{Actual LIP})$$

$$\sum_{j=1}^n \lambda_j Z_{pj} = Z_{p0} \text{ for } p = 1, 2, \dots, C \quad (4) \quad \text{Target SC} = \text{Actual SC}$$

$$E_0 + \theta_0 = 2 \quad (5) \quad \text{Balanced SIP/LIP Orientation}$$

$$\sum_{j=1}^n \lambda_j = 1 \quad (6) \quad \text{Weights Must Sum to 1}$$

$$\lambda_j \geq 0 \text{ for } j = 1, 2, \dots, n \quad (7) \quad \text{Nonnegative Weights}$$

$$E_0, \theta_0 \geq 0 \quad (8) \quad \text{Nonnegative Improvements}$$

*Figure 1: DEA Formulation*

The computation of the factor performance scores uses the formulas shown in Figure 2.

$$\text{For SIP } i, \text{ Factor Performance Score} = \frac{\sum_{j=1}^n \lambda_j X_{ij}}{X_{i0}} (\leq E_0)$$

$$\text{For LIP } r, \text{ Factor Performance Score} = \frac{\sum_{j=1}^n \lambda_j Y_{rj}}{Y_{r0}} (\geq \theta_0)$$

*Figure 2: Factor Performance score formulas.*

## **Applications of DEA to Performance Measurement**

In this section, we describe applications of DEA to measuring organizational performance. We show how each organization can examine its own target and factor performances to determine which specific SIPs and LIPs are most in need of attention. By researching the organizations that contribute high weights to its target, the organization may identify specific operational practices to improve its own performance.

## **Nursing Homes in New York State**

### ***Background***

The quality of care provided in a nursing home is a primary concern for both the consumer in selecting a nursing home and the nursing home administrator when identifying areas of improvement. Performance outcomes and quality assessment in healthcare involve a complex array of variables making it difficult to compare the performance of one nursing home to another or to identify critical areas in need of improvement.

For example, a nursing home can measure the percentage of its long-term stay residents who suffer from depressive symptoms. The number alone is difficult to interpret without context. How does the percentage compare to those observed at other nursing homes? If the percentage is above average, does it follow that the nursing home has a problem requiring action? Or might the higher-than-average percentage be attributable to differences in the resident characteristics (age, sex, medical condition, etc.) or other conditions, such as ownership?

We present a DEA model the results of which allows consumers, nursing home administrators and nursing home regulators to answer these questions. By including multiple measures of performance, referencing a carefully selected group of peer institutions, and incorporating other measures that describe the relevant characteristics of the home and its residents, the model provides a focused analysis of the nursing home's performance. The analysis presented here is currently under consideration at *Quality in Health Care* (Pitocco and Sexton).

### ***The DEA Model***

Our model differs from earlier DEA models of nursing homes in that it measures quality performance rather than operational or economic efficiency. Each nursing home is a DMU in our

model which uses 8 quality dimensions that pertain to nursing home quality of care. Five of these are SIPs:

Percentage of long stay residents with

1. depressive symptoms
2. one or more falls with major injury
3. with pressure ulcers
4. with a urinary tract infection
5. with excessive weight loss.

Three of these measures are LIPs:

Percentage of

1. employees vaccinated for the flu
2. long stay residents who received the seasonal influenza vaccine
3. long stay residents who received the pneumococcal vaccine

Our model incorporates one site characteristic, ownership type, coded using three indicator variables for public, voluntary, and proprietary. We use a variable returns to scale model with constraints that ensure that the target nursing home is a weighted average of only homes of the same ownership type as the nursing home under analysis. Thus, our model is equivalent to three separate DEA models, one for each ownership type. Therefore, each public (or voluntary or proprietary) nursing home is measured relative to a set of 24 (or 171 or 331) homes with the same ownership type. We use a mixed orientation.

### ***Data Sources***

We obtained data from the NYS Department of Health (NYS Department of Health for the year 2015) for the year 2015.

### ***Results***

We downloaded data for 589 nursing homes and removed 63 with missing data. Overall, 212 of the 526 nursing homes (40.3%) lie on the performance frontier; there is no evidence that these nursing homes can improve their performance. We note that public nursing homes are most likely to lie on the performance frontier, with voluntary nursing homes second most likely and proprietary nursing homes least likely.

We performed a series of ANOVAs in which the dependent variable was (the natural logarithm of) the overall or factor performance score. In each case, ownership was the factor. We found that proprietary nursing homes perform worst overall. There is evidence that voluntary nursing homes have a higher average performance score relative to proprietary nursing homes; there is insufficient evidence that the other differences are nonzero. We find a similar pattern with respect to the factor performance score for depression.

We used a nonparametric analysis of variance (Kruskal-Wallis test) to examine the relationship between the DEA-based performance score and the NYS regionally adjusted Five-Star quality rating for health inspections. We find that the mean performance scores among the five groups defined by the 5-Star ratings are statistically significantly different with  $P < 0.00005$ . Using Dunn's post-hoc all-pairwise comparisons test, we find three groups of 5-Star ratings within which the mean performance scores are statistically indistinguishable. They are (1) 1-Star and 2-Star, (2) 2-Star, 3-Star, and 4-Star, and (3) 3-Star, 4-Star, and 5-Star. Thus, the mean performance score of nursing homes with a 5-Star rating is higher than that of nursing homes



with a 2-Star or 1-Star rating. Similarly, the mean performance score of nursing homes with a 4-Star rating or a 3-Star rating is higher than that of nursing homes with a 1-Star rating.

### *Discussion*

Nursing homes are complex operations, and we should not expect to capture their quality performance on a single scale with only 5 values. Thus, while the Five-Star health inspection rating awards more stars, on average, to nursing homes with better performance as measured by our more comprehensive DEA model, the Five-Star rating explains less than 4% of the variation in the DEA performance scores, as measured by the  $R^2$  in a linear regression analysis.

NYS reports only its regionally adjusted rating for health inspections and ignores the CMS ratings for staffing and quality measures; therefore, it does not report an overall Five-Star rating. It is possible that the inclusion of such information might improve the strength of the relationship between the Five-Star system scores and those developed using DEA. However, in our opinion, it is unlikely that even the overall Five-Star rating would explain appreciably more of the variation in the DEA scores, especially since CMS bases its overall rating by starting with the health inspections rating and then adjusting upward or downward based on staffing and quality measures. In short, NYS presents consumers of nursing home services with a Five-Star rating that is only one component of the CMS evaluations and that does not correspond very well with the more comprehensive DEA-based performance score.

## **Hospitals in New York State**

### *Background*

Like nursing homes, the complexity of a hospital's services makes it difficult to evaluate organizational performance, to compare one hospital's performance with that of another or to

identify critical areas in need of improvement. We use DEA to evaluate hospital performance along multiple dimensions. The analysis presented here appears in Pitocco and Sexton (2020).

### ***The DEA Model***

Each hospital is a DMU. The analysis is predicated on the concept that an ideal hospital stay is one in which the patient is discharged alive, does not need to be readmitted within 30 days, and is discharged as quickly as possible. Thus, our analysis focuses on three dimensions: mortality rate, readmission rate, and average length of stay (LOS), all of which are SIPs. The model contains no LIPs. It incorporates several site characteristics:

- number of discharges
- percentage of discharges whose risk of mortality is extreme or major
- percentage of discharges who are at risk for readmission
- average expected LOS (the expected LOS for a patient is computed by New York State based on patient and case characteristics that may affect patient outcome).

We assume variable returns to scale.

### ***Data Sources***

We extracted data for 2,233,214 hospital inpatient discharges in 2014 from 183 facilities from the NYS DOH Statewide Planning and Research Cooperative System (SPARCS) (2015).

### ***Results***

Most NYS hospitals (145 of 183, 79.2%) can improve the quality of the care they provide. Of the 183 facilities, 38 (20.8%) are on the performance frontier: 32 of the 155 not-for-profit facilities (20.6%) and six of the 28 hospitals with other ownership types (21.4%). In addition, 58 of the 183 facilities (31.7%) received a performance score greater than or equal to 90%. This was true

for 49 of the 155 not-for-profit facilities (31.6%) and 9 of the 28 facilities with other ownership types (32.1%). Overall, if all hospitals in NYS were to increase each of their factor performance scores to 100%, there would have been 11,722 fewer deaths (24.8% fewer), 17,840 fewer readmissions (15.8% fewer), and the statewide average LOS would be 0.71 days less (13.5% less).

### ***Discussion***

This analysis provides guidance for hospital administrators and healthcare decision makers in their quest to improve quality. In addition, it can also assist the NYS DOH monitor statewide hospital performance over time.

## **Hospital Acquired Infections in New York State Hospitals**

### ***Background***

A hospital-acquired infection (HAI) is one that presents during or after hospital admission that is not associated with the patient's initial condition. These infections usually arise within 48 hours of a patient's admission to the hospital, and they may present a serious patient safety issue. Thus, HAIs are closely tracked by large healthcare organizations such as the National Healthcare Safety Network (NHSN) of the U.S. Center for Disease Control and Prevention (CDC) (Monegro et al., 2021).

According to the 2015 HAI Hospital Prevalence Survey, 1 in 31 hospital patients acquire at least one type of HAI. There were an estimated 687,000 HAIs in U.S. acute care hospitals in 2015; 72,000 of these patients (10.5%) died. However, this represents an improvement as patients in 2011 were at least 16% more likely to have contracted an HAI (Center for Disease Control, 2021). In addition to the risk to the patient, an HAI also places a financial burden on the health care facility and the patient.

There have been many widespread efforts at the hospital level and beyond to lower the incidence of HAIs. For example, there is evidence that simple infection control procedures, such as hand cleaning with an alcohol-based hand rub, can help prevent HAIs and thereby save lives, reduce morbidity, and lower health care costs (Haque, 2018). Guidelines such as “A Compendium of Strategies to Prevent Healthcare-Associated Infections in Acute Care Hospitals” (2008) assist hospitals in controlling and preventing HAIs (Yokoe et al., 2014).

Pitocco, Lewis and Liu (2020) showed how to use the binomial and Poisson distributions to identify hospitals that are poor performers and those that are good performers with respect to HAIs. They do this using upper tail probabilities (UTPs) to screen for poor performers and lower tail probabilities (LTPs) to screen for good performers. The goal was to identify specific HAIs in specific hospitals that need improvement.

In this study, we use DEA to measure, for each hospital, the degree to which it can reduce HAIs. Our focus is on five major HAI categories: Clostridium difficile infections (CDI), surgical site infections (SSI), central line-associated bloodstream infections (CLABSI), carbapenem-resistant Enterobacterales (CRE) considering both body (CRE-Body) and bloodstream (CRE-Blood) origins. The analysis presented here is taken from an unpublished manuscript (Lewis, Pitocco, and Sripada).

### ***DEA Model***

The numbers of each type of infection serve as the five SIPs in the DEA model. The target hospital would have the same or fewer of each type of infection. There are no LIPs in the model.

New York State uses a model to predict the number of HAIs of each type that would have occurred in each hospital if every hospital in the state performed according to statewide

averages. The State's predictive model is applied to each patient at risk for a given HAI – for example, only patients who underwent surgery would be at risk for an SSI – and includes several patient and case characteristics as predictor values. The average of the predicted values across all patients treated at a particular hospital serves as a site characteristic in the DEA model since higher average predicted values indicate that the hospital treated patients at higher risk for HAIs. In addition, the number of surgeries, patient days, and central line days also serve as site characteristics. These are factors that are beyond hospital managerial control and could impact overall performance. The target hospital in the DEA would be working under equal or more severe conditions, meaning an equal or greater number of predicted infections, surgeries, patient days, and central line days.

### ***Data Sources***

We used data from the “Hospital-Acquired Infections: Beginning 2008” dataset obtained from the NYSDOH website (NYSDOH (2015)) to calculate overall and factor efficiency scores for each hospital for each of the years 2015-2018.

### ***Results***

Table 1 shows the number of hospitals with performance scores equal to 1 overall and by type of infection for the year 2015. Table 2 shows the summary statistics of the overall and factor performance scores for the year 2015. Factor performance score for hospitals with no infections of a given type cannot be computed because a factor performance score is defined as the ratio of the target to the actual number of infections, and we cannot divide by zero.

Table 1: Number of hospitals with performance scores equal to one overall and by type of infection for the year 2015. Factor performance scores for hospitals with no infections of a given type cannot be computed. See Table 2.

	Hospitals	Number of Hospitals, by Type of HAI				
		SSI	CLABSI	CDI	CRE Body	CRE Blood
Performance Score = 1	67	54	52	62	42	26
Performance Score < 1	85	81	79	85	60	34
<b>Total</b>	<b>152</b>	<b>135</b>	<b>131</b>	<b>147</b>	<b>102</b>	<b>60</b>
No Infections	0	17	21	5	50	92

Table 2: Summary statistics of overall and factor performance scores for the year 2015. Factor performance scores for hospitals with no infections of a given type cannot be computed.

	Overall Performance	Factor Performances				
		SSI	CLABSI	CDI	CRE Body	CRE Blood
Number of Hospitals	<b>152</b>	<b>135</b>	<b>131</b>	<b>147</b>	<b>102</b>	<b>60</b>
Mean	.780	.753	.717	.770	.567	.598
SD	.249	.258	.285	.250	.408	.410
Minimum	.133	.133	0	.133	0	0
1st Quartile	.556	.524	.467	.544	.136	.192
Median	.851	.817	.783	.843	.536	.695
3rd Quartile	1	1	1	1	1	1
Maximum	1	1	1	1	1	1

The radar plot in Figure 3 shows HAI factor efficiency scores for hospital #513 in 2017. We note that the overall HAI efficiency is 0.752 as are the SSI and CLABSI factor efficiencies.

However, the CDI, CRE Body, and CRE Blood factor efficiencies are 0.408, 0.512, and 0.058, respectively. Thus, this hospital could have reduced all categories of HAI infections to 75.2% of

their observed values. In addition, the CDI, CRE Body, and CRE Blood factor efficiencies indicate possible reductions to 40.8%, 51.2%, and 5.8% of their actual observed values, respectively. These metrics provide insight into specific problematic infection categories, allowing hospitals to target interventions accordingly. In this case, we see that CRE (Blood) infections require attention. Similar radar plots can be developed for each hospital in each year.

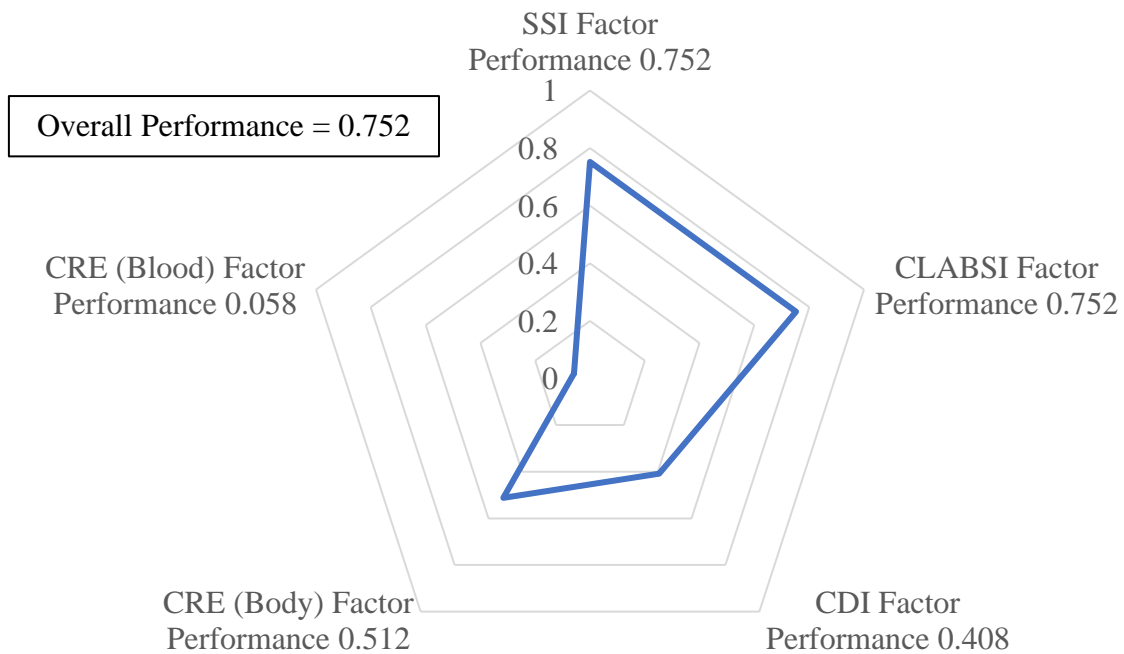


Figure 3: Overall and factor performances for Hospital #513 in 2017. It appears that CRE (Blood) infections require attention.

Table 3 shows the actual and the target number of infections, the potential reductions, and the percentage reductions statewide for each year overall and in each category. We observe that the number of HAIs has declined each year while the percentage reductions have remained nearly

constant at slightly below 20%. These results may be helpful at the statewide level to specifically target the HAI categories that are in most need for improvement.

*Table 3: Possible improvements for years 2015 - 2018 overall and by HAI category.*

Year		All HAIs	CDI	SSI	CLABSI	CRE (Body)	CRE (Blood)
2015	Actual	12,095	7,414	1,739	1,513	1,210	219
	Target	9,688	6,250	1,432	1,182	691	134
	Difference	2,407	1,164	308	331	519	85
	% Improvement	<b>19.9%</b>	<b>15.7%</b>	<b>17.7%</b>	<b>21.9%</b>	<b>42.9%</b>	<b>38.9%</b>
2016	Actual	10,732	6,436	1,530	1,327	1,228	211
	Target	8,824	5,509	1,290	1,086	802	137
	Difference	1,908	927	240	241	426	74
	% Improvement	<b>17.8%</b>	<b>14.4%</b>	<b>15.7%</b>	<b>18.1%</b>	<b>34.7%</b>	<b>35.2%</b>
2017	Actual	8,935	5,059	1,581	1,143	951	201
	Target	7,189	4,149	1,308	855	736	141
	Difference	1,746	910	273	288	215	60
	% Improvement	<b>19.5%</b>	<b>18.0%</b>	<b>17.3%</b>	<b>25.2%</b>	<b>22.6%</b>	<b>29.8%</b>
2018	Actual	7,918	4,454	1,471	992	855	146
	Target	6,379	3,605	1,216	765	691	102
	Difference	1,539	849	255	227	164	44
	% Improvement	<b>19.4%</b>	<b>19.1%</b>	<b>17.35%</b>	<b>22.9%</b>	<b>19.2%</b>	<b>30.2%</b>

### *Discussion*

The results of this study provide insight to hospital administrators and state health officials indicating how each hospital is performing over time with respect to HAIs. In addition, a hospital may compare their results to other hospitals within a given year and over time. The goal of this study is to identify areas where HAIs may be reduced thus improving the overall quality of care.



## **Rail Transportation**

### ***Background***

The U.S. public transit system consists of bus and rail systems that play a critical role in the nation's social and economic development. The importance of these systems is made evident by the fact that every public transit system in the U.S. relies heavily on government subsidies for its operations.

Commuter rail is the third most used public transit mode in the U.S.; it uses electric or diesel propelled trains to provide urban passenger service between a central city and its suburbs (National Transit Database (NTD) 2012). We apply our model to measure the performance of U.S. commuter rail systems.

Presently, governments at all levels face significant budget shortfalls and public transit must compete with other pressing public needs, such as education, health care, and defense, for financial support (Williams E. et al. 2011). Therefore, it is critical for public transit systems to become more economically viable and depend less on public financial support. To complicate matters, they need to do this while dealing with rising energy and labor costs.

To accomplish this, public transit systems must raise fare revenue or reduce operating costs, or both. However, increasing fares may lead to reduced ridership and reduced fare revenue (Fielding 1987). Hence, transit systems need to optimize their service effectiveness and focus on cost reductions through increased operational performance. To do so, transit managers must identify the sources of poor performance within their systems, leading to two questions:

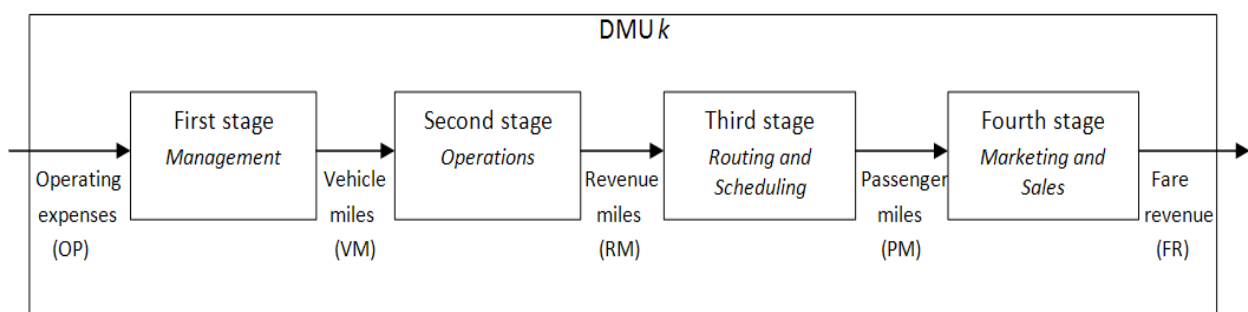
1. How well does each U.S. transit system perform?
2. How can transit managers improve operational performance?

We address these questions using a four-stage sequential unoriented network DEA model that identifies the sources of poor performance within each U.S. public transit system and measures the overall performance of each system. This model allows transit managers, funding agencies, and policy-making bodies to understand the sources of poor performance and set realistic goals to improve public transit systems.

The application described here appears in *Socio-Economic Planning Sciences* (2014) and as a book chapter in *Managing Service Productivity* (2014).

### ***The DEA Model***

As shown in Figure 4, we model the operation of a public transit system as a four-stage sequential process. We do not include capital expenditures in the model. The first stage is the Management stage, which consumes operating expenses (OP) for staff, labor, fuel, and other materials for maintenance and operation to produce vehicle miles (VM), the miles that a vehicle travels between leaving its yard to go into revenue service and returning into the yard from revenue service.



*Figure 4. The four-stage sequential model for a public transit system.*

The second stage is the Operations stage, which consumes VM and produces revenue miles (RM), defined as the miles the vehicle travels when it is available for carrying passengers.

Unlike VM, RM excludes deadhead miles, which are the miles that a vehicle travels when out of revenue service. RM includes miles traveled leaving or returning to the yard or when changing routes. The third stage is the Routing and Scheduling stage, which consumes RM and produces passenger miles (PM), which are the total miles traveled by all passengers during its revenue service. The fourth stage is the Marketing and Sales stage, which consumes PM and produces fare revenue (FR), the total income received from passenger fares through cash, prepaid tickets, or passes.

To improve the performance of public transit systems, transit managers seek to reduce operating costs and increase fare revenue, which requires an unoriented model. The methodology employed in this paper expands on those developed by Sexton and Lewis (2003), Lewis and Sexton (2004), Lewis et al. (2013), and Mallikarjun et al. (2014) The DEA model assumes variable returns-to-scale (VRS) in each stage. The model has one SIP (OP) and one LIP (FR).

In addition to measuring overall operational performance, the four-stage sequential model computes various performance dimensions, shown in Figure 5.

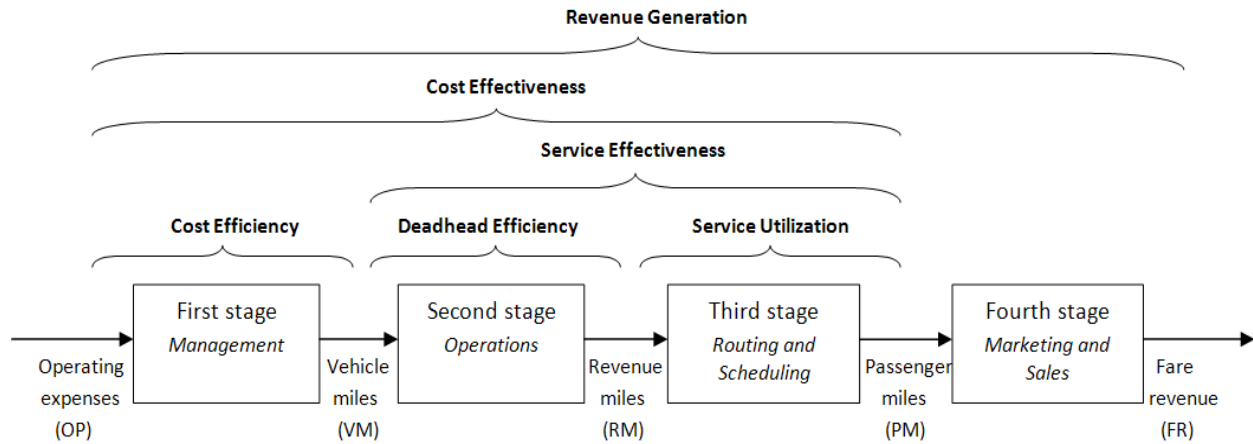


Figure 5. Performance dimensions.

Commuter rail systems operate under different conditions that may influence the organization's ability to operate efficiently. We identify five site characteristics for the commuter rail model: two for the second stage, two for the third stage, and one for the fourth stage:

- Vehicles available (VA) and directional route miles (DRM) are site characteristics for the second stage. VA is the number of vehicles available for maximum service and DRM is the total miles of route in each direction over which vehicles travel to provide revenue service (NTDprogram. National Transit Database Glossary 2011). DRM is a measure of the route path, which we calculate with respect to direction of service. VA and DRM are capital assets and are beyond the control of public rail transit operational managers. We expect that a rail system that has more VA or more DRM will be able to convert a given number of VM into a larger number of RM. This is because the additional VA or DRM offers more options to the system's operational managers.

- Population density (PD) and number of stations (ST) are site characteristics for the third stage, in which the system interacts directly with its ridership. Higher values of these characteristics are expected to result in increased passenger miles.
- Per capita personal income (PCI) is the site characteristic for the fourth stage. A commuter rail system operating in an area with relatively high PCI can charge higher fares than a system operating in an area with relatively low PCI.

### ***Data Sources***

We apply the model to determine the relative performance of 24 U.S. commuter rail systems for the years 2001-2010. We obtain annual commuter rail data from: (1) the National Transit Database website (NTDprogram. National Transit Database Glossary 2011) and (2) the American Public Transportation Association website (APTA Statistics 2011). We obtain annual demographic and socioeconomic data (population density and per capita personal income for urbanized areas) from the U.S. Census Bureau (2011) and the U.S. Bureau of Economic Analysis (2011), respectively.

### ***Results***

To determine the organizational performance scores and organizational target levels of OP, VM, RM, PM, and FR, we apply the iterative unoriented network DEA algorithm to each rail system. As the algorithm proceeds, the input OP tends to decrease (or remain constant), while the output FR tends to increase (or remain constant). Interestingly, the intermediate products VM, RM, and PM oscillate and dampen (or remain constant) until they converge to their target levels. Figure 6 shows the convergence of optimum (or target) values for the Southern California Regional Rail Authority (SCRRA) Metrolink in revenue year 2010. In general, the optimum levels of OP, VM,

RM, PM, and FR suggest best practice targets for management and provide a deeper understanding of the organization's performance to policy analysts and funding bodies.

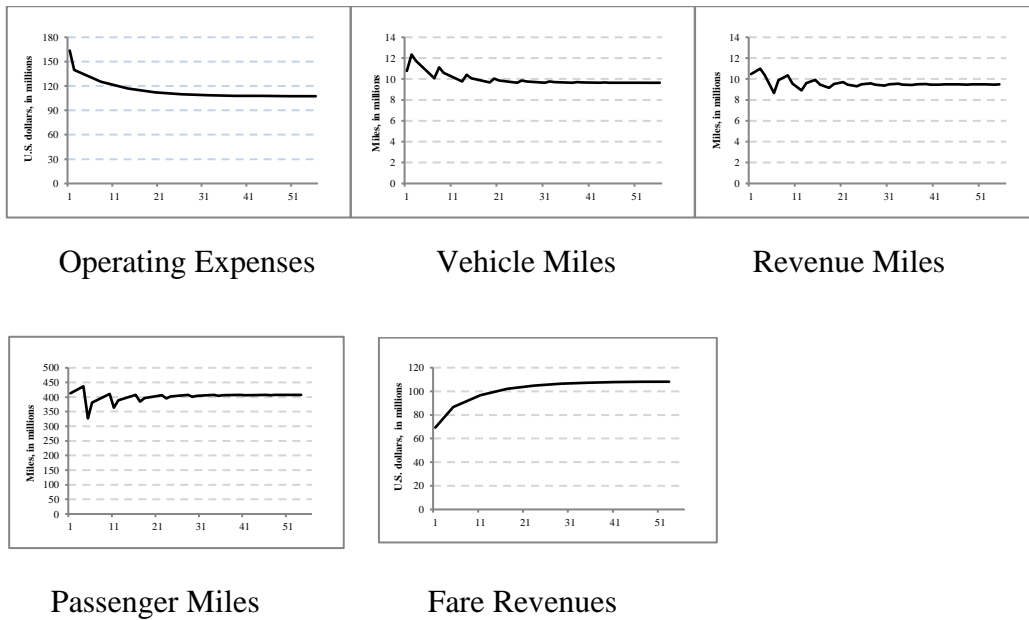


Figure 6: The convergence of the input (Operating Expenses), the three intermediate products (Vehicle Miles, Revenue Miles, and Passenger Miles), and the output (Fare Revenue) using the iterative algorithm. The horizontal axis in each graph is the iteration number of the algorithm. We can see the convergence of each quantity to its final value.

Table 4 shows the actual and final target levels of OP, VM, RM, PM, and FR for SCRRRA Metrolink for revenue year 2010. In addition, it shows the factor ratios of the final target levels of OP, VM, RM, PM, and FR to their respective actual levels, which indicate areas for improvement in the system. The ratios of target to actual values shows that SCCRA Metrolink is generally performing well with respect to the intermediate products, which deal with actual railroad operations, but that they have considerable room for improvement in OP and FR, the two quantities that deal with financial operations.

Table 4. SCRRRA actual values, target values, savings, and factor ratios for revenue year 2010. The system performs reasonably well for VM, RM and PM, which are operational measures, but poorly for OP and FR, which are financial measures.

OP(\$)	Actual	\$163,645,240
	Target	\$107,329,429
	Reduction	\$56,315,811
	OP Ratio	<b>0.656</b>
VM (mi)	Actual	10,790,505
	Target	9,642,747
	Reduction	1,147,758
	VM Ratio	<b>0.894</b>
RM (mi)	Actual	10,478,750
	Target	9,482,580
	Reduction	996,170
	RM Ratio	<b>0.905</b>
PM (mi)	Actual	413,398,867
	Target	407,707,278
	Reduction	5,691,589
	PM Ratio	<b>0.986</b>
FR(\$)	Actual	\$69,343,040
	Target	\$108,266,106
	Increase	\$38,923,066
	FR Ratio	<b>1.561</b>

Due to the unoriented nature of the DEA model, organizational performance of a commuter rail system is presented as two factor performance measures – one is the input factor performance (or OP ratio) and the second is the output factor inverse performance (or FR ratio). Input factor performance is the ratio of the target level of operating expenses (input) to its actual level. Thus, input factor performance scores are less than or equal to 1. Output factor inverse performance is the ratio of the target level of fare revenue (output) to its actual level. Thus, all inverse performance scores are greater than or equal to 1.

Figure 7 shows industry-wide mean OP ratio and mean FR ratio for revenue year 2010. There appears to have been no industry-wide trends in either ratio over the ten-year period, indicating that the OP ratio has remained at approximately 0.7 and that the FR ratio has remained at approximately 1.7.



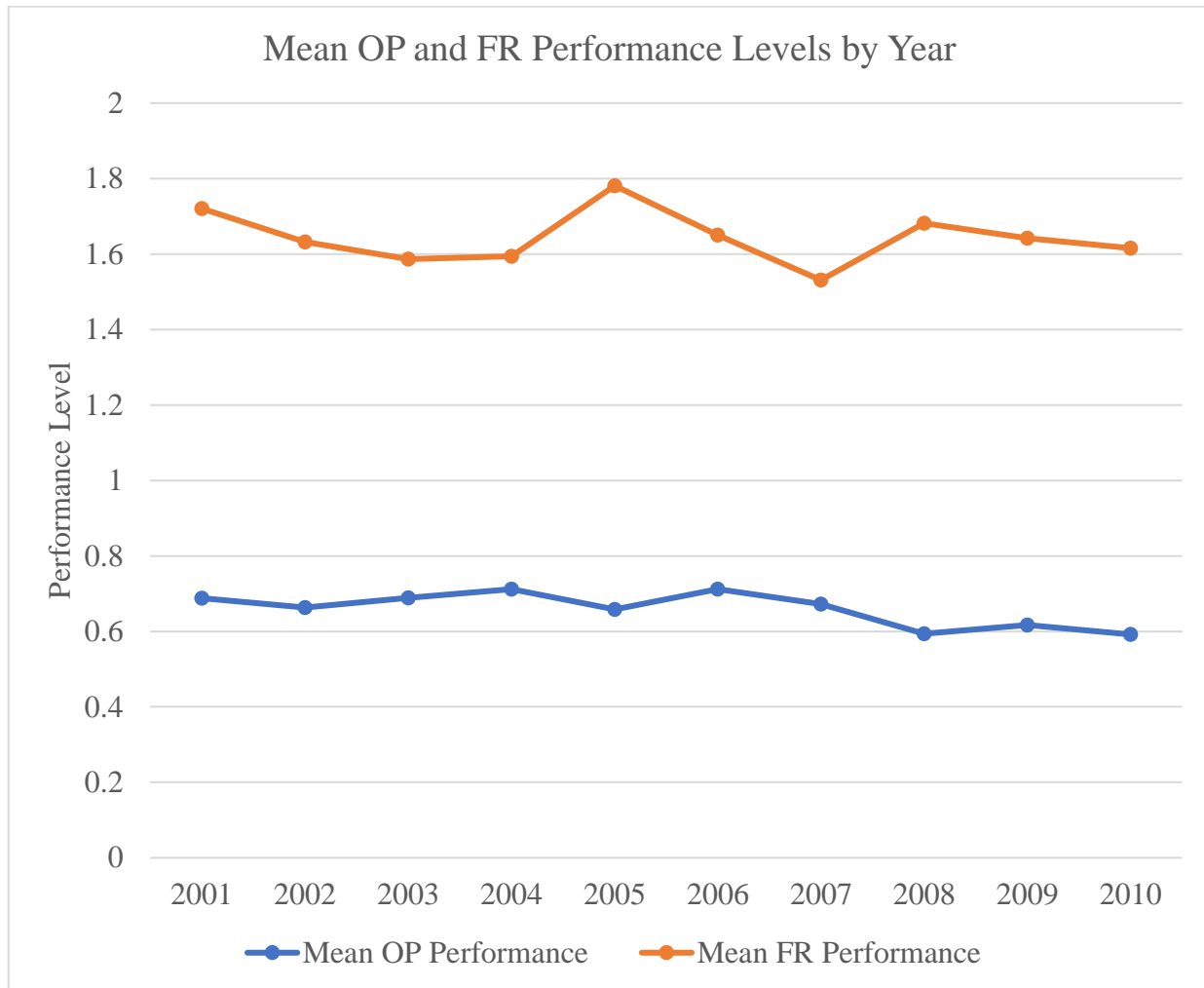


Figure 7: Industry-wide mean OP ratio and mean FR ratio for revenue year 2010.

Note that FR and government subsidies are significant contributors to OP. Therefore, when FR increases, the transit system generally can depend less on government subsidies to support OP. Subsidies tend to change the behavior of producers (to produce more) and consumers (to consume more), but they act to resist the pressure of competitiveness in an organization (Comes 1996 and Becker 1983). Subsidized organizations have reduced incentive to improve their productivity, minimize costs, and maximize revenue. Hence, those organizations tend to become less innovative and less efficient (Comes 1996 and Oum 1994). Therefore, from a public policy

perspective, it is important to investigate the role of public subsidization of operating expenses on the operational performance of U.S. commuter rail systems.

We perform time-series analysis of the panel data of 24 U.S. commuter rail systems for the years 2001-2010 to investigate the relationships between each of the two organizational performance measures – input factor performance and output factor inverse performance and the independent variable – percent subsidization. Percent subsidization is the percentage of operating expenses subsidized by public funds. Figure 8 shows the scatter plots for the two organizational performance measures versus percent subsidization for the years 2001-2010.

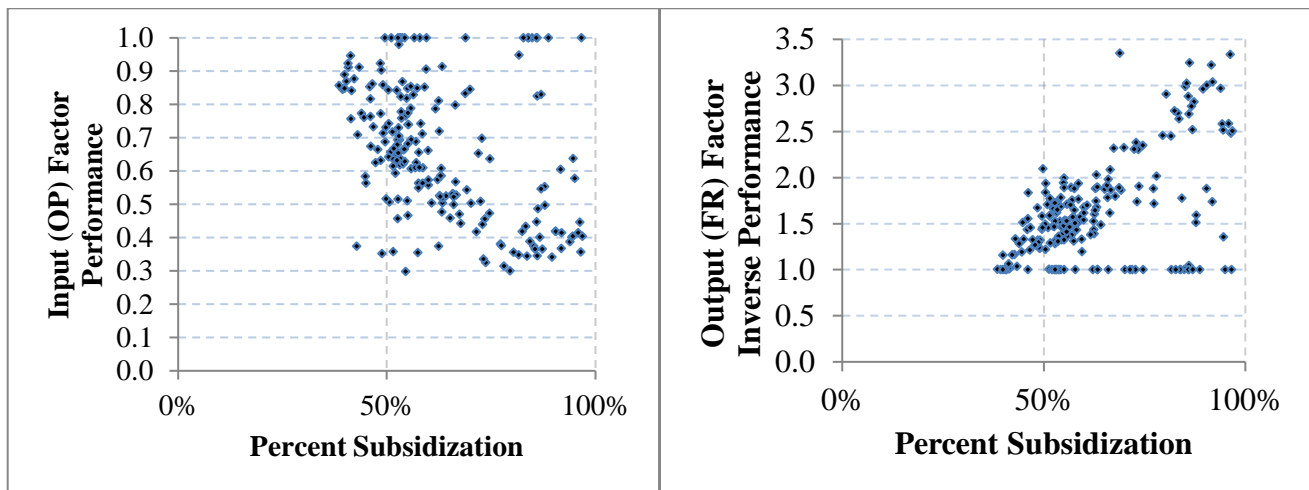


Figure 8. Scatter plots for organizational performance measures vs. percent subsidization. The P-values for the slopes are less than 0.005 using Censored Tobit with bootstrapping and time-series modeling and using generalized least squares with bootstrapping and time-series modeling.

To examine the relationships, we use the Censored Tobit regression technique with bootstrapping and time-series modeling. The Censored Tobit regression technique is widely applied to DEA performance scores (Tobin 1958). McDonald (2009) argues that the ordinary

least squares (OLS) regression approach is appropriate to investigate the relationship between the DEA performance scores and independent variables. To establish robust statistical validity, we use the generalized least squares (GLS) regression approach with bootstrapping and time-series modeling as a secondary approach to examine the relationships (Wooldridge 2010). We note that some commuter rail systems began operations within the study period and therefore provide no data for earlier years. Thus, the panel is unbalanced.

In both regression models, the coefficients of percent subsidization are highly statistically significant. The coefficient is negative in the input performance models and positive in the output inverse performance models. Thus, we conclude that commuter rail systems that are highly subsidized are, on average, less efficient with OP and FR relative to those that are less highly subsidized. These results suggest that commuter rail systems subsidies are associated with higher spending and lower fare revenues.

### *Discussion*

We present a methodology that measures the operational performance of public transit systems and provides sources of inefficiency within each system. The methodology aims to improve the operational performance of public transit systems by reducing operating expenses and increasing fare revenue to depend less on public funds. By specifying appropriate site characteristics, our model can be applied to bus, paratransit, commuter rail, heavy rail, light rail, and other public transit systems. We believe that the results provide useful information to transit managers and policy analysts.

## **Global Greenhouse Emissions**

### ***Background***

Climate change is widely accepted as an existential threat to the planet and its inhabitants.

Storms and flooding have increased in frequency and intensity, wildfires have caused unprecedented destruction and loss of life, and rising sea levels resulting from melting icecaps have started to encroach on coastal areas around the world. These and other effects have been predicted for decades and global leaders have been slow to respond.

While various climate models differ in their precise predictions, we know why this is happening.

We understand the “greenhouse effect” in which certain gases in the atmosphere result in the retention of heat. We know which man-made gases lead to the greenhouse effect: carbon dioxide, methane, nitrous oxide, and the fluorinated gases known as F-gases.

Nonetheless, the nations of the world struggle to achieve the needed reductions in global GHG emissions. Agreements are reached but nations too often, for many reasons, fall short.

It is unlikely that the world can find a global solution that every nation will trust without a clear and rational method for establishing emissions goals for each country. We start with a simple basic assumption: The first step should be the elimination of wasteful emissions, by which we mean emissions that do not enhance our well-being. Put another way, if we can achieve the same social and economic goals with less emissions, then we ought to do so.

Our analysis uses DEA to answer the following questions:

1. To what extent are GHGs being emitted wastefully?
2. How much can each country reduce its emissions of each individual GHG without reducing its GDP or the wellness of its people?

3. If every country eliminated its unnecessary GHG emissions, how much would global emissions decline?

The second step is to allocate additional reductions to all nations in a fair and transparent way.

The simplest method is to ask each nation to reduce emissions by the same percentage. This across-the-board approach makes sense only after all wasteful emissions have been eliminated.

Otherwise, an across-the-board approach penalizes efficient nations that have already worked hard to reduce emissions. By performing the DEA first, we “give credit” to those nations that have already improved their efficiency.

### *The DEA Model*

The DMUs are the set of 170 countries for which recent emissions and other data are available.

There are four SIPs:

- CO<sub>2</sub> emissions
- CH<sub>4</sub> emissions
- N<sub>2</sub>O emissions
- F-Gases emissions

There are two LIPs:

- Gross Domestic Income
- Human Development Index

We identify two site characteristics:

- Population
- Average Annual Temperature

- Human Development Index (HDI)

The HDI was created by the United Nations Development Programme “to emphasize that people and their capabilities should be the ultimate criteria for assessing the development of a country, not economic growth alone.” The HDI assesses the health dimension by life expectancy at birth. The education dimension is measured by mean years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita (GDI). The HDI uses the logarithm of income, to reflect the diminishing importance of income with increasing gross national income. The HDI does not reflect inequalities, poverty, human security, or empowerment.

The goal of our DEA model is to reduce emissions while maintaining GDI and the HDI.

Therefore, we use a SIP orientation. Finally, we assume variable returns to scale (VRS) because it seems unlikely that a given percentage increase in greenhouse gas emissions will lead to an equal or higher percentage increase in GDI and HDI. VRS provides more achievable, and therefore more acceptable, targets. The VRS assumption is supported by a post-DEA statistical analysis of efficient countries.

### ***Data Sources***

We obtain data from the following sources:

- greenhouse gas emissions (millions of tons of CO<sub>2</sub> equivalent, MtCO<sub>2e</sub>) for 2012 from the World Resources Institute CAIT Climate Data Explorer
- HDI for 2017 from the United Nations Development Programme
- GDI (US\$MM) for 2017 from the International Monetary Fund

- Population data from “Total Population - Both Sexes”, World Population Prospects, the 2017 Revision and United Nations Department of Economic and Social Affairs, Population Division, Population Estimates and Projections Section. June 2017.
- Average Annual Temperature (°C, average over 1961-1990) from Lebanese Economy Forum.

### ***Results***

We find that 85 of the 170 countries (50.0%) are on the performance frontier. Table 5 presents a summary of the radial and factor performance scores. The radial performance score of a country represents the level to which the country can reduce each GHG emission. A country with a radial performance score of, say, 0.8, can reduce each of its GHG emissions to at most 80% of its current level, or a reduction of at least 20% in each GHG emission. The factor performance scores represent the level to which a particular GHG emission can be reduced.

*Table 5: Summary of radial and factor performance scores.*

<b>Performance Score</b>	<b>Mean</b>	<b>SD</b>	<b>Minimum</b>	<b>Median</b>	<b>Maximum</b>
Radial Performance	.772	.271	.110	.000	1.000
CO <sub>2</sub> Factor Performance	.725	.323	.066	.988	1.000
CH <sub>4</sub> Factor Performance	.742	.294	.013	.935	1.000
N <sub>2</sub> O Factor Performance	.741	.297	.032	.953	1.000
F-Gas Factor Performance	.761	.281	.110	1.000	1.000

Only ten of the 170 countries are responsible for approximately half of the current total. Table 6 shows the performance scores of these 10 countries. Iran’s radial performance score of 0.537, for example, indicates that it can reduce each GHG emission level to 53.7% of its current value.

However, it can do even more, reducing CO<sub>2</sub> levels to 12.6% and CH<sub>4</sub> levels to 37.7% of their current values. This illustrates the importance of the factor performance levels.

*Table 6: Performance scores of the countries with the 10 highest total GHG emissions. Factor performance scores in bold font are those equal to the radial performance score.*

Country	Radial Performance	Factor Performances			
		CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	F-Gases
Iran	.537	.126	.377	<b>.537</b>	<b>.537</b>
Mexico	.519	<b>.519</b>	.357	<b>.519</b>	.447
Republic of Korea	.505	.499	<b>.505</b>	.415	<b>.505</b>
Venezuela	.314	.173	<b>.314</b>	<b>.314</b>	<b>.314</b>
Ukraine	.276	.107	.250	<b>.276</b>	<b>.276</b>
South Africa	.412	<b>.332</b>	.412	.412	.412
Malaysia	.423	.304	<b>.423</b>	<b>.423</b>	<b>.423</b>
Argentina	.404	<b>.404</b>	.305	.239	<b>.404</b>
Kazakhstan	.341	.111	<b>.341</b>	<b>.341</b>	<b>.341</b>
Poland	.452	.199	<b>.452</b>	.326	<b>.452</b>

Table 7 shows the percentage reductions in each GHG if every country were to lower its emissions levels to the target levels. Elimination of wasteful emissions would reduce global GHG emissions by 14.5%.



*Table 7: The percentage reductions in each GHG if every country were to lower its emissions levels to the target levels.*

	<b>CO<sub>2</sub></b>	<b>CH<sub>4</sub></b>	<b>N<sub>2</sub>O</b>	<b>F-Gases</b>	<b>Overall</b>
Actual	34,732	7,132	3,049	765	<b>45,678</b>
Target	29,907	5,924	2,543	693	<b>39,066</b>
Reduction	4,825	1,208	507	72	<b>6,612</b>
% Reduction	13.9%	16.9%	16.6%	9.5%	<b>14.5%</b>

However, a 14.5% Phase 1 global reduction in GHG emissions is not considered sufficient by climate scientists. Suppose we decide that we need a 25% reduction. We then apply the across-the-board approach. Then every country, primarily China and the U.S., will need to contribute. In that case, the 12 countries shown in Table 8 would account for approximately half of the total reduction for all gases combined.

*Table 8: Phase 1 and 2 emissions reductions required to achieve a 25% total reduction in global GHG emissions.*

<b>Country</b>	<b>Phase 1 Reduction</b>	<b>Phase 2 Reduction</b>	<b>Total Reduction</b>	<b>Percent Reduction</b>	<b>Cumulative Reduction</b>	<b>Cumulative Contribution</b>
China	0	1314.88	1314.88	12.3%	1314.88	11.5%
United States	0	716.60	716.60	12.3%	2031.48	17.8%
Iran	587.24	15.34	602.58	84.6%	2634.06	23.1%
Mexico	393.01	43.80	436.81	58.3%	307.87	26.9%
Korea	332.60	4.46	373.06	56.4%	3443.93	3.2%
India	0	355.30	355.30	12.3%	3799.24	33.3%
Venezuela	317.25	9.78	327.04	82.4%	4126.27	36.1%
South Africa	303.15	19.76	322.92	69.6%	4449.19	39.0%
Ukraine	311.39	6.76	318.15	86.9%	4767.33	41.7%
Malaysia	292.02	17.39	309.42	71.4%	5076.75	44.5%
Russian Fed	0	277.45	277.45	12.3%	5354.20	46.9%
Argentina	258.25	18.06	276.31	68.2%	563.51	49.3%

### ***Discussion***

We need a global effort to find ways to assist every nation in reducing its GHG emissions. This effort needs to be led by a coalition of established international organizations. The atmosphere does not care which country emits greenhouse gas. Therefore, it makes perfect sense for any country to help any other country to reduce its GHG emissions and to receive credit toward its own emissions target.

### **Conclusions**

The measurement of organizational performance is challenging for many reasons. Organizations typically have many performance measures, many with no natural point of comparison. Our tendency is to compare a value to the overall average within an acceptable reference group. But we want to be the best we can be, not simply average. We could compare the organization to the

best performers in the reference group, but we quickly recognize that organizations operate under quite dissimilar conditions. The organization with the best performance measure may be operating under the easiest conditions, reaching a level that would be impossible for another organization. We could compare our current performance levels to our levels from the previous period – the common year-over-year analysis – but conditions change over time and can make these comparisons dubious. The recent pandemic illustrates the dangers of such an approach.

We have shown how DEA, which historically has been applied to measuring organizational efficiency, can be used to measure organizational performance by categorizing our measures into those for which we prefer a smaller value or those for which we prefer a larger value. We have also shown how prevailing conditions can be incorporated directly into the DEA model. Since DEA is a frontier-based method, we can then determine how much an organization needs to improve to reach the performance frontier, aspiring to be the best it can be rather than simply average.

We have demonstrated this approach in five applications, each of which was conducted by the authors, using actual data. We examine nursing homes, hospitals (twice), transit systems, and nations. We believe that our approach is widely applicable to even the most complex organizations and can alter the way we approach the difficult problem of measuring organizational performance.

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# **DSS, Machine Learning, and Artificial Intelligence**



## Severity Prediction Models To Support MBTA Winter Storm Planning

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### Abstract

The Massachusetts Bay Transportation Authority (MBTA) operates the public transportation system in and around Boston. Their ability to plan for the mobilization of personnel, equipment, materials, and contractors during periods of inclement weather affects passenger safety and MBTA operating costs. This project, initiated by the City Innovate STIR Labs, seeks to improve the timeliness and accuracy of winter storm planning activities by providing a more analytical approach than presently exists. Using data from the National Atmospheric Oceanic Administration and the Massachusetts Department of Transportation, models were created to predict the severity and timing of dangerous conditions affecting roads and rails. The models incorporate empirical methodologies like multiple regression and binary logistic regression, as well as theoretical constructs. The models are currently being evaluated by the MBTA within a prototype decision support system.

### 1. Introduction

The Massachusetts Bay Transportation Authority (MBTA) operates the public transportation system in Greater Boston. It is the sixth largest public transportation system in the U.S. and serves over 1 million customers daily. The transportation system operated by the MBTA may be the oldest public transportation system in the U.S. because Boston was the first U.S. city to operate a ferry service (circa 1631) and the nation's first subway tunnel was built in Boston in 1897. The MBTA currently operates about 170 bus routes, 5 subway lines, 13 commuter rail lines, and 3 ferry lines. Its physical infrastructure includes approximately 6000 bus stops, 140 commuter rail stations (spanning 400 miles of track), 148 subway stations (about 75% of them are above ground, spanning 65 miles of track), and about 100 parking lots (with 44,000 spaces). The system also includes about 5 million square feet of property in the form of yards, garages, and other facilities where vehicles are stored and maintained.

Effectiveness of the MBTA's system requires that its physical infrastructure be available for safe operation to protect passengers and employees, and to ensure reliable service. New England winter storms pose a particular challenge. The MBTA has a well-documented snow and ice operations plan to support resource allocation decisions in preparation for upcoming storms. This plan, developed after the unprecedented snow events of Winter 2015-2016, assigns each storm a severity level based on a variety of weather variables and other factors. Individual department managers schedule storm-related resources (i.e., labor, equipment, materials) and snow-removal contractors based on national weather service briefings. These briefings contain information describing the magnitude and timing of weather details using a text format. Managers make decisions that are also informed by their prior experiences in conjunction actions planned by local municipalities.

A project was initiated by the City Innovate STIR Labs (<https://www.cityinnovate.com/stirlabs>), an NSF-funded organization that brings together researchers and public entities. The project's aim was to support the MBTA's quest for continuous improvement by determining if and how storm planning can be executed using a more quantitative and analytical approach. If successful, the system would add more nuance and objectivity. It would improve the accuracy and timing of resource allocation decisions and

potentially lower maintenance costs without a decrease in service quality. The main analytical challenge is finding accurate but accessible ways to translate weather forecast information to relevant conditions of concern to MBTA winter storm planners. Visualizations showing time-trends of adverse conditions, specific to various resource allocations, would be helpful. This project was focused on the bus and subway system in Boston (i.e., commuter rail and ferry services were excluded).

## 2. Background

Public entities that manage a transportation system need to ensure safe and effective operation by preparing for and reacting to adverse weather conditions. Although weather forecasts are readily available, the diversity of weather effects across locations precludes a one-size fits-all approach that translates these forecasts to recommended actions. Highway systems provide an exception because of their unique focus on plowing and treating highways. Pisano et al (2005) describe the winter Maintenance Decision Support System (MDSS) that many highway departments use to plan road plowing and salting activities. The MDSS includes time-based visualizations that show severities (e.g., accumulation of snow) with three line trends that represent effects if: (a) no action is taken, (b) the planned action is taken, and (c) the optimal (MDSS) action is taken.

There is no comprehensive system that has been utilized in public transit systems. Unlike highways where the main task is clearing the roads, municipalities need to deal with a range of conditions that are unique to their locality, with weather patterns that are unlike other locations. And they must pay close attention to the safety of riders. A few examples may be noted. Steen and Morsut (2020) present an approach to flood preparedness in Norway that is informed by an in-depth analysis of a major storm event. And, Lu and Sun (2020) describe the development of a subway system preparedness system in Nanjing (China) using a multi-objective scenario analysis modeling approach.

## 3. Methodology

The work began by interviewing the MBTA managers who were responsible for the allocation of resources that were affected by winter storms. These managers oversaw buses, subways, right of way, and parking. Interviews also included bus drivers and MBTA personnel who provide support to decision makers, as well as contacts at the Massachusetts Department of Transportation (MassDOT), and meteorologists from the National Oceanic and Atmospheric Administration (NOAA).

Unlike systems that forecast general storm severity levels (Sturges et al, 2020), a model needs to be developed for each actionable decision based on severities that will impact the effectiveness of resource deployment. The models need to be applied on an hourly basis (to hourly forecast data), so that the actions are not triggered sooner or later than necessary. Table 1 shows examples of the required tasks before and during winter storms including key resources that are allocated and their purpose.

Tasks	Resources	Description
Clear Transmitters	Labor	Train signal detectors can be disrupted when covered by ice.
Clear Tracks	Snow Train	Snow needs to be cleared from rail tracks to prevent delays.
Treat Platforms	Sand & Salt	Passengers waiting for subways or buses can slip and fall.
Clear Air Intake	Labor	Fluffy snow can clog air intakes on train engines.
Move Long Buses	Buses & Labor	Articulated buses have difficult maneuvering on slippery streets.
Shovel Bus Stops	Labor	Snow at stops cause difficulties for riders entering and exiting a bus.
Plow Parking Lots	Labor	Snow covered lots can cause delays for park & ride commuters.
Cut Branches	Labor & Vehicles	Snow- & ice-covered branches can break especially if windy.

*Table 1: Example MBTA Winter Storm Tasks*

### 3.1 Data Sources

NOAA is the main U.S. entity responsible for forecasting weather and monitoring weather conditions in the U.S. (its weather forecasting arm is known as the National Weather Service). Their National Centers for Environmental Information maintains a comprehensive database of historical weather data (<https://www.ncdc.noaa.gov/cdo-web/>), called Climate data Online (CDO). This site formed the basis for the predictor (i.e., independent) variables used for modeling severities. CDO allows users to specify dates, locations, and specific variables for downloading. Table 2 includes the predictor variables that were downloaded and used for the severity modeling that follows. The response data varied for each prediction model; these data sets are described as applied in the sections below.

Code	Description
ADPT	Daily Average Dew Point Temperature
ADBT	Daily Average Dry Bulb Temperature
RH	Daily Relative Humidity
SLP	Daily Average Sea Level Pressure
SP	Daily Average Station Pressure
AWBT	Daily Average Wet Bulb Temperature
WS	Daily Average Wind Speed
CDD	Daily Cooling Degree Days
TD	Daily Departure From Normal Average Temperature
HDD	Daily Heating Degree Days
XBPT	Daily Maximum Dry Bulb Temperature
NDBT	Daily Minimum Dry Bulb Temperature
XBPT	Daily Maximum Wet Bulb Temperature
NDBT	Daily Minimum Wet Bulb Temperature
PWD	Daily Peak Wind Direction
PWS	Daily Peak Wind Speed
P	Daily Precipitation
DS	Daily Snow Depth
SF	Daily Snowfall
SWD	Daily Sustained Wind Speed
SWS	Daily Sustained Wind Speed
DW	Daily Weather

*Table 2: Data Description*

A concern with the model development was multicollinearity across the set of predictor variables, which will reduce the power of coefficients and decrease the accuracy of p-values that identify the significant predictor variables. For example, many variables concern temperature such as the average, minimum, and maximum dry bulb and wet bulb temperatures each day. Therefore, each model's development began with the creation of a reduced set of input variables, using the uncorrelated variables that were most relevant for the subsequent model development. This procedure was informed by a correlation matrix that provided correlations across the entire set of potential inputs.

### 3.2 Modeling Approaches

NOAA does ongoing research that relates weather conditions to potential problems that affect people, traffic, and other activities. In most cases, their research is focused on meteorological theories and climate effects. NOAA's research usually does not address day to day or hour by hour conditions that affect entities like the MBTA. Therefore, models need to be created that are specific to the Boston region and the conditions that affect MBTA operations. The following modeling approaches were used (they were

implemented using packages in R, Python, and MINITAB): (1) stepwise multiple regression (Kutner et al, 2005, pp. 570-586), (2) binary logistic regression (Kutner et al, 2005, pp. 559-562), (3) published models (cited below as introduced), and (4) existing NOAA models which translate variables to dangerous conditions. The last category includes conditions, such as wind severity and wind chill, that are not addressed here. In the sections that follow, three models are described that predict the severity and timing of: (1) slick roads, (2) surface & branch ice, and (3) snow density & weight. In each case, the model is described along with its means of validation.

#### 4. Slick Road Modeling

Two independently derived response data sets were used to create prediction models for slick (i.e., slippery) roads, which should form the basis for decisions such as when to take articulated buses off the road and when to treat bus and subways platforms. Both data sets were obtained from MassDOT. The first data set consisted of road grip indices collected on a highway within Boston proper. The second data set consisted of City of Boston vehicle crash data. The two alternative data sets provided an opportunity to validate the models by comparing their predictions for common sets of prediction variables. Below, the development of each model is described, followed by their comparison.

##### 4.1 Slick Road Model Based on Road Grip Data

MassDOT collects data on an hourly basis in various locations using a surface friction test. The data are recorded as a unitless “grip” index that typically ranges from about 0.1 (very slick surface) to about 0.8 (very dry surface). Matching the hourly grip indices to daily weather conditions presented a challenge. Because it was rare that roads were slick over an entire day, each day’s minimum grip index was used for the analysis. This approach appeared sound because the NOAA data (Table 2) includes average, minimum, and maximum values for potentially important variables.

A binary logistic regression approach was applied. The grip index data was first studied to determine the “safe” versus “unsafe” road conditions. The bimodal histogram for grip index data during winter months as shown in Figure 1. The response variable “GRIPmin” represents each day’s minimum grip index value. A value of 0.45 was chosen as the threshold to categorize a day as “safe” (0.45 or above) vs. “unsafe” (below 0.45). The resulting data set included 365 winter days starting from December 2016. Of the 365 days, 94 were classified as slick (26%).

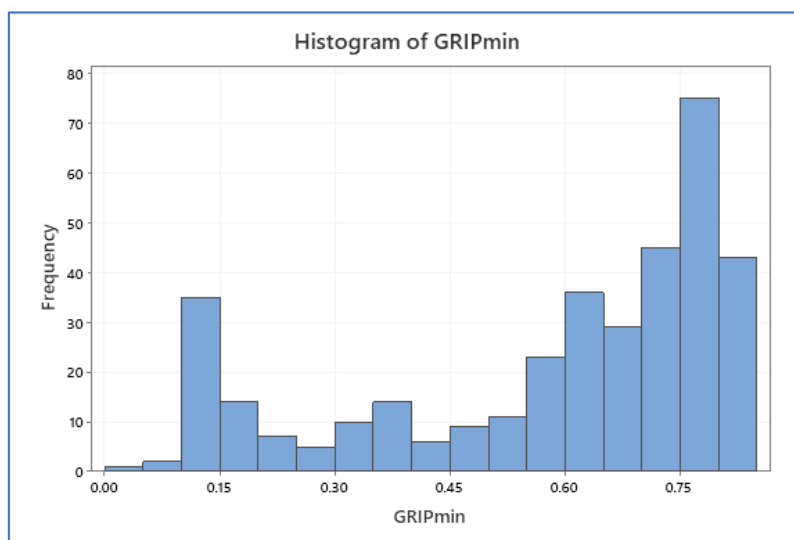


Figure 1: Minimum Daily Grip Indices (2016-2020)

By using MINITAB, the significant variables were minimum dry bulb temperature ( $p < 0.001$ ) and precipitation amount ( $p < 0.001$ ). The prediction equation is shown in Equation 1, where  $P$  is the probability of a slick road surface,  $X_{NDBT}$  is the minimum dry bulb temperature ( $^{\circ}\text{F}$ ) and  $X_P$  is the precipitation (inches). The accuracy of the model was 82.2%.

$$P = \frac{e^{-Y'}}{1+e^{-Y'}}, \text{ where } Y' = 0.307 - 0.0658X_{NDBT} + 2.758X_P \tag{1}$$

#### 4.2 Slick Road Model Based on Car Accident Data

A second model for slick road prediction was based on the MassDOT vehicle crash data for the City of Boston. This data set included the date, time, and location of each crash, along with information about the vehicle and occupants, and the observed road condition. Using data from 2016 through 2021, a total of 2,145 days existed. For each record, the road condition was reclassified as “slick” (i.e., unsafe) if the reported condition was listed as snow, ice, or slush.

Using the statsmodels module in Python, the significant variables were average dry bulb temperature ( $p < 0.001$ ), precipitation amount ( $p < 0.001$ ), and snowfall amount ( $p < 0.001$ ). The binary logistic regression model is shown in Equation 2, where  $P$  is the probability of a slick road surface,  $X_{ADBT}$  is the average dry bulb temperature ( $^{\circ}\text{F}$ ),  $X_P$  is the precipitation (inches), and  $X_{SF}$  is the snowfall (inches). The accuracy of the model was 87.4%.

$$P = \frac{e^{-Y'}}{1+e^{-Y'}}, \text{ where } Y' = -0.774 - 0.031X_{ADBT} + 0.81X_P + 2.95X_{SF} \tag{2}$$

#### 4.3 Model Validation

The two versions of the slick road model were validated by comparing their values for example days. Figure 2 shows a comparison of their predicted slick road probabilities for a 24-hour period on December 18, 2021. The lines are remarkably close given the disparate nature of the response data, the imprecision associated with some of the data (e.g., judgments in describing road conditions at a chaotic accident scene), and the necessary use of variables that only approximate a cause-and-effect (e.g., minimum daily grip predicted by minimum daily temperature).

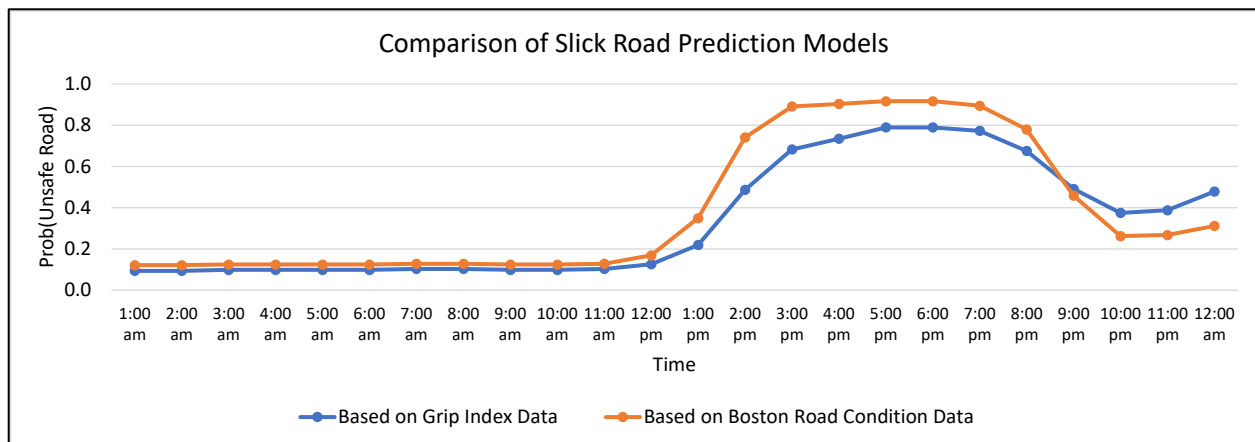


Figure 2: Comparison of Slick Road Models

### 5. Surface & Branch Ice Modeling

Ice accumulation during some winter snowstorms can cause problems for the MBTA, such as signal transmitter malfunctions, fallen tree branches, and downed power lines. The models presented in this

section will be used to predict ice accumulation both on flat surfaces, and on radial surfaces such as branches and power lines. The models were developed by Sanders and Barjenbruch (2016). The model inputs are wet-bulb temperature ( $X_T$ , °C), wind speed ( $X_V$ , knots), and precipitation rate ( $X_P$ , inches per hour). The models are based on a predicted ice liquid ratio (ILR), that is determined by ice formation due to precipitation ( $I_P$ ), wind velocity ( $I_V$ ) and temperature ( $I_T$ ), as shown in Equations 3-6.

$$I_P = 0.1395X_P^{-0.541} \quad [3]$$

$$I_V = 0.0014X_V^2 + 0.0027X_V + 0.7574 \quad [4]$$

$$I_T = -0.0071X_T^3 - 0.1039X_T^2 - 0.3904X_T + 0.5545 \quad [5]$$

$$ILR = \begin{cases} (0.70I_P) + (0.29I_T) + (0.01I_V), & \text{when } T > -0.35 \\ (0.73I_P) + (0.01I_T) + (0.26I_V), & \text{when } T \leq -0.35 \text{ and } V > 12 \\ (0.79I_P) + (0.20I_T) + (0.01I_V), & \text{when } T \leq -0.35 \text{ and } V \leq 12 \end{cases} \quad [6]$$

Because the ILR value is applied on hourly data, the accumulated ice is determined using Equation 7, where  $h$  is the number of hours over which the precipitation occurs,  $P$  is the total precipitation, and  $T_i$  is the ice depth on horizontal platform (inches).

$$T_i = \sum_1^h IRL \times P \quad [7]$$

Gravity effects and the lack of a flat surface cause the ice accumulation to differ from the ice formed on a flat surface. Typically, a small amount of ice will accumulate on the top of the radial surface and an icicle will form below the radial surface. The resulting ice accumulation is estimated by Equation 8, where  $R_{eq}$  is referred to as the elevated radial ice thickness.

$$R_{eq} = 0.394T_i \quad [8]$$

### 5.1 Model Validation

The model validation procedure involved applying the model to a range of conditions expected in Boston and reviewing its results to gauge its usefulness. A  $2^3$  factorial experimental design was created where the three factors affecting the model's prediction with each set at a low and high level, and the model was applied to the eight sets of conditions. Thus, the experimental design was used to observe the response predictions rather than determine the significant factors and interactions.

Table 3 shows the eight experimental combinations. The predicted ice accumulation amounts proven to be reasonable, and the model will be used in the prototype system developed for the MBTA. More validation is planned by using power outage data in Boston, collected in the next winter period.

Factors	Conditions							
	1	2	3	4	5	6	7	8
Temperature (°C)	-6	1	-6	1	-6	1	-6	1
Wind Speed (knots)	5	5	15	15	5	5	15	15
Precipitation (inches/hour)	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05

Table 3: Eight Experimental Combinations



## 6. Snow Density & Weight Modeling

Boston's location near the Atlantic Ocean creates a humid climate that is favorable for snow accumulation, which is a critical storm preparation concern for the MBTA. Although the City of Boston is responsible for plowing and salting streets, the MBTA needs to notify contractors who plow bus stops and park-and-ride lots. Planners may also need to mobilize the MBTA snow trains to clear snow from rails, and they may need to cover air intakes to prevent fluffy snow from clogging train engines.

A snowfall's main physical characteristic is its weight, which is quantified as its snow water ratio (SWR). The SWR is the ratio of the volume of snow and its equivalent volume of water. A SWR of 10 is deemed average, while values below 10 are increasingly wetter (i.e., heavier snow) and values above 10 are increasingly drier (i.e., light and fluffy). The typical SWR ranged from about 5 to about 25 (Barnwell, 2017). Both light and heavy snow are concerning to the MBTA. Fluffy snow can clog a train's engine intake and cause potential damage to train engines. Heavy snow requires more time and resources to plow.

A stepwise multiple regression model was used in R to predict SWR using NOAA data in Boston from 2000-2021. Only days with snowfall were used for the analysis. The procedure started with 20 input variables (Table 2) with a response variable calculated by dividing the day's snowfall amount by the precipitation amount. This ratio, calculated only for days with snow, is imperfect – but it approximates the SWR for that day. The model for SWR is shown in Equation 9, where  $X_{ADBT}$  is the average daily dry bulb temperature.

$$SWR = 19.164 - 0.343X_{ADBT} \quad [9]$$

The SWR quantification itself determines the risk of air intake clogging, where higher values represent higher severities. Snow weight depends on both quantity of snow and its SWR. Equation 10 is the weight (in pounds) for a one square foot cross-section of snow (about one full shovel), where  $X_{SF}$  is the accumulated snowfall amount in inches. For example, one square foot of 4 inches of snow having a SWR of 6 would weigh 3.5 pounds.

$$\text{Weight} = 5.2X_{SF} / SWR \quad [10]$$

### 6.1 Model Validation

The model validation analysis has begun. During the first snow fall of winter 2021-22, snow was collected, and its water content is determined by melting the snow. The results were consistent with the model, and the validation procedure will continue throughout the winter.

## 7. Prototype Implementation

Visualizations (similar to Figure 2) that show severities, by hour, were developed to support the allocation of each resource shown in Table 1. They were included in a prototype decision support system that is being testing during winter 2021-2022. The prototype testing proceeds as follows. For each approaching storm, the researchers download weather forecasts for the upcoming 24-hour period. An Excel file, with one tab per severity condition, is provided to the MBTA team personnel. Each severity condition is shown as a time series trend over the next 24 hours. The MBTA team members use the results to inform upcoming resource allocation decisions while paying close attention to the preliminary nature of the decision support recommendations. The visualizations include preliminary green-yellow-red zones, although the precise determination for these zones will be ongoing during prototype testing.

## 8. Limitations & Future Work

It is surprising that models to predict specific weather-related severities are not well researched. Most meteorologists tend to study climate, rather than localized weather, and their main concern is future weather patterns rather than weather impacts on daily activities. Sets of reliable response data (needed to predict local weather-induced severities) are also in short supply. The dearth of reliable response data necessitated the use of surrogate response variables for many models (e.g., road conditions in the Boston vehicle crash data). However, the intent of the models is to provide guidance to the MBTA rather than perfect predictions and, therefore, approximate predictions can be very useful.

The models will be tested as a prototype system for the winter of 2021-2022. Plans are in place to continue model validation from the theoretical standpoint and from the implementation standpoint. Specifically, the following four action plans exist:

1. Find ways to automate the downloading of weather forecasts over a period of 24 hours into the future.
2. Review the prototype system's severities for each upcoming storm during weekly meetings with the MBTA team. The precise relationship of severities to resource decisions will also be discussed so that the system can make detailed resource allocation recommendations.
3. Update and improve the prediction models for practical use by researching more theory and finding more relevant data sources; consider including margins of uncertainty with severity level predictions.
4. Work with information technology specialists at the MBTA to begin embedding the models into a fully functioning design support system.

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# **Education, Curriculum, and Cases**

## **Culturally Adaptive Thinking in Education (CATE): Strategies for Assuaging Algorithmic Bias and Artificial Intelligence Risk Concerns in Learners.**

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### **Abstract**

Artificial Intelligence (AI) is shaping our society and our lives across cultural and socioeconomic contexts and therefore, it is critical to understand how AI education, which includes the teaching and learning of the science of AI and its interaction with humans - individual and collective, will shape the future. Though a fair amount of research has addressed the role of AI technologies in education, little to no attention has been given to the unique challenges of teaching AI curricula to learners. The present research seeks to address this gap by highlighting the need to better understand how AI topics can be taught to a culturally diverse audience. Context and culture-influenced resistance to AI is amplified by the fact that AI also suffers from various biases such as interaction bias, associations bias and other performance imbalances due to a range of data-driven algorithmic biases. These tend to reinforce cultural biases and lead to hesitancy and resistance towards AI and AI education. To gain a deeper understanding of how AI education can become more inclusive and accommodative of diverse cultural contexts, we develop an original teaching strategy mounted on the principles from the theory of Culturally Responsive Teaching (CRT) theory to develop a Culturally Adaptive Thinking in Education (CATE) Framework. In this paper, we posit that the CATE framework can help address concerns about algorithmic biases and artificial intelligence risk concerns in learners.

## 1. Introduction

*“As new audiences of learners are exposed daily to intelligent learning environments through mobile devices and ubiquitous Internet access, significantly different challenges to the original goal of personalized instruction are presented. In particular, learners have cultural backgrounds and preferences that may not align with most mainstream educational systems.”*

- Mohammed & Watson (2019)

We live in a world increasingly influenced by rapid technological advancements, and a pervasive and growing dependence on artificial intelligence (AI). AI is now a significant part of our daily lives and is becoming prevalent in almost every domain and discipline. This has led to a growth in AI curricula, courses, programs and academic initiatives at all levels of education (Samuel, 2021; Touretzky et al., 2019; Chiu, et al., 2021). The growing and compelling need to expand and improve AI education is clearly evident, as summarized by Samuel (2021): *“Every human will interact with artificial intelligence (AI) in the visible future, directly or indirectly, some for creating products and services, some for research, some for government, some for education, and many for consumption”*. Samuel (2021) also describes the global phenomena of mass ignorance of *“AI technologies and their potential impacts”* and hence the need for formal and

informal education, without which a significant majority of people across the world will be “*unprepared for facing the emerging AI wave*”. However, AI education does not occur in a vacuum, but rather it appears to occur in subjective and contextual settings with varying degrees of acceptance and resistance toward modern technologies and diverse culturally influenced risk-reward perceptions of AI.

**The Framework:** Therefore, it is important not only to acknowledge and act on the need for AI education, but also vital to ensure that AI education is delivered in a way that is contextualized to social, cultural, individual and future workplace factors and needs. To achieve this, we posit that it is critical to:

1. Identify the unique challenges of AI education
2. Acknowledge the need to be culturally and socially sensitive
3. Develop an unambiguous strategy to assuage learner concerns about algorithmic bias and artificial intelligence risks.
4. To integrate thinking-adaptivity into the multiple dimensions of education, starting with the ‘teachers’ and the ‘learners.’

Building upon culturally responsive teaching (CRT; Gay, 2002, 2021), we present our early-stage research articulation for Culturally Adaptive Thinking in Education (CATE) as an integration of the four points listed above to describe a set of strategies for assuaging algorithmic bias and artificial intelligence risks concerns in learners.

**AI Education versus Use of AI for Education:** We note that our research on AI education and AI curricula development are distinct and differ significantly from previous research on the use of AI technologies in education (Chassignol et al., 2018; Tuomi, 2018). It is evident that the use of AI technologies in education would be influenced by developments in AI education, but the two streams are distinct, and each serves its own purpose.

The rest of the presentation of this early-stage research articulation of CATE strategies for assuaging algorithmic bias and artificial intelligence risks concerns in learners is as follows: we discuss the nature of AI, the unique needs and challenges of AI education and curricula development, and the value of CRT in AI education. Next, we elaborate on the CATE framework (Figure 1.), as well as its limitations, and conclude with a discussion of future research and practitioner implications.

## 2. What is AI?

Artificial intelligence has been parsimoniously defined as being “... *a set of technologies that mimic the functions and expressions of human intelligence, specifically cognition and logic*” (Samuel, 2021). Furthermore, given the close association of informatics and big data with current AI implementations, informatics is summarized by Samuel (2021) as being “... *advanced technology-driven big data analytics.*” AI holds tremendous promise for value creation and presents humanity with an opportunity to develop new solutions for previously unsolvable problems and challenges. AI has already led to significant advances in multiple domains and

disciplines such as medicine, healthcare, manufacturing, finance and even music. Ill-advisedly, researchers and practitioners often mystify AI to circumvent the need to explain complex technologies and to create a sense of awe toward the capabilities of AI applications (Campol & Crawford, 2020). However, irrespective of the mathematical, design and technological complexities, AI is ultimately a meta-technology, or simply stated – a cluster of advanced technologies that *‘mimic the functions and expressions of human intelligence’*.

From the perspective of this study the most important aspect is how human intelligence will relate to AI, and this AI-driven fourth industrial revolution comes with immense potential and a very distinct set of risks and challenges: *“The critical difference between past scientific industrial revolutions and the current artificial intelligence (AI) spearheaded transformation is that past revolutions replaced human muscle power, while AI has the potential to replace human intelligence (HI) in many areas.”* (Samuel et al., 2022). Therefore, it is critical for us to study how we can prepare human intelligence for the AI revolution that is beginning to permeate and envelop human society through strategic education and training initiatives (Gleason, 2018).

### 3. Why consider AI Education separately?

AI education poses unique challenges – the world recognizes a need to teach AI courses to learners of all ages, and in interdisciplinary and multidisciplinary frameworks (Touretzky et al., 2019; Chiu, et al., 2021). However, there is an awareness among learners of the many threats posed by AI technologies, which include the loss of jobs, replacement of humans in many activities by artificially intelligent machines, risks of AI failures, cumulative systemic and systematic risks, and the dangers of AI bias amplification, namely *“dataset bias, association bias, automation bias, interaction bias and confirmation bias”* (Lloyd, 2018; Chou et al., 2017). These dangers are evident as an increasing number of cases demonstrate bias amplification in AI technologies such as natural language processing (NLP) applications leading to AI augmented gender and racial bias amplification. This leads to a potentially unique combination of factors in prospective learners, such as resistance to AI, culturally induced biases against AI technologies and a fear of AI amplified biases affecting their lives and cultural sensitivities. In plain language, teachers in AI education may be faced with the daunting task of teaching students who dislike AI, are resistant to trusting AI, and perceive AI curricula as anti-cultural and anti-contextual.

Prospective AI learners and AI students across the world are embedded in diverse socioeconomic and cultural ecosystems with their own psychological and systemic needs and rules. Furthermore, the general notion is that most of the publicized research on AI has been predominantly conducted by the ‘WEIRD’ (White, Educated, Industrialized, Rich and Democratic) nations, and most of that research does sufficiently factor cultural context into account and therefore have *“clear cultural imbalances”* (Mohammed & Watson, 2019; Henrich, Heine & Norenzayan, 2010; Schulz, 2018). It has also been shown that gender-related factors also influence AI usage, and academic and career success (Samuel, et al., 2018). When considered cumulatively, the above factors present a defensible case for addressing the unique challenges of AI education and AI curricula development with new and creative culture and context-specific strategies.

## 4. What is culturally responsive teaching (CRT)?

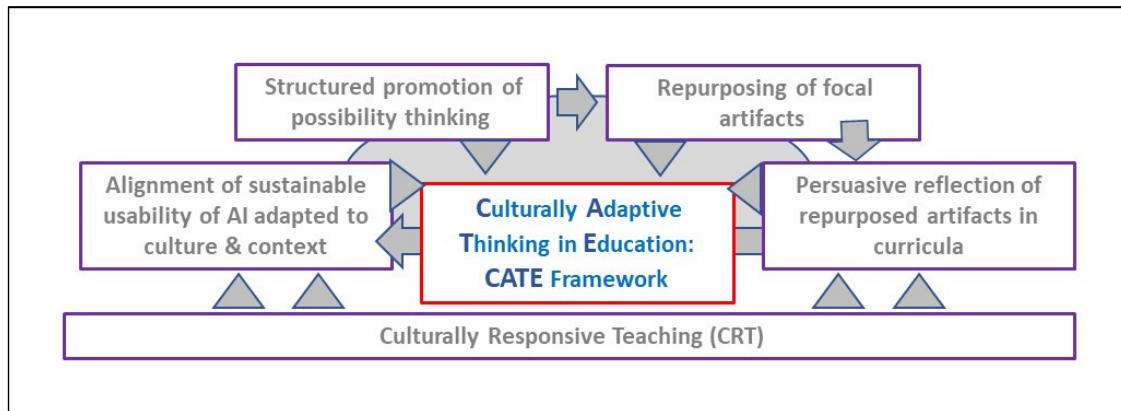
Culture has been broadly defined to be the “*language, beliefs, values, norms, behaviors, and material objects that are passed from one generation to another*” and it is generally considered that “*Every person on the planet is a member of at least one culture.*” (Bal, 2018; Skiba and Ritter, 2011). Though ‘culture’ is a multidimensional and complex construct, extant research has developed robust articulation which includes perceptions of culture which often dictate and explain variance in human behavior under changing circumstances. This view has reinforced the understanding that “*Humans are biologically cultural. There is no part of human life that is unmediated by culture*” (Bal, 2018). Bal (2018) also posits that non-dominant communities are significantly underrepresented in research, strengthening the WEIRD argument. Though technology solutions for cultural and learning styles mapping have been attempted in the past, there is a lack of proven AI applications that can help select learning models contextualized to specific learning environments (Bajaj & Sharma, 2018). Personalized learning has been shown to improve the quality of education (Chassignol, et al., 2018). However, in order to implement personalized learning successfully in a global context, it needs to be culturally responsive.

According to Geneva Gay (1993, 2002, 2013, 2021), one of the early progenitors of CRT, the CRT framework can be defined “*as using the cultural knowledge, prior experiences, frames of reference and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them.*” She emphasizes that CRT “*teaches to and through the strengths of these students*”. Geneva elaborates on the nature of CRT and describes it as facilitating “*the behavioral expressions of knowledge, beliefs, and values, that recognize the importance of racial and cultural diversity in learning*”. CRT is said to have “*many different shapes, forms and effects*” and has been adapted in diverse ways to a variety of educational settings. The general purpose of culturally responsive teaching is to deliver curricular content in a way that is sensitive to the learner's cultural background, cultural proclivities and preferences, and the learner’s associated needs so that the learner feels comfortable with the educational environment and is able to learn effectively. Educators are shaped by their own cultures, and we as teachers bring our culture - values, beliefs and biases -into our classrooms. CRT helps build self-awareness, and awareness of learners’ cultural contexts, leading to improvised teaching which makes students more comfortable with learning processes and improves learning outcomes.

## 5. Introduction to CATE

We build upon the culturally responsive teaching approach (CRT; Gay, 2002, 2021), to articulate the framework for ‘Culturally Adaptive Thinking in Education’ (CATE) which reflects a set of strategies for assuaging algorithmic bias and artificial intelligence risks concerns in learners. The need to create a new framework arose from experiential and observed motivations, the prominent of which have been summarized in the ‘Why consider AI Education separately’ section above. Additional drivers included the learner-centric approach promoted by CRT, which catalyzes social and cultural sensitivity in AI education and supports AI curricula to address learner-specific concerns about algorithmic bias and learner-relevant perspectives on artificial intelligence risks and the future of AI driven jobs, economy and way of life. These drivers and motivators led to the currently posited early-stage research-based articulation of the CATE

framework. We identified the unique challenges of AI education, acknowledged the need to be culturally and socially sensitive, and argued for the development of clear strategies to assuage learner concerns AI in the section above. In the next section, we focus on the main ‘kernel’ of CATE: the integration of thinking-adaptivity into the multiple dimensions of AI education.



**Figure 1:** Culturally Adaptive Thinking in Education (CATE) Framework

We define culture and context-specific thinking-adaptivity in education as the promotion of possibility thinking, the repurposing of the focal artifacts, the reflection of repurposed artifacts in the curricula, and the alignment of sustainable usability of AI adapted to the culture and context of the learner. Such adaptivity of thinking starts with those responsible for curricula development as well as the teachers and extends paradigmatically to adaptive thinking in individual learners, and collective groups of learners with shared cultures and contexts. We elaborate on these CATE kernel concepts in greater detail below:

- ***Alignment of sustainable usability of AI adapted to culture and context:***

It is necessary for learners to gain a long-term usability perspective of AI, AI technologies and AI applications, adapted to their own cultural needs and contextual determinants. These consist of not only the technological control and customization dimensions, but also of governance and policy development to both foster value creation and to protect the rights and privileges of individual users

- ***Structured promotion of possibility thinking:***

This refers to a formal activation of creative thinking by requirement of evidence of out-of-the-box thinking in educators and learners engaged in AI education. This, along with the points listed and the other motivators and drivers of CATE, will instill a measure of confidence in educators that they are creating value, and in learners that they will have the power to increase their control over AI applications and effect customizations to match their comfort levels.

- ***Repurposing of focal artifacts:***  
This is a critical component of CATE, addressing the need for progressively adaptive thought processes in educators and learners. “Focal artifacts” refers to the real-world expressions of the science and other subjects of education. For example, when teaching AI, a specific course may cover robots and robotics applications. In such a scenario, applying CATE would motivate creative thinking and repurposing of artificially intelligent robotics applications to be aligned with the culture, beliefs and value systems of the learners. The essence here is to step up from creative thinking into deliberate repurposing of artifacts which may have original intent which is not aligned with the culture, values and belief systems of the learner.
- ***Persuasive Reflection of repurposed artifacts in curricula:***  
The repurposing of focal artifacts will not instill the desired levels of confidence and self-efficacy in learners unless educators are able to emphasize their belief and commitment to such repurposing by institutionalization and formal representations of the processes and output of culture and context-specific ethical repurposing of focal artifacts.

## 5. Limitations & Discussion

CATE cannot be applied to all academic disciplines – for example, the CATE framework would not be suitable for teaching history because the subject matter may not be ethically suitable for repurposing and adaptation. However, the CATE framework could be used for policy education which may factor history as context. Similarly, it would be difficult to use the CATE framework for teaching biology, but the framework could be used for medicine and healthcare which can involve culture and context-specific development of medicines and healthcare protocols. We anticipate identifying additional limitations as we proceed with developing the framework and studying relevant cases.

## 6. Future Research & Practitioner Implications

AI and Informatics applications have been employed effectively across a broad range of research domains and practitioner interests. Applied AI technologies such as machine learning have been used for studying the development of educational technologies, trading behavior insights, healthcare policy, market trends, pandemic insights, social media analytics and there has also been an increasing interest in the conceptual aspects of AI such as selfishness in AI, and AI philosophy (Chassignol, et al., 2018; Samuel, 2017; Ali, et al, 2021; Samuel, et al., 2020 a, b; Rahman et al., 2021; Samuel, et al., 2021 a, b). The need for domain-specific AI education is thus evident across domains and disciplines and hence the need for the CATE model is evident, especially in the context of global and multiracial multicultural education. We plan to extend this stream of theoretical development on CATE into robust empirically validated models and educational strategies. We have also collected social media data containing comments and posts on AI, which will be analyzed for topic association. Future research can empirically validate the CATE framework and its extensions. Practitioners can adopt the CATE framework (Figure 1) in part or in whole to move closer to effective AI education. Without CATE, there is a risk of



learners feeling subjugated by AI technologies and applications while effective use of CATE will lead to *learners adopting a critically important AI ownership and AI-driven solutions mindset.*

## 7. Conclusion

There has been an increasing emphasis on AI education, which has expanded far beyond the traditional boundaries of computer science education. AI education “*also means rethinking the content and methods used to deliver instruction at all levels of education.*” and a compelling need to “*define ‘AI competencies’ beyond basic ICT competencies*” (Pedro, Subosa, Rivas and Valverde, 2019). In their recent call for papers, Samuel et al. (2022) invite AI education and governance manuscripts positing that “*AI education is a critical component of preparing HI (human intelligence), and we welcome studies that address this preparatory aspect of AI-HI interaction using formal and informal pedagogical formats. We are interested in topics that address compelling issues of human behavior in the context of AI.*” The increasing global interest in AI education and worldwide efforts to increase AI education into all levels of learning from K-12 to graduate programs in higher education attest to the need for an improved understanding of the dynamics of effective learner-centric AI education strategies. We hope that relevant researchers, academics, educators and practitioners will increasingly adopt strategies from culturally responsive teaching and Culturally Adaptive Thinking in Education (CATE) frameworks to attract learners to AI education and to assuage fears and AI risks concerns in learners.

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## **Disruptive Technologies to Build an Integrative Entrepreneurial Experience in a Post Pandemic World**

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### **Abstract**

The impact of the ongoing pandemic on our institution, as with many other higher education institutions, resulted in a transition from primarily classroom-based modality to hybrid and/or hyflex course modalities. The transition proved challenging for both students and instructors. In this paper we discuss deployment and assessment of technology-supported experiential education (EE) activities during the Fall 2021 semester wherein a hybrid and/or hyflex modality was implemented as the standard course modality. The EE activities included use of a documentary film supplemented by a live Q & A with the producers, use of a business simulation leveraged across multiple sections of an introductory level course, and over one hundred students engaging with peer-created webpages to generate proof of concept (POC) through preorder email tokens. The adaption of these disruptive technology-based modalities also required new assessment protocols to evaluate student learning. Utilizing the discussion board feature of our institution's learning management system (LMS) to evaluate reflective assessment, and peer and self-assessment methods is discussed. Finally, we discuss possible future use of new and disruptive technologies for EE activities.

**Keywords:** Assessment, Entrepreneurship Education, Experiential Education, Hyflex, Hybrid

## **Introduction**

The lockdown of academia during the Covid-19 pandemic required educators to change modality and instructional approach, and as such assessment became more critical to ensure learning outcomes were met. The drastic change from classroom-based to a hybrid and/or hyflex modality was rapid and proved to be challenging. Online learning can be challenging for both students and instructors with training needed to enhance course engagement. The sudden evolution of course modality brought about many questions for both the educators and students. Educators needed to find ways to keep the students motivated, inspired, and engaged. Further, educators needed to ensure learning outcomes could be met.

This paper will explore how faculty at a small liberal arts college, with a robust entrepreneurship program, approached deployment and assessment of experiential education (EE) activities during the Fall 2021 semester wherein a hyflex and hybrid were implemented as standard course modalities. We discuss our teaching practices and digital tools, including a documentary film used as a business case study, the use of social media networks, business simulations applied competitively across course sections, and digital Proof of Concept (POC) leveraged collaboratively across courses, and our ongoing assessment of these experiential activities.

## **Experiential Entrepreneurship Teaching Modalities and Assessment**

The current generation of students are digital natives and consider being digital integral to their life interactions (Blaj-Ward & Winter, 2019; Kennedy et al 2008). Their digital lives have shaped their requirements for the design and deployment of the educational process and were impetus for development of the hybrid and hyflex modalities (Beatty, 2013; Senner, 2010).

Adoption of these modalities accelerated due to the demands of educating students during the

Covid-19 lockdowns and necessitated extensive use of online tools, such as Learning Management Systems (LMS) and virtual tools, such as video conferencing platforms.

Traditional class-lecture based approaches are not sufficient for teaching and learning entrepreneurship. (Bell, 2008; Neck et al, 2014; Vincent & Farlow, 2008) The need to augment didactic teaching methods with activities that seek to replicate real-world experiences is well-acknowledged as best-practices within entrepreneurship pedagogy (Bell, 2008; Lv et al, 2021; Neck et al, 2014; Vincent & Farlow, 2008). Entrepreneurship educators utilize interactive methods such as hackathons or business-idea pitches and project-based learning opportunities such as developing/testing minimal viable products (MVP) or creating Go-To-Market plans.

The implication of technology-driven experiential education on students’ entrepreneurial intentions and attitudes can be significant and require assessment (Bandera et al, 2018; Jena, 2020). Lackeus and Williams (2018), identified performance assessment, reflective assessment, peer and self-assessment, e-assessment, and constructive alignment as the five methods for assessment of experiential entrepreneurship education. The authors defined these five methods as follows:

Assessment Method	Abridged Definition
Performance assessment	Accomplishments of real-life tasks
Reflective assessment	Reflections upon own learning experience
Peer and self-assessment	Student-driven assessment of self and others
E-assessment	Computer-assisted assessment
Constructive alignment	Assessment aligned with critical learning activities

The hybrid or hyflex course modality allows for a more nuanced and developed approach to combine the reflective assessment method, and the peer and self-assessment method than the traditional classroom-based modality. One example is by creating opportunities for dynamic verbal class-based interaction (hybrid) or virtual interaction via video conference(hyflex) to be directly augmented by asynchronous online-LMS discussion boards. Discussions can start as class-based or virtual interactions and move online or start as online LMS-based and move to live or virtual. In our courses this helped to extend discussions about particularly complex issues and encouraged students to increase their analysis and engagement.

### **Research Driven Simulation-Based Learning**

The students pivoted to hyflex or hybrid course modalities and were required to take more accountability in the flipped classroom setting as well as navigating the course and proactively interacting with the course materials. Providing the students with more engaging technology-driven content was the solution for achieving the course learning outcomes. Further, the switch in modality, provided students with more interactive work and afforded them additional opportunity to work in their digital native environment. Adaption to Hyflex, supported by use of video conferencing, provided students with a variety of opportunities for participation including use of virtual break-out rooms and chatbox features.

No longer able to host live invited speakers, our courses switched to virtual guest lecturers. Students were prepped to research the guest speaker and to develop questions for a live Q and A session that would focus on uncovering the guest speakers' entrepreneurial journey and mindset. The entrepreneurial mindset is explained to the students as, "an awareness and focus on identifying an opportunity through solving a problem, and a willingness to move forward to

advance that idea.” (Rice University, 2021). Once the students are exposed to this style of pedagogy, they are ready to complete a self-directed learning simulation which has been successful for engagement and absorption. Throughout the simulation, students function as entrepreneurs and become immersed in the entrepreneurial journey and absorb the experience. The simulation is interactive with multiple options via image selection to increase creative and critical thinking. The efficacy of using the simulation is supported by Tellegen (1981), who states, “Persons who score high on absorption are described as those who are emotionally responsive to engaging sights and sounds, are readily captured by entrancing stimuli, and think in images.”.

The simulation allows students to conduct their own primary and secondary research and establish an entrepreneurial perspective. In this sequential assignment, students are all owners of a food truck in a live simulation derived from Harvard Business Publishing, (2016). The simulation (Harvard Business Publishing, “New Venture Simulation: The Food Truck Challenge.”), is set up as a competition among students across multiple section of the course, each student has the opportunity to review market research to decide on the best location and achieve maximum profits. (Harvard Business School Publishing, 2021). The students’ scores are visible to all students which creates competition and serves to increase student engagement. As part of a multi-step assignment, students use the LMS discussion board to post reflections on their learning experience with the simulation and provide peer feedback.

### **Transdisciplinary Use of Documentary Film**

Film is a proven multimedia medium to build empathy. It is being used in education across various disciplines – from medical to marketing to business education- to understand different perspectives and visualize impact (Vezzali et al, 2014, Ahmadzadeh et al, 2019). Documentaries

offered on streaming media platforms, such as Netflix and Hulu, provide students insights on the makings (and failings) of businesses. Examples are “[WeWork: Or the Making and Breaking of a \\$47 Billion Unicorn \(2021\)](#)” and “[FYRE \(2019\)](#)”. Most documentaries center on high profile, venture-backed companies, which had rapid growth, or an epic failure. Their lessons are not always applicable to small and mid-sized companies, which are the biggest job creators of our global economy. The Entrepreneurship program collaborated with the college’s Communications Arts department to use the faculty-produced documentary “[If You Succeed](#)” as a small business case study. The documentary follows the steps of two restaurant owners in New York City who plan to open a second location while keeping their first restaurant running. At the beginning of the semester, the film, which is available on Vimeo, was viewed by students and followed by a question-and-answer session with the filmmakers. Throughout the semester the classes used the film-based case study to discuss different facets of launching and managing a business including the decisions entrepreneurs make about financing, operations management, marketing, and product/service development. We use self-reflection and peer reflections in the onsite and online classroom. Students discuss the documentary in class and via online discussion boards. They identify hurdles that the entrepreneurs were facing and reflect upon alternative approaches and solutions. Discussing topics include selecting a location, developing a clear value proposition, and understanding the target market. In the marketing classes students also reflect individually on the role of marketing.

### **Digital POC**

The 2000-level marketing and innovation course asks students to imagine the classroom as an incubator and themselves as founders working to transform their business idea into a prelaunch startup. Traditionally the course ended with a pitch-a-thon event that served as a tool to establish



proof of concept (POC). Students pitched their products to potential ‘customers’ (students from other classes) and these ‘customers’ were each given two tokens to ‘preorder’ from, in their opinion, the two best concepts. The number of preorders tokens received by each student ‘founder’ was used to evaluate POC.

The POC project needed to transition to a digital project due to the change to hyflex modality. Students were now tasked with creating a POC webpage by using free tools including an ecommerce widget that allows preordering (email address as currency). Once the webpages were finalized, students posted a reflection of their learning experience and a link to their webpage on an online LMS discussion board. Students were required to provide feedback to at least three of their fellow classmates and to ‘preorder’ from one. Additionally, four other entrepreneurship classes (total of 117 students) were given an assignment requiring each student to provide feedback on three POC webpages of their choice (out of a total of 24 webpages) and to ‘preorder’ from one. As with the traditional place-based pitch-a-thon, the number of preorders were used to evaluate POC.

### **Future Considerations**

A multimedia case study based on the "If You Succeed" documentary is in development as a transdisciplinary collaboration and is a next step to expand the use of technology and digital tools within our program. The digital case study will include interviews with the producers, and if possible, interviews with the entrepreneurs featured in the documentary. Inclusion of the producers’ and entrepreneurs’ updated perspectives can serve to deepen the reflective assessment, and peer and self-assessment method in our entrepreneurship courses. The long-term vision is to create a series of digital case studies focused on the types of businesses that our student population finds most engaging. Most of our institution’s student entrepreneurs either

have or want to start a small business, including food and drink businesses as well as online jewelry and fashion stores. The case studies will not only provide academic learning material but deliver real-life examples that our students may use as instructive best practices.

The next frontier for using digital tools for entrepreneurial education in a post-pandemic world is the metaverse. Companies across industries started exploring the metaverse to market and sell products and services – going beyond gaming and buying real estate. We could extend simulations like running a food truck to the metaverse. Based on reflection feedback, students enjoy the gamification aspect of the current food truck simulation. Creating a food truck game for the metaverse could enhance their entrepreneurial experience and expand their entrepreneurial mindset and decision-making. It would, however, require a software and hardware investment, which may not be possible for our small institution.

Finally, we plan to gamify more assignments by adding competitive elements and, thereby, mimic the competitive environments that entrepreneurs are in. Looking into the future, as digital tools continue to evolve, we will have more opportunities to create an integrative entrepreneurial experience that replicates and prepares for our rapidly changing business environment.

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## **Identifying the core antecedents to positive online learning**

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### **Introduction**

The online teaching environment thrust onto society due to Covid has created a number of significant issues for education. Most teachers had no prior training in the technology required for remote teaching, and often found that techniques used in the classroom did not translate to a remote teaching environment. Managers in business share the same challenges, with loss of productivity and an uncertainty on how to coordinate and communicate activities (Galanti et al., 2021). This paper will apply theories of end user computing and IT innovation to the educational environment to better understand dilemmas teachers face in the challenge of online primary school education. In the educational environment, teachers were uncertain as to how to split children into groups effectively and have them work collaboratively and successfully. It also raised questions regarding how teachers could facilitate the same level of interactivity they were used to in the classroom. Teachers were beset with these problems all at once, often with no background in online teaching or the technology involved. Furthermore, students also lacked the technological competency to navigate remote learning, and so many students—particularly younger students—had to rely on significant guidance from their parents, many of whom either did not have the time or the competency themselves to provide help and support in the way the students needed. In this paper, we will be exploring various antecedents to successful outcomes and experience in online education. The challenges online learning presented is explored, with a goal of identifying opportunities to improve the experience for students and educators alike.

### **Literature Review**

### *Stress*

The impact of stress on teachers has been shown to impact student's performance. In prior studies, social-emotional competence—a set of teaching skills and processes including emotions—has been shown to affect key interactions between students (Oberle et al., 2020). Stephanou (2011) demonstrated the lower performance of students based on their emotions. Stephen et al. (2019) examined 182 students and found that online students in an online education course reported significant higher levels of anxiety and boredom. These emotional issues compound the difficulties faced by teachers during a pandemic, and thus teachers must explore ways to not only improve their social emotional competence, but find ways to make the experience more enjoyable for students as well. Teachers are well aware of how their emotions impact the learning of their environment in their classrooms, but do not always have the same awareness of how the emotional anxiety they might feel around remote teaching might be translating to a more anxious environment for their students as well (Naylor and Nyanjom, 2021). If the root cause of teachers' competency around remote teaching is addressed, teachers and students will both benefit.

### *Socialization*

Moreover, there is significant stress impacting the way parents are perceiving remote learning (Midcalf and Boatwright, 2020). Bereft of their ordinary classroom environment, children take social cues from their parents, who might feel overwhelmed by a new medium, or hostile to their children not learning in the physical spaces they are used to. Classical IS literature for over four decades has shown that the impersonal nature of electronic communication, specifically email, reduces social cues, which are a predictor of substantial deregulating effects in communication (Sproull and Kiesler, 1986). With parents having to juggle difficult schedules, childcare, quarantine protocols and the like, younger children who require parental support are perhaps especially impacted as a result. We posit that the optimal learning environment requires

a review of the competency and efficacy at three levels: the teachers, foremost, the students, and finally the parents as well. With the requisite training, teachers, students, and parents can work together, instead of at cross purposes.

### *Student Technology Skills*

Although remote teaching was a novel experience for most students and teachers, online teaching itself can be seen as a moderating factor that can amplify or depress educational outcomes, depending upon foundational skills the students possess or lack to varying degrees, such as executive functioning skills, independence, and self-motivated learning. Students who struggled with executive functioning skills, such as task initiation, had their academic performance decrease with remote learning. While in an ordinary classroom teachers would provide these children with the support and prompts they require, isolated at home these children were left to struggle alone without the support they needed (Lemberger et al., 2015). Optimally, therefore, online learning needs to adapt to the needs of the child, not only in an educational sense, but in a developmental sense. Otherwise, the moderating effect of adding a technological element to the student's education will continue to amplify their preexisting problems.

### *Self-Efficacy*

Online learning does not affect students in a universally negative way, however. While students who struggled with executive functioning skills like task initiation found their struggles amplified, students who struggled in school due to their struggles with organizational skills improved during remote learning on account of the way their work was organized on online platforms for them (El Mansour and Mupinga, 2007). Understanding and analyzing these dynamics will help teachers assess which students will require certain methods of support during online learning, and which students are likely to thrive. The example cited above, of the

way work is organized online, was incidental, and not at all intentional. If online learning can be intentionally organized with the developmental needs of the student in mind, technology can be a powerful tool to aid in educational outcomes. In the end, both teachers and students stand to benefit from an educational medium that is likely here to stay.

### *Focused learning online environment*

Challenges with remote learning, however, didn't only amplify pre-existing educational struggles, but also created unique obstacles all their own. Computer-related distractions proved to be a significant obstacle in remote learning. In an ordinary classroom environment, students will often distract themselves, either with the help of other students, or sometimes on their own, with a pencil or toy or the like. Ordinarily, however, teachers are usually able to observe the entire environment, and have an easier time intervening before the student loses focus completely (Erickson et al, 1980). In an online environment, teachers lack the ability to monitor the students in a similar manner, and are therefore handicapped from supporting and guiding their students in the ways they usually can. Previous studies have shown the importance of turning on cameras in the onboarding of professionals in a technology department as having a positive impact in building collaboration among team members (Rodeghero et al., 2021). With students frequently disabling their own cameras, it became clear that many students were engaging in social media activities and playing games, instead of focusing on their instruction. Even if cameras are kept on, however, there is no way for teachers to regulate the way students are using their screens at home, nor is there any way for teachers to monitor whether students are distracting themselves with other possible, unseen screens. By prompting the students to engage with the teacher, attention was retained, but even otherwise high-achieving students had difficulty maintaining their previous levels of achievement during remote learning. Even if students are sincerely attempting to focus on the lesson at hand, remote learning does not place students in the social environment of a classroom with their teachers and peers. Students



are isolated in their own spaces, unable to make eye contact with others, and unable to engage with their teachers except through a screen. The business literature is rich with examples of issues related to video conferencing and a more recent phenomenon called "Zoom Fatigue" (Nesher and Whert, 2021). Nesher and Whert (2021) provide recommendations to help feelings of isolation and propose strategies and how exhaustion and boredom play a role in productivity, which are part of the "Zoom Fatigue" phenomenon. Using these recommendations, strategies could be created to help make online classes more immersive, with more social cues and more social interaction, and this would benefit both the high-achieving students who miss the immersion of their classrooms, as well as students who struggle to retain focus even under the best of circumstances.

#### *Distance - Supervision*

Finally, another issue in remote learning centers on teacher supervision of classwork and homework. Oftentimes, students would hand in assignments that would significantly differ from the instructions provided in the assignments themselves. This is largely due to the lack of direct teacher supervision, support, and guidance that a student would otherwise receive in the classroom. When students would be alerted by their teachers that assignments were not being completed according to the teacher's expectations, many students would not respond as readily to this correction as they would in a classroom setting. While in an ordinary classroom a student might hand in their work at the teacher's desk, only for it to be immediately reviewed with the student standing or sitting nearby, in an online teaching environment children might hand in work, and then work under the assumption that their work was now "done", and they might leave the computer and eat a snack or play outside, with no immediate feedback from the teacher at all. Such problems might be addressed by increased interactivity and an increased social element (such as chat features), but by and large, these compounding factors led to a

deterioration in most students' academic performances, and overwhelming stress and even burnout from teachers.

### *IT Competency*

Perhaps the single most important factor in improving the online experience lies in the core competency of stakeholders with the medium. Teachers are expected to attend graduate school to learn how to become teachers, but very few receive training in the technology involved with online learning, and fewer still are trained in navigating the educational issues that arise in a remote learning environment. For example, teachers might be accustomed to giving an assignment in class, with instructions, with the understanding that many children will need support reviewing those instructions, and will likewise require supervision while they undertake the work of that assignment. While attempting to give the same assignment in a remote learning environment, teachers must keep in mind the core competency issues that students also face at home, and break up one single assignment into many smaller constituent steps. Instead of having the assignment due by the end of the school day, as it might be in an in-person environment, teachers can help retain the attention and engagement of their students by having several deadlines for those smaller constituent steps over the course of the day. This keeps students from mistakenly thinking that they can push their work until the end of the day, then rush through it, submit it at the moment it's due, then expect the same grades they may have gotten in an ordinary classroom environment.

The more communication a teacher has with his or her students, the better the students' performance and behavior. Therefore, the more a teacher can replicate the constant communication with the student that they might ordinarily receive over the course of a school day, the more it will engage a student, and keep them from becoming distracted and logging off. One strategy that might be implemented in this regard would be "check-in times" over the

course of the day. Students would be expected to log on to check-in sessions at pre-scheduled times, and during those sessions the number of students would be limited as far as possible in order to mimic the kind of focused attention they might receive from their teachers if they were in an in-person environment. Ultimately, however, such an engagement is demanding for teachers, particularly if they lack technological training. Teachers must be given the training they need in order to develop the core competency necessary for fast-paced multitasking that this kind of engaged remote learning demands.

## **Methodology**

A small private school in the New York Metropolitan area served as a pilot school for a program at a nearby university in which students from the local university go to local schools to teach technology education such as Python, Excel, SQL and Scratch. The program was funded by a large financial firm for the purposes of enhancing K-12 STEM education. The program had discussed plans to move to a hybrid online learning environment with synchronous and asynchronous learning modules. However, this portion of the program was only at the conceptual stage when the pandemic and subsequent closures hit. Using the technology and preliminary planning from this project the school was able to quickly move to an online format in response to the pandemic.

The program director and the school director, luckily, held a meeting three days prior to the announced closures to plan for such an event, which seemed an inevitability. With no budget, no direction and no guidance, a plan was devised to utilize free software for video conferencing, learning management and communication. The program director would conduct training with the help from university students for the teachers and administrators in some of the

technologies and provide ongoing support through the crisis which would last three months to the end of school.

Using the information available, a survey was quickly constructed in order to collect needed data from the very beginning of the closure while the technology plan was being implemented. Unfortunately, teachers were not consulted, as decisions needed to be made quickly. The survey compiled consisted of a limited number of survey questions for teachers and parents. Parents and teachers were given a questionnaire with one open ended question at the beginning of the lockdown and prior to the first online class.

## **Results**

A review of the open ended qualitative responses from teachers and parents showed a significant amount of emotional frustration and physical challenges. The teachers thrust into a herculean effort with no training, understandably, had a significant amount of fear. A key difference between the teachers was their comfort level with technology. However, even though it appears that some teachers may have been more comfortable, overall their concern over the performance of the children was almost unanimous. Teachers at the beginning of the crisis stated their concern clearly:

*'Just as e-mail cannot pick up emotion and inflection, on-line teaching is cold. There are extraneous computer issues to put up with, less control over kids movement and focus, etc. When necessary, on-line teaching is a life saver. In my opinion, if not a necessity, on-line education should be to enhance, not to deliver totally.'*

*'Since I am so used to teaching in the classroom, switching to an online format will most likely be quite a challenge. Sometimes, I find classroom technology frustrating, so having to depend so much on technology may be difficult. However, I am open-minded, so I know that I would be able to make it work.'*

Similarly, we found that parents expressed many of the same concerns. Since the school varied from Kindergarten to 8th grade, the range of responses was vastly

different, and seemingly aligned with parents' self-efficacy on technology use and the allowance of technology in the home. Some parents clearly made the distinction between the concepts of the type of learner and the capabilities of the learner and the parent.

*'The results will vary dramatically by student and by parents. Parents who are technologically comfortable and have motivated students who eager to learn will clearly have a far greater experience than those who struggle with technology and have children who would rather do anything rather than school work. Those are the polar extremes but I would think they both exist, even in a small student population like [this school]'*

*'I think that kids learn better hands-on in a classroom with other children, it's important for them to have that experience growing up and have an emotional and trusting relationship with their teacher.'*

*'Online instruction would probably work better for middle school students and possibly very motivated late elementary schools students. For younger students and reluctant learners there will be a great burden on the parents.'*

From the qualitative responses, we begin to see an emerging pattern that can help identify a theoretical foundation to aid in developing paradigms for online education. It is noted from the comments that the intersection of skills between teachers, students and parents, coupled with their own self-efficacy in technology are critical components.

Teachers	Students	Parents
Technology Self-Efficacy	Technology Self-Efficacy	Technology Self-Efficacy
Control / Oversight	Executive Functioning	Oversight Capabilities
Emotional Recognition	Motivation	Level of Participation
Communication	Socialization	Learning Environment

### Direction for Future Research

Our goal is to explore the data provided and create a strong theoretical framework to understand the moderating effect of online education on performance. Utilizing the data collection in this first limited study, future projects are planned in an effort to identify technologies that could be more beneficial in an online setting. In addition, the information and studies should shed light on how technologies can be more effectively deployed. For example, allowing students to work in groups, and allowing a teacher to have more screens in an effort to have more visibility in students performance might prove beneficial. The research and study could provide for the development of new teacher techniques, such as changing the time duration students spend in front of a screen, or developing new ways for students to communicate with each other. Finally, it may be possible to identify new ways of communicating with students and parents to ensure all students are getting the level of education they need. The latin phrase "*Fortes in Unitate*", Strength in Unity, the motto of a local high school may be the key to ensuring a successful online program, whereby teachers, students and parents work toward the common goal of educating children successfully. Business partnerships are not only beneficial to the studies, but they are critical, since the future workforce is dependent on these children for their collective future. More importantly, children growing up in these conditions will have a set of technological expectations, which can dramatically transform businesses not only from a productivity standpoint but also from a consumer standpoint. The lessons learned from online "work from home" can be applied in the school, but the lessons learned in the school can have a profound and positive impact on the future of the workplace.

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Integrating Sustainability and Data Analysis in Teaching Service Operations Management through a Collaborative University Business Experiences (CUBEs) Project  
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## Abstract

This teaching note shares the experiences of integrating the data collected in the weather station at the Bridgewater State University Permaculture Garden, into teaching the course of Service Operations Management. Students used this weather data to conduct forecasting analysis and investigate the planting and harvesting timing decision. Through cleaning and analyzing data, students got a better understanding about how climate change influenced the decision making in agriculture, which further inspired them to advocate sustainability practices. As one of the Collaborative University Business Experiences (CUBEs) projects, this course project helped students enhance their career readiness through the rigorous training and requirements. With the pre- and post- course survey data collected, some insights can be obtained through the comparison.

## 1. Background:

### 1.1 Bridgewater State University and CUBEs

Bridgewater State University is the largest public school in Massachusetts after all of the UMass universities in the system. It's a comprehensive university with four colleges including the Ricciardi College of Business, the College of Humanities and Social Sciences, the Bartlett College of Science and Mathematics and the College of Education and Health Sciences. The university has always put an emphasis on enhancing students' career readiness and promoting undergraduate research and social justice over years (Liu 2015). In total we have around 9900 students currently, most of whom are from Southeastern Massachusetts, which satisfies our school's mission of serving the Southeastern Massachusetts community, workforce, and regional economy.

Collaborative University Business Experiences (CUBEs), supported by the prestigious university Academic Innovation Award, was started in 2019. Its goal was to bring together a team of faculty to explore ways to reinforce career readiness through collaborative university business experiences (CUBEs). The project team stimulated the college-wide dialogue about how to collaborate with local businesses and organizations to conduct semester-long CUBEs with external businesses and organizations to help students better prepare for their future careers. Like the other high impact practices traditionally promoted by BSU, it encourages deep learning and problem-solving skill development for students. Through clearly mapping students' learning outcomes with career skills expected from the real world and a semester-long onsite/offsite experience, those upper-level undergraduate courses are being designed and delivered in an innovative way with career and professional development orientation.

### 1.2 Service Operations Management

Service Operations Management is a required course for almost all concentrations in the Ricciardi College of Business. This 3-credit course teaches fundamental operations management, which is the foundation and prerequisite for all the rest of the courses in the Operations Management and Supply Chain Management Concentration. Forecasting is one of the major components in this course along with



statistical process control in quality management. We spend significant time (2-3 weeks) to explain and highlight each of those large components.

We usually run 6-8 sections of Service Operations Management in the College of Business. The cap for this class size is 35 and we normally have 20-35 students in each section. Most students are junior and senior students. We require students to take some fundamental math courses before taking this course. Those math courses include Statistics and fundamental calculus courses. Most of our students are active in the workforce by having part-time jobs or even full-time jobs. However most of these jobs are acting as service providers in grocery stores, restaurants, daycares etc. They are expecting to go to a more professional workplace where they can apply what they learned in the classroom. However, this could be very challenging because many students are likely to be first generation college students in a family without sufficient support financially and limited networking resources. Therefore, students gaining sufficient skills and knowledge to feel they are ready for a career is not always possible outside the classroom. It is for this reason that applying realistic projects in a class setting, allows students to enhance their resume and skills while also preparing them for the job market.

This teaching note showcases the systematic and seamless integration of a CUBEs project component into the Service operations management course.

The main purposes of introducing this undergraduate CUBEs project include:

1. Helping students utilize fundamental forecasting methods such as the Naïve method, moving average method, weighted average method and exponential smoothing method using Excel.
2. Helping students analyze the traditional service operation process and its implication in the real business world.
3. Helping students realize the sustainability issues involved in this problem and develop better understanding on the impact of climate change in agriculture and the urge of taking action to provide for the environment, motivating students to become a better business leader with social responsibility and equity in mind.
4. Helping students experience handling a large database, compiling, and cleaning data, searching, and evaluating the other data sources, and more generally, becoming familiar with the complexity of a large database.

### 1.3 Literature Review

As one type of experiential learning, CUBEs projects associated students' academic studies learning experiences with real problems from a real-life client, which can be called as "client-based projects" (CBP), somehow interchangeable with "client-sponsored projects", "client projects", "work-based learning", "service learning", "project with industry", and "community-based learning" (e.g. De los Santos & Jensen, 1985; Swan & Hansen, 1996; Clark & Whitelegg, 1998; Finterwalder et al, 2010; Hillon et al, 2012; Cadwallader et al, 2013; Lopez & Lee, 2005; Bravo, 2018).

Academic studies have found those projects with real clients are more intriguing not only because of the realistic elements such as clients, products and business scenarios, but also due to the connection with their future career choices. (De los Santos & Jensen, 1985; Burns, 1990; Razzouk et al, 2003). These projects also enhance students' feeling of ownership because students are immersed into the decision making process and the potential led to clients' call for actions (West, 2011). While the new hires in the survey conducted by MacDermott and Ortiz (2017) found that oral and written communication are listed as the most important soft skills for job effectiveness.

The implementation of the project and experiences gained from the project are discussed in the following sections. Section 2 introduces the primary dataset; Section 3 explains the class setting and the implementation of this research project; and Section 4 concludes the paper with the feedback from students and the discussion of limitations.

## 2 Data

The permaculture garden was built in 2015 and it was established by a group of faculty and the Sustainability Program to promote the idea of permaculture on campus. Permaculture is the combination of “perma” from permanent and “culture” from Agriculture to embed the concept of how to conduct agriculture practices in a sustainable way. After the installation of the garden, the Sustainability Program has worked with students, faculty, staff and the local community to maintain the garden..

The Sustainability Program at BSU has a long history of more than 10 years. The major mission of it is to “advocate for the integration of sustainability principles at Bridgewater State University into teaching and learning, faculty-mentored undergraduate research, internships and student sustainability literacy”( <https://www-stg.bridgew.edu/center/sustainability>). It has 22 faculty members from different departments such as Anthropology, Geography, Art, English, Biology, Political Sciences, Management etc. It always uses the garden as an active on-campus resource and hub to conduct teaching demonstrations and connect faculty students, staff, and local community members through this sustainable practice.

The weather station was established in 2016. It records the weather data such as temperature, pressure; RH, wind speed, Gust Speed, Water Cont, PAR every 15 minutes and throughout the year. Dr. Hellstrom compiled and updated all the data in the website, which is a great resource for teaching Sustainability and the other relevant courses. All the weather data between June 2016 and August 2021 of the permaculture garden were stored here: [https://bsuweather.bridgew.edu/?page\\_id=34](https://bsuweather.bridgew.edu/?page_id=34)

## 3. Implementation

Here is the outline of the implementation of this CUBE's project- Weather Forecasting using Data Collected from the BSU Sustainability Program Permaculture Garden. 1) We introduced the basic project outline at the first meeting of the semester; 2) In the second week of the semester (the middle of September), we took students to visit the permaculture garden and provided students with hands-on experience. They were even invited to put some beet seeds and radish seeds into the soil. Students can observe the growth of the plants and have a direct impression of how weather changes influences the growth of the plants, which builds their participation and ownership over a piece of the garden. Dr. Hellstrom was invited to participate in the kick-off meeting with students. He, as one of the co-coordinators for the Sustainability Program and the founder of the Weather Station, talked about the expectations from our Sustainability Program and demonstrated how the weather has been measured in the weather station. 3) Students studied the forecasting methods as the third major chapter during September and October. Along with the material, concepts and methods of learning, students formed a clear picture of the forecasting methods and had some practice with exercise problems in the textbook. 4) Along the way, the data sheets and database were introduced to the students and they started to manage data. They compiled data from different sheets into one sheet based on the month they chose to explore (based on the plants they were interested in and what they were hoping to learn) over different years and the measurement they chose; 5) Students applied the forecasting methods they learned in the classroom to the data sheet and they generated and conducted analysis; 6) Students

summarized all the results into Powerpoint slides and made the presentation in our Undergraduate Research Midyear Symposium in the end of November. Students made recorded audio/video presentations and uploaded to Youtube and some of these presentations were made in-person to report to our client Dr. Hellstrom (who represented the Sustainability Program) and Dr. Jacobsen (who represented CUBEs) to collect their feedback.

Students originally felt a little puzzled when they thought about the relationship between the permaculture garden with the course Service Operations Management. After the kick-off meeting with Dr. Hellstrom and the instructor’s clarification, students were excited to see how the forecasting techniques learned in Service Operation Management can be applied to assisting decision making for the Sustainability Program in their advocacy of sustainability practice through this permaculture garden. In this sense, the Sustainability Program really serves as a service organization on campus while students also see the importance of information in directing planting and harvesting through daily operations with limited resources.

#### 4. Survey Results

We conducted two surveys throughout the semester with students. One was done before project implementation at the beginning of the semester, and the other was completed after this CUBEs project was finished, before the end of the semester. 23 students filled in the pre-CUBEs test and 37 students filled in the post-CUBEs test while only a few students did both tests.

Here are the basic demographic results of the surveys:

Table 1: Demographic information

Pre-Test Demographic Information			Post-Test Demographic Information		
Variable	Categories	N	Variable	Categories	N
<b>Age</b>	20-30	21	<b>Age</b>	20-30	32
	>30	2		>30	2
<b>Gender</b>	Male	22	<b>Gender</b>	Male	22
	Female	10		Female	14
	Other	1		Other	1
<b>First Generation College</b>	Yes	11	<b>First Generation College</b>	Yes	11
	No	11		No	11
	Unsure	1		Unsure	1
<b>Working Status</b>	Part time	14	<b>Working Status</b>	Part time	18
	Full-time	6		Full-time	11

	Not currently working	2			Not currently working	6
	Internship	1			Internship	1

Table 2: Career Readiness Self-Evaluation before and after-course.

Pre-test Career Readiness		Post-Test Career Readiness	
Very Ready	1	Very Ready	8
Somewhat Ready	13	Somewhat Ready	19
Neither Ready nor Not Ready	6	Neither Ready nor Not Ready	5
Somewhat Not Ready	2	Somewhat Not Ready	3
Very Not Ready	1	Very Not Ready	1

Table 3: Skill Proficiency Self-Evaluation before and after-course.

Pre-test student rating of skill proficiency	Rating	Post-test student rating of skill proficiency	Rating
Teamwork	4.09	Teamwork	3.9
Research	3.26	Research	3.6
Creativity	3.22	Creativity	4.1
Critical Thinking	3.87	Critical Thinking	4.0
Professional Writing	3.39	Professional Writing	3.5
Public Speaking	3.39	Public Speaking	3.4
Leadership	3.09	Leadership	3.6
Data Analysis	3.05	Data Analysis	3.5
Computer/technological Skills	3.35	Computer/technological Skills	3.7
<b>Which of the following skills do you think you will improve most?</b>	<b>Rating</b>	<b>Which of the following skills do you think you improved most?</b>	<b>Rating</b>
Teamwork	2.37	Teamwork	2.5
Research	3.55	Research	3.8
Creativity	3.11	Creativity	2.8
Critical Thinking	3.41	Critical Thinking	3.4
Professional Writing	2.70	Professional Writing	2.5
Public Speaking	2.89	Public Speaking	2.6

Leadership	2.94	Leadership	2.3
Data Analysis	4.04	Data Analysis	4.2
Computer/technological Skills	2.76	Computer/technological Skills	3.7

More students felt very or somewhat ready for their careers after completing this hands-on project. This project allowed students to learn more about research, and data analysis and use some new technologies. Students felt more proficient in these skills upon completion of this project. Students also rated themselves as more proficient in creativity and leadership. This may be due to the independent nature of the project, all students had to take on a leadership role and create their own visual presentation. Because the final product was an individual presentation and not a paper, it is not surprising that students did not feel they improved their writing or teamwork skills. Students were aware that they would learn some data analysis before beginning the project, but felt they learned far more once the project was over.

It would be meaningful to adopt a paired-t test to analyze the above data if all the students who participated in the pre-CUBEs test also participated in the post-CUBEs test. However, since this is not the case, the direct unpaired test also gives us some useful information here. We also asked students about what they felt they gained from this course. Here is the summary of the results.

Table 4: Students’ gain of the course:

Forecasting and how to clean data
How to predict future demands in a business
Probability and statistical analysis
Gained valuable experience in knowledge on cleaning and analyzing data, learning how to predict a possible future in using the data.
well i learned different methods how to use excel
How to use excel a little more and operations in businesses
I learned a lot about forecasting methods and how to use them in the real world when I have a professional job. I learned teamwork working with a friend in the class. I also gained more excel experience.
learned about management, research, projects
Knowledge on how business work, learned how to better do research etc
practical skills
I gained new knowledge and worked on skill sets that will be beneficial for my future career.
Data Analysis skills
I did lots of research for the garden project and it was great
More excel experience
Data analysis skills
Learning how to forecast based on past data seemed very beneficial to learn. especially knowing what I want to do after I graduate.

New opportunities for my career
Insight regarding data analysis as well as many other components of service operations management. I gained a sense of independence and leadership.
New ways on how to approach different situations in the workplace
Knowledge of data analysis as well as organizing that data in a meaningful way to interpret or discuss a specific issue.
forecasting calculations
data analysis
data analysis
I gained the understanding of forecasting and the benefits it can bring to businesses
Research Knowledge
Knowledge for my career
Data analysis skills, refreshed Excel knowledge
I gained the ability to dial in on my researching capabilities and my technical skills.

Most students chose average temperature as the major measurement to do forecasting, looking for instance at the suitable temperature for planting beans etc. But some students did look at different dimensions of weather. A few students studied how the wind speed impacts the pollination of corn and the support corn might need during the maximum wind speed. Those topics are very interesting and meaningful.

Some students did recognize that 5 years of data might be too short for them to draw the conclusion of “global warming”, but they definitely noted the trend. Many realized that weird weather patterns occurred throughout the data. Those variations will create more challenges to farmers to maintain a stable yield to fight with food insecurity in the long run.

Most students eventually recognized the existence of the permaculture garden and its role in teaching students sustainability on campus. They are willing to serve as ambassadors to advocate sustainability on campus, some of them are enrolling in a sustainability minor and getting participation in the events organized by the BSU sustainability program.

## 5. Conclusions and Limitations

The implementation of the whole project was very successful and smooth. We did reach our preliminary learning goals in this course:

- Understand the complexity of real data and be confident with data clean
- Understand how to analyze data and utilize forecasting methods to do forecasting with real data;
- Critically evaluate different forecasting methods through observing and comparing Tracking Signal (the pattern of the errors);
- Visualize data for the professional audience and future employers;
- Communicate results for the profession audience and future employers;
- Understand how climate change influences the decision-making in-Service Organizations considering Sustainability Program Permaculture Garden is a service organization;

- Through a field trip and experiential learning, students get equal opportunities to experience real-world skill development and career building;
- Build connections on campus, get better at utilizing on-campus resources.

However, we are also aware of some limitations to this teaching experience, which we can improve:

1. Comparatively small sample size;
2. Comparative small number of years for data analysis;
3. It would be ideal to have multiple years of data collection in the garden. Then the comparison of methods would be more meaningful;
4. It would be ideal to have an instructional video to distinguish those weather measurements and their units which help students clarify those basic concepts. The instructor and the organizational representative will continue to work on this.

Overall this was a very successful teaching experience which embedded sustainability and climate change into a business course using data analysis. With enhancing career readiness in mind, the course actively engaged with internal organization to provide students the task of investigating the data, conducting forecasting analysis and concluding with meaningful suggestions for future planting, harvesting and maintenance.

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# Text Data Mining to Track Information Technology Trends

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## ABSTRACT

We present a technology trend analyzer that displays the frequency of demand for information technologies based on text data mining of job descriptions. It analyzes the term frequency of the leading technologies required of applicants in job descriptions scraped from a prominent job board. The tool is programmed in the R programming language with a Shiny interface and deployed on a Shiny server. It produces a bar graph of the technology frequency grouped by standard technologies from a taxonomy provided by O'Reilly, a prominent publisher of technology information. We based our job search on a list of the most frequently occurring technology job titles from the U.S. Bureau of Labor Statistics O\*NET occupation database filtered for STEM IT occupations. We also provide analysis to support our selection of the R development environment (versus Python or Java) given the constraints of the project of the allocated time, the experience level of the analyst, and the expected quality of the final product. The tool supports the download of the technology frequency tables as a CSV file. This tool has applications for students to determine which technology skills are in the highest demand in the job marketplace. Likewise, faculty may use this tool to determine which technology skills the marketplace is seeking in shaping their curricula. Most importantly, it may be used by technology adopters to gauge the readiness for adoption of contemplated technologies in order to minimize adoption risk.

Keywords: technology adoption, technology risk, technology trends, technology tracking



## INTRODUCTION

Tracking technology trends is an essential activity for technology adopters. To reduce the risk of adopting technologies too early and risking adoption failures, a technology adopter needs to know what technologies are in demand in the marketplace at any given time. The adopter also needs to track the trends in adoption over time. Technology managers develop personal approaches to observing when emerging technologies have crossed the adoption chasm from bleeding edge to leading edge. Elaborate schemes have been proposed (Fortino, 2007) for such a technology watch based on the technology diffusion curve of Rogers (Rogers, 2003). For these schemes to work, the technology adopter must know the market acceptance of any one technology, thus driving the need to know the relative popularity of any one technology over another in any one sector. Seeking the opinion of technology subject matter experts and practitioners is one approach, but it is time-consuming and onerous (Fortino, 2007). This process may only be exercised infrequently. In his paper, Fortino calls technology managers to survey technology colleagues on their opinion of the bleeding/leading status of any technology they are interested in adopting. Industry surveys (Piatetsky, 2019) may be undertaken once per year, with substantial effort, and may cover one sector at a time. Piatetsky surveyed data analysts on their preference and use of various analytics languages and tools.

We contend that there is a ready-made database of market demand for technology at any one point in time: job descriptions. It is readily available and may be interrogated at any point in time. If we interrogate a database of technology jobs at the proper level (technology workers, not managers or clerks) in an industry sector for the skills and knowledge in demand at any one time, we would know what the most important technologies are. The frequency of appearance of one technology over another could provide a good indicator of the popularity of that technology at the point in time of the inquiry. It's not a perfect indicator but good enough for most business needs. Others may be able to use such quick snapshots of technology's popularity, such as H.R. managers who are seeking to train staff and arrange for technology training. They could use this as evidence to guide the trainers and arrange the proper training of their employees. Job seekers hoping to improve their preparation for the job marketplace could use this tool to look for gaps in their resumes or use it in preparing their resumes to match market expectations. It can be used in academia for faculty to decide what technology to use in their courses or what technology to emphasize in the subject matter taught.

The Technology Trend Analyzer we developed to answer this need is an R-based web application hosted on the shinyapp.io server. It scrapes 30 job descriptions from Indeed.com for 30 different job titles selected from the BLS O\*NET Occupation database filtered for STEM occupations. It analyzes the frequency of technologies skills and knowledge called for in the job descriptions. It shows a bar graph of technology frequency grouped by I.T. categories from a standard technology taxonomy defined by O'Reilly's comprehensive compilation of technologies. The tool not only displays the snapshot of all the technology domains but also supports the download service of frequency tables in CSV files. It employs a keyword analysis technique

provided by the standard library of R scripts. Users do not need to manually count the frequency of technologies that appeared in job descriptions anymore. Instead, they can use this tool monthly to understand the trend of technology requirements in the human resource market to prepare themselves to find a job matching their skills and create trend curves. This tool also provides opportunities for technology workers to understand the trends in I.T. to minimize the risk in technology investment.

### **Problem Description and Opportunity**

We first envisioned this tool to be used by students graduating from our university as an aid in finding a job. The employment rate of graduates of the school is one of the vital factors of concern for students when selecting a university. With the influence of COVID-19, the unemployment rate was 4.2% in November 2021, which is higher than in the pre-COVID-19 era (Amadeo, 2021). Therefore, increasing the employment rate of graduates at our university became a problem for all university stakeholders.

A previously created tool, Job Description Compiler, that scrapes job information such as job titles, job descriptions, and other job metadata from Indeed.com and automatically creates a CSV file for users to download, was a helpful starting point for development (Guan, 2021). This tool is convenient for users to search for jobs they are interested in and save the search results. The job descriptions provide users with information to match their resumes to job requirements.

The Job Description Compiler solves the problem of creating CSV files by hand, but users still do not know what skills are in great demand by employers. If users want to know the most recent in-demand skills, they must count the keywords in the job descriptions manually. This situation provided us with an opportunity to create a tool to automatically count the keywords in job descriptions.

We needed to obtain a comprehensive standard set of job descriptions used on a going base by the tool rather than have the user submit them. We used the database of occupation descriptions provided by the O\*NET database from the U.S. Bureau of Labor Statistics. This tool scrapes job descriptions for the appropriate occupation titles culled from the O\*NET occupation database from Indeed.com and analyze the technologies' frequency in the job descriptions. This tool will also produce a result in the bar graph of key technologies' frequency grouped by different categories so that users can easily visualize the most in-demand skills requirements in recent times. This tool will save the frequency data in a CSV file and provide it for downloading for users to analyze further. The tool can also be used by university faculty and administrators to help them understand the trend of technical requirements in the job marketplace and provide courses related to these technologies to help students prepare for finding a good job and performing well at the desirable jobs.

## Importance of the Project

The twenty-first century is the era of technology. Since 1945, the invention of the first Electronic Numerical Integrator and Computer brought changes to the world and pushed the technology development a step forward. The main application of computers changes from initially calculating artillery firing tables for the United States Army's Ballistic Research Laboratory to process statistics data, program mobile apps, create websites, and enjoy online entertainment. Programming languages are developing at a rapid pace. With new programming languages or tools being invented frequently, employers may change their preferred programming language from the well-known programming language like C, SQL, C++, R, Java, JavaScript, Python to other new programming languages like TypeScript and Swift. Therefore, tracking the real-time dynamics of technology trends is necessary to help students find a job by learning the technology required before job hunting. It can also help students find the most suitable job opportunities by checking whether students have the technical skills companies require. Analyzing the technology trend by counting the keyword frequency by hand takes is a long and arduous process, so an automated tool could be useful to analyze technology trends.

## LITERATURE SURVEY

Since 1995, search engines have provided a means of communication that allows companies to organize and diffuse information efficiently to customers (Humphreys et al., 2021). With the development of the Internet, many things are transmitting from traditional paperwork to digital work. Moret-Tatay et al. (2018) consider that, in some cases, electronic devices seem to have won the battle over traditional books because people tend to find out what has been said about a subject using Google more often than consulting an encyclopedia. This implies that analyzing online communications, like discussions and comments, can help people track the real-time dynamics of society. Therefore, to track the real-time dynamics of the trend of employers' technology requirements, analyzing the online job descriptions should be a good choice for developing a useful tool.

This project aims to create a technology trend analyzer using R with a Shiny interface to analyze technology trends by extracting information from job postings. The analyzed results will be shown as a histogram with the frequency of the number of jobs found to call for knowledge and skills in that technology.

Text analysis technology has been around for some time. This technology has been applied in many scenarios since its development. For example, a study by Humphreys & Wang (2018) used text analysis technology to analyze the consumers' desires, psychology, and process of making decisions. They stated that consumer discussions on the Internet, product reviews, and digital archives of news articles and press releases are potential insights into consumer attitudes, interaction, and culture (Humphreys & Wang, 2018). Other potential sources come from consumer-generated content, including discussions of products, hobbies, or brands on feeds, message boards, and social networking sites. Though text analysis technology has been available

for a long time, there is not much agreement on the standard set of methods, reporting procedures, steps of data inclusion, exclusion, sampling, and, where applicable, dictionary development and validation. Humphreys & Wang (2018) sampled internet data, developed word lists to represent a construct, and analyzed sparse, non-normally distributed data to address the text analysis task. These procedures are employed in our technology trend analyzer project.

In Jia's (2018) study of text mining of restaurant customers' online reviews, she used text analysis tools to analyze customers' ratings and reviews to help restaurants improve their quality. Rating is easy to analyze using the statistical tool, but the review is hard to analyze without a text analysis tool. Therefore, Jia creates a text analysis tool that integrates the rating and review to reflect whether and why a customer enjoys dining in a restaurant. Other applied scenarios of text analysis technology include predicting the financial markets based on Google's search queries, analyzing annual corporate disclosures, making hotel selections based on online reviews and tourists' sentiment preferences, identifying phishing emails, and making decisions on the title of movies.

How to predict the stock market trend correctly is a hot topic for investors. In Perlin et al.'s (2017) study, they mentioned a new way to predict the stock market trend, which is analyzing the keyword that the general public searches in Google to predict the stock market trend. They consider that this way can at least analyze systematic patterns and effects on the market (Perlin et al., 2017). The result of this study also verified their ideas, which is that Google Trends data can be used to forecast the behavior of financial markets (Perlin et al., 2017). Yang et al. (2018) did a similar study with Perlin et al.'s (2017). Yang et al. (2018) use text analysis technology to assess the bankruptcy risk of companies. They extract high-frequency words, related concept links, and topics from MD&As and find that some high-frequency words appear to suggest differences between bankrupt and non-bankrupt companies regarding their financial position and ongoing status (Yang et al., 2018). However, Yang et al.'s (2018) study concluded that most of the top topics extracted merely recapture the characteristics of industries in which companies operate, and they do not provide useful information in differentiating between bankrupt and non-bankrupt companies. Yang et al. (2018) believed that one possible explanation for this result is that they conducted their topic extraction using the entire sample without classifying companies into industries. The different results of Perlin et al.'s (2017) study and Yang et al.'s (2018) study remind the importance of having and using an accurate word list.

Text analysis technology is not only used in the finance field but is also used in the tourism and cybersecurity fields. In Liang et al.'s (2019) study, they create a novel DL-VIKOR method for ranking and selecting the most suitable hotel for tourists. This method went through with online reviews and tourists' sentiment preferences and transformed them into the format of distribution linguistic with respect to sentiment levels (Liang et al., 2019). Then, they determine the ideal solution and nadir solution for the linguistic distribution evaluations (Liang et al., 2019). Finally, they determine the weight vector of the evaluation features based on the frequency of words for evaluating hotels and the distribution of linguistic evaluations (Liang et al., 2019).

The applied scenario of text analysis to the cybersecurity field includes identifying and

preventing phishing emails. COVID-19 radically reshaped the global economy and accelerated the pace of digital transformation (Li, 2021). An article from Deloitte states that “the increase in remote working calls for a greater focus on cybersecurity because of the greater exposure to cyber risk” (Deloitte, 2020). The data of Deloitte shows that 47% of individuals fall for a phishing scam while working at home (Deloitte, 2020). Therefore, identify a phishing email and prevent people from being deceived by a phishing email. O’Leary’s (2019) study used text analysis to explore differences between phishing emails and other emails. Furthermore, O’Leary generated a model of phishing as power based on independent variables of a friend (who they pretend to be), achievement (of their goal), (to take you) money, and (typically done at) work (O’Leary, 2019).

Text analysis technology is also used in the entertainment industry. Kim et al. (2020) studied whether a correct name can influence the success of films. The result of this study showed that it is correct to choose a title for a movie, and specific movie titles work better than others (Kim et al., 2020). In the study, Kim et al. (2020) applied the social network analysis R package applied to Hollywood movie title keywords to extract some meaningful information from Hollywood movie title keywords.

R is a well-known programming language, and it is widely used among statisticians and data miners for developing statistical software and data analysis (Wikimedia, 2021). The first official release of R was in 1995. It was first developed by Ross Ihaka and Robert Gentleman at the University of Auckland in 1991 and publicized in 1993. In 1995, they were decided to make R free and open-source software under the GNU General Public License. The Comprehensive R Archive Network (CRAN) was officially announced in 1997 with three mirrors and 12 contributed packages (Wikimedia, 2021). The first official "stable beta" version (v1.0) was released in 2000 (Wikimedia, 2021).

Until 2019, there were more than two million R users around the world (Datanami, 2020). Such a large user base makes programs written in R easier to be accepted and understood. This is one of the reasons that this technology trend analyzer project team choose to write the code in R. Nevertheless, R has many other reasons for this team to decide to use it. As open-source software, writing in R code enables anyone to access, modify and share the source code and libraries without any restrictions (Datanami, 2020). This prevents the situation that other people who want to modify the code need to buy access to read or modify the code. R also has many packages that can be an add-on. For example, ggplot2, plotly, dplyr, and tidyr provide some of the best-in-class data visualizations that are aesthetic yet insightful (Datanami, 2020). In this project, the team uses ggplot2 and dplyr to visualize the data. It is very convenient to add on these packages in R to complete a complicated project. R has extensive community support. R has an active and welcoming community for all skill levels, whereas boot camps and workshops encourage cooperative behavior (Datanami, 2020). This welcoming community can help R to perfect its loopholes and bugs. One of the essential reasons we choose R is that it is easy to understand. Workers who have some coding experience in Python or AMPL, it is easier for them to understand coding in R. All these reasons supported our choice to create the technology trend analyzer using R code.

## DESCRIPTION OF THE TOOL

The goal of the project was to create a technology trend analyzer using R with a Shiny interface that can analyze the trends required in job descriptions. This project is based on a previous project which collects job information from online sources. After collecting the information from websites, our tool analyzes the frequency of main words in job requirements and plots a histogram showing the recent job requirement trend of specific skills like Python or R.

This tool requires a list of technologies, a job title list, and job descriptions to create and run the analysis. The list of technologies is used to categorize the counted frequencies after the counting process completes and display histograms with categorized technologies. The job title list provides the job titles for the tool to search and define this project's scope. Based on the job titles from the job title list, this tool can scrape job descriptions from Indeed.com, then go through the analysis process and count the frequency of technologies appearing in the technology list in job descriptions.

### **The Technology Taxonomy**

This program uses an I.T. technology taxonomy derived for a comprehensive listing of technologies compiled by O'Reilly, a prominent I.T. technology book publisher (O'Reilly, 2021). The technology list is used in this project to categorize specific technologies. The categories in the O'Reilly technology chart include (1) Methodology, (2) Security, (3) A.I./Machine learning, (4) Data, (5) Web, (6) Mobile, (7) Infrastructure, (8) Cloud, (9) Software/Architecture, and (10) Programming Languages. O'Reilly is a well-established publisher of books on information technology. Their catalog of books covers the widest variety of technology topics and does so in-depth. It is a well-regarded source of technical information in the I.T. industry. As such, O'Reilly is well-positioned to create a comprehensive taxonomy of I.T. Rather than embark on the creation of such a comprehensive taxonomy as a separate task in this project, it was expedient to use an existing taxonomy to create a proof of concept for the tool. As more comprehensive and exhaustive technology taxonomies are made available, the tool can be retrofitted and perfected.



Category	Technology
<b>AI / Machine Learning</b>	AutoML, Neural Networks, TensorFlow/PyTorch, Modeling, Data processing, Deployment, scikit-learn, Tuning, Math, SQL, NoSQL, Analytics, Visualization, Pipelines
<b>Cloud</b>	Amazon Web Services, Microsoft Azure, Google Cloud Platform, Alibaba, Oracle Cloud Infrastructure, IBM Cloud
<b>Data</b>	SQL, NoSQL, Analytics, Visualization, Pipelines, Cassandra, Data warehouses
<b>Infrastructure</b>	Kubernetes, Docker, AIOps, DevOps, SRE, VMs, Servers
<b>Methodologies</b>	Lean, Agile, Scrum, Kanban
<b>Mobile</b>	OS / iOS / Android, Caching, Toolkits
<b>Programming Languages</b>	Java, Go, Python, Ruby, JavaScript, React, Vue, Angular, COBOL, C, C#, R, SQL, C++
<b>Security</b>	Secure programming, Threat modeling, Monitoring / Alerting, Incident Response, Cloud Security, Pentesting
<b>Software Architecture</b>	Event-driven, Domain-driven, Microservices, Monoliths
<b>Software Development</b>	Coding, Pair programming, TDD, Version Control, Testing, Continuous integration / continuous delivery, DevOps, Legacy
<b>Web</b>	JavaScript, CSS, HTML, Monitoring / Alerting, OS / iOS / Android, Caching, Toolkits

Figure 1 – The technology domains and associated technologies used in this tool. After O’Reilly’s Technology Topic Chart (O’Reilly, 2021).

Creating the list of technologies based on the O'Reilly technology chart produces the keywords for the program to extract their frequency from the job descriptions. This step also prepares for classifying technologies after counting the frequency. When this program scrapes the job descriptions based on the job title list, it will match the scraped job descriptions with the technology names in the technology list and count the frequency of the words' appearance in the job descriptions.

**Job Titles from the STEM O\*NET Occupation Database**

The job title list used in this project was extracted from the O\*NET Occupation database. The O\*NET Occupation database contains over eleven hundred definitions of occupations, and job seekers in the United States use it often to find jobs. Roughly half of the occupations are

considered STEM occupations. We used the STEM occupations list as a starting point to refine it further and generate the 30 most prominent I.T. occupations. We used several subject matter experts to determine which of the STEM occupations to use as I.T. job titles in scraping jobs from the job service. We focused on the most prominent and popular jobs representing I.T. staff positions, those who would be doing the technical work of I.T. and for whom one would find technologies defined at the most granular level. For example, we did not include managers or supervisors.

We limited the job titles to 30 occupations to assist in reducing the job search scope so that the search through the job board would not take an inordinate amount of time to complete the scraping task. Though having more samples can increase the accuracy of the results, it takes excessive time to finish the scraping process. Also, the job service selected for job scraping (indeed.com) employs an anti-web-crawler system. Making too many requests at one time will cause the tool to hang up. Using a maximum of 30 job descriptions is a practical operating parameter. More specifically, these occupations include Bioinformatics Scientist, Blockchain Engineer, Clinical Data Manager, Computer and Information System Manager, and other occupations are shown in Figure 2 shows the list of occupation titles used.

1	Job_Title			
2	Bioinformatics Scientist			
3	Bioinformatics Technician			
4	Biostatistician			
5	Blockchain Engineer			
6	Business Intelligence Analyst			
7	Clinical Data Manager			
8	Computer and Information Research Scientist			
9	Computer and Information Systems Manager			
10	Computer Hardware Engineer			
11	Computer Network Architect			
12	Computer Network Support Specialist			
13	Computer Programmer			
14	Computer Systems Analyst			
15	Computer Systems Architect			
16	Computer User Support Specialist			
17	Data Scientist			
18	Data Warehousing Specialist			
19	Database Administrator			
20	Database Architect			
21	Information Security Analyst			
22	Information Security Engineer			
23	Information Technology Project Manager			
24	Network and Computer Systems Administrator			
25	Penetration Tester			
26	Software Developers			
27	Software Quality Assurance Analyst			
28	Statistician			
29	Web Administrator			
30	Web and Digital Interface Designer			
31	Web Developer			

Figure 2 – The 30 O\*Net STEM occupations titles selected for scraping I.T. job descriptions from the job board.



The tool searches for each job title on Indeed.com to get job descriptions using these O\*NET occupation titles as job titles. We retrieved 30 jobs per occupation to stay within the Indeed.com anti-web-crawler system limits. This gives us a pool of 900 job descriptions which is sufficient to get a good indication of the current popularity of each technology. It is not necessary to have a high degree of accuracy since generating an imperfect indicator is sufficient for most business purposes or when looking for a job.

### **Term Frequency Analysis**

Once the 30 job descriptions for each of the 30 job titles have been extracted, the tool will analyze the specific technology by the keywords in the O'Reilly technology list and match them with the words that appear in each job description. This program uses the R function CountTech to count how many times the keyword in the technology list appears in the texts of the job descriptions. To avoid miscounting single keywords like R and C, we used space plus keyword plus period, space plus keyword plus comma, and space plus keyword plus space as keywords for single-word keywords like R and C to check the frequency of these words in the text to view. The tool also considers the situation of having a slash in keywords; it uses `str_split` to split the keyword with "/" and count them split and then add them together as one keyword. When all the possible keywords problems are analyzed, the tool can use for loops for R to count keywords in job descriptions.

The tool provides a good indicator of technology use because it reflects employers' current and future talent demand for that technical knowledge and skill. Online job-finding websites can reflect the real-time demand of the market. Job boards provide more immediate and recent indicators of market demand for technology knowledge than an official year-by-year statistical compilation from surveys of staff. This tool can be run once per month, for example, to track the real-time dynamics of technology use, which is more valuable than the official yearly industry statistics. Displaying the appearance of technical terms in jobs sorted by frequency can show the skills most in-demand in the technology job market. The tool also provides the function of displaying a bar graph of the data by the O'Reilly categories.

### **Using the tool**

The tool may be found on a public Shiny app server (You, 2021). Users are provided with only two functions when the tool is run: a "TRACK" button to run the tool and a "Download CSV" button to download a table of results. Once the "TRACK" button is pressed, bar graphs of technology frequencies presented by categories will display. After running the tracking function, users can click on "Download.csv" to download the frequency table for users' further analysis.

## SELECTING THE DEVELOPMENT PLATFORM

### Evaluation of Alternate Solutions to R

We carefully considered the development environment for programming the tool. There are several adequate choices for the development of the program we envisioned. We limited our choice to the three most popular development environments. Two alternative solutions to using R are Python and JavaScript. After comparing all the pros and cons of R, Python, and JavaScript, we found that R was the most effective programming language to finish the project.

### Positive aspects of using Python for tool development

Python is a general-purpose programming language, so it is convenient to write the whole application in Python and then include the Python-based model. Python also emphasizes code readability, making it easier for beginners to learn and understand writing code. As a general-purpose programming language, most programmers and developers know Python well. When they write code in Python, they do not need to transfer programming language syntax to a new syntax. Python is suitable for deep learning and machine learning. The deep learning and machine learning libraries like scikit-learn, Keras, and TensorFlow enable sophisticated data models that plug directly into a production system. Python supports most kinds of data formats, from CSV files to SQL tables.

### Negative aspects of using Python for tool development

The primary objective of R is Data analysis and Statistics, whereas the primary objective of Python is Deployment and Production. Besides, visualization is not a strength of the Python language. Though Python can use the Matplotlib library and the Seaborn library to draw graphs, it is more complicated than using ggplot2 to draw graphs in R. The other negative point in using Python to write this project is that the project is based on previous student's work, which was written in R. To change the programming language to Python, we needed to transfer the other project code to Python first. That would have added time to the project unnecessarily. In addition, writing in Python will make it hard for other workers to develop further functions based on this tool's code. And the Python language learning curve is steep.

### Positive aspects of using JavaScript for development

The second alternative solution is writing a webpage using JavaScript instead of the Shiny app. JavaScript and Shiny app are not a zero-sum situation; they can be used together in R. R has a J.S. package to implement bindings to several popular JavaScript libraries for validating, reformatting, optimizing, and analyzing JavaScript code. JavaScript can satisfy the more

advanced requirements of designers. When designers have advanced features that go way beyond what Shiny can do, JavaScript can help realize the imagination. Most of the Shiny functions are JavaScript wrappers with some narrowed functionality, so using JavaScript can achieve the same effect as the Shiny app. In addition, when some loops are used, JavaScript runs faster than the Shiny app. Finally, JavaScript allows users to operate on existing DOM elements while Shiny often re-renders objects.

### **Negative aspects of using JavaScript for development**

Many R and Shiny app developers have a data science background, not a programming background. Therefore, using JavaScript requires them to spend time learning it first. It was expected that this project was foundational to mane revisions and enhancements and that other analysts would be using the R code produced. Using JavaScript rather than R to create the web interface will make it harder for future analysts to extend the work.

### **Criteria for Evaluating Solutions**

*Time* – This project was projected to be completed in three months. The work was to be accomplished by a single student analyst as part of a capstone project, and the time allocated was one academic semester. Time became a major driving factor to consider in selecting the best development approach. Any development environment and language that risks exceeding the project deadline should not be chosen. Given the state of preparedness of students (minimal), it was felt that R has the lowest learning curve of the three development languages and had the most significant possibility of bringing the project in on time.

*Quality* – Whether the solution can satisfy all the metrics is one factor in comparing all the solutions. The speed of running the program, the stability of the program, and the accomplishment rate of the client's requirements should be considered quality factors. A faster, more stable, and higher accomplishment rate should be preferred.

*Efficiency* – The amount of time and effort spent learning the development programming language to complete the project is considered the efficiency factor. The lower the learning curve, the higher the efficiency. A lower learning curve makes the project more effective and is preferred.

*Continuous Improvement* – Because this project will have follow-up projects, the readability of the code should be considered a factor in deciding the best solution. Easier to understand code is better because it will allow future analysts responsible to easily follow the work and build upon it.

## Selection Rationale

	Time	Quality	Efficiency	Continuous Improvement	Total
Using R with Shiny app	3	2	3	3	<b>11</b>
Using Python	2	3	1	1	<b>7</b>
Using R with JavaScript	2	3	2	1	<b>8</b>

Figure 3 – Scoring of the development platform alternatives.

Each criterion was scored from one to three in collaboration with a subject matter expert. One means this approach performs poorly compared to other solutions. Three means that the approach is a superior solution in that dimension. All factors were equally weighted. We see that using the R with Shiny app to complete the project is superior to the other two. Using all three solutions can complete the project by the deadline. Still, by using R with a Shiny app interface, we can finish the project faster than using Python and JavaScript because of the lower learning curve for the analyst. On the other hand, even though using R with the Shiny app can satisfy all the client’s requirements, using Python can make the program run faster, and using JavaScript can make the web page look more professional. I have experience of using R before, so it is easier, faster, and more convenient for me to learn R more deeply. This project is based on a previously finished project written in the R and Shiny app. Using the R and Shiny app can make later students more convenient to understand each step in the coding and keep writing their project based on this project. In conclusion, using the R with Shiny app to create the technology trend analyzer is the best choice.

## APPLICATION

We provide here some results of using the tool. The Shiny interface provides a web page for users to run the tool. The Shiny interface is Shown in Figure 4. The tool runs when users click the “TRACK” button.

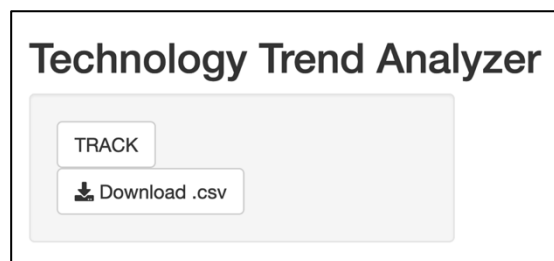


Figure 4. The Technology Trend Analyzer tool start interface.

After a few seconds, the bar graph of technology frequencies divided by categories will display on the screen like in Figure 5. When users click on the “Download.csv” button, the browser will pump up a window to set the download pathways like in Figure 5 or automatically download the counted frequency file (depends on the browser the users employ).

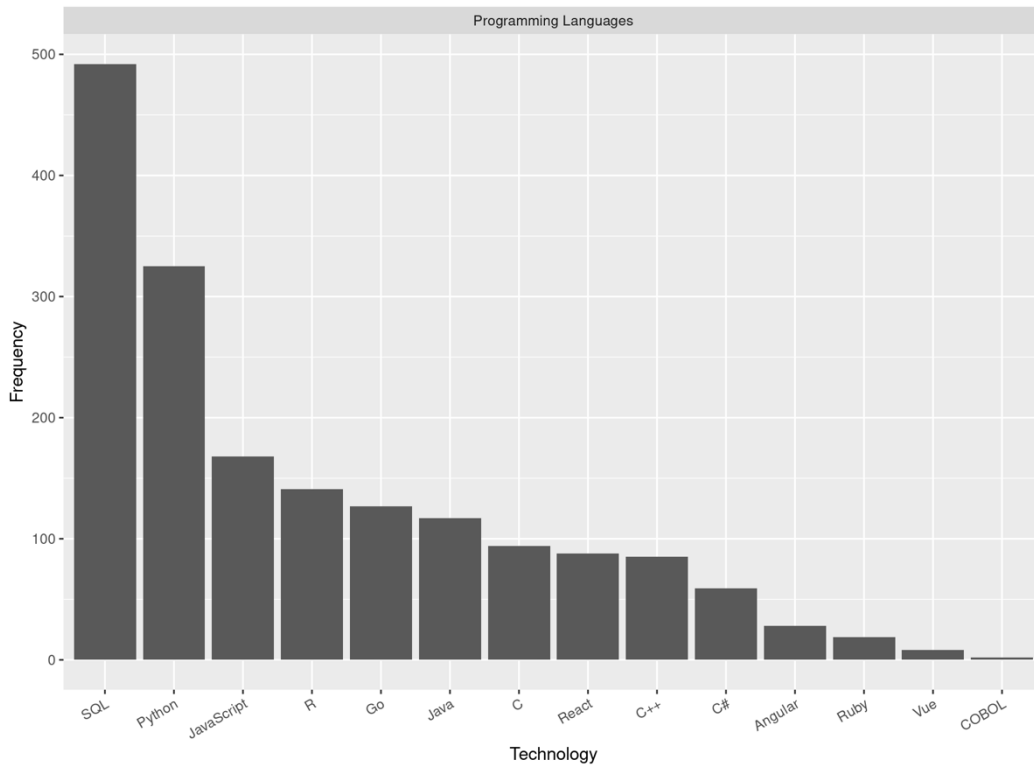


Figure 5 – Typical bar graph results of technology frequency from the 900 scraped job descriptions for the Programming Languages technology category.

As of the time and date the tool was run the most in-demand technology in the Programming Language category appears to be SQL, shown in Figure 5. The second and third in-demand technologies are Python and JavaScript. In the Methodologies category, Agile is the highest in-demand. In the Software Architecture category, the most in-demand technology is Microservices. Monitoring / Altering is the most in-demand in the Security category. In the Cloud category, shown in Figure 6, Microsoft Azure is a very close second, although Amazon Web Services appears most frequently. Therefore, Amazon Web Services and Microsoft Azure should be considered essential technologies required for job seekers in the Cloud category.

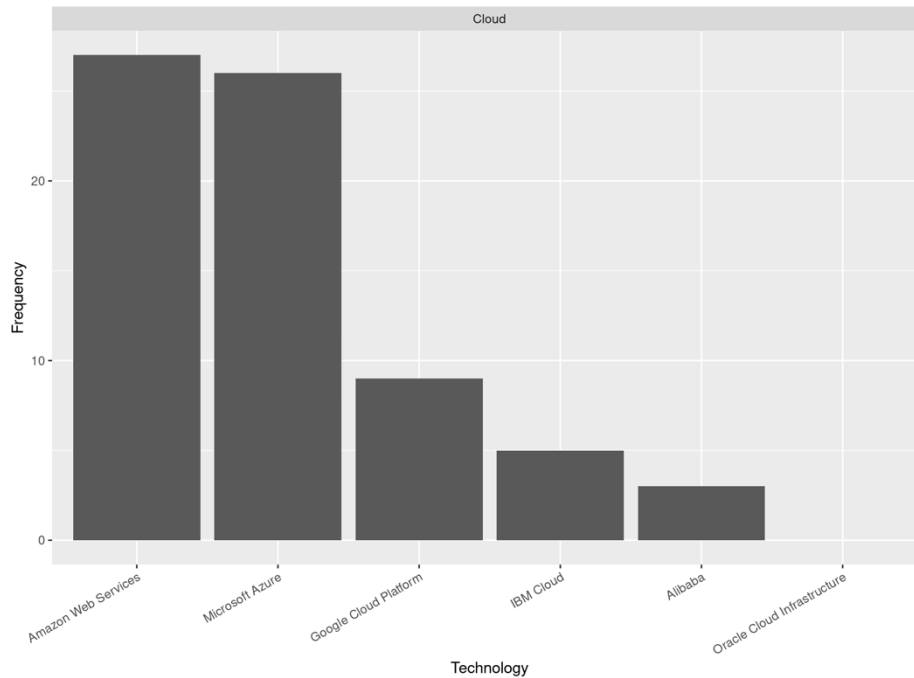


Figure 6 – Typical bar graph results of technology frequency from the 900 scraped job descriptions. – Cloud Technologies

In the A.I./Machine Learning category, Modeling, Deployment, and Tuning are the top three technologies required. In the Data category, both Analytics and SQL bear watching since they both have high frequencies of appearance in jobs. Servers is the most frequent keyword in the infrastructure category, while Testing is the most frequent keyword in the Software Development category. In the Web category, JavaScript has the highest frequency, while in the Mobile category, Monitoring/Altering has the highest frequency.

### LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORK

Though this project is based on the work of scraping job descriptions from Indeed.com and counting the frequency of the keyword in job descriptions, it faces a problem of the anti-web-crawler system limits, which means this tool cannot scrape as many job descriptions as possible to make an analysis. Even for this project, this technology trend analyzer tool cannot scrape a more desirable 3000 job descriptions (30 job titles X 100 job descriptions) from Indeed.com at a time. It is not a problem with the code, but the problem of the website the jobs are scraped from. The anti-web-crawler system is not limitation of Indeed.com alone. Other websites, like LinkedIn, also have an anti-web-crawler system. This situation limits the number of job descriptions scraped from the website at any one time and may lower the accuracy of the counting process.

An existing solution to this problem is running the frequency function one by one 30 minutes apart and letting R count the frequency of these job descriptions. After running the R code of main function, users can use the shiny app to see the bar graph and download the frequency table in a CSV file. However, this solution can only be useful for a limited number of job descriptions. If the number of required job descriptions increases, this solution will be very time-consuming. Therefore, the best way to find a way to solve this problem, perhaps by finding a job searching website that does not require verification to scrape job information—or applying more advanced programming techniques to develop a tool that can break the anti-web-crawler system to scrape job information from websites without any limitations.

Another future development for this project is to add the time dimension. If a person is interested in tracking technology trends over time, the program may be run repeatedly (once per week perhaps), and, with modifications, the program can accumulate the results of each run into a database. At the end of each weekly run, the program will also display a slope graph of the trend from previous runs. Thus, allowing the analyst to obtain a current snapshot for ratios of technology popularity and a slope of the trend as well.

## CONCLUSIONS

The Technology Trend Analyzer is an R-based web application hosted on a shinyapp.io server. It can scrape 30 job descriptions from Indeed.com for 30 different job titles selected from the BLS O\*NET Occupation database filtered for STEM IT occupations. It analyzes the frequency of technologies skills and knowledge called for in the job descriptions. It shows a bar graph of technology frequency grouped by I.T. categories from a standard technology taxonomy as defined by O'Reilly's comprehensive compilation of technologies. The tool not only displays the snapshot of all the technology domains but also supports the download of the frequency tables as CSV files. It employs a keyword analysis technique as provided by the standard library of R scripts. Users do not need to manually count the frequency of technologies that appeared in job descriptions any more. Instead, they can use this tool monthly to understand the trend of technology requirements in the human resource market so that users can prepare themselves for finding a matchable job. This project also provides opportunities for technology workers to understand the trends in I.T. to minimize the risk in technology investment.

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# **Healthcare Analytics and Services Management**

## A CONCEPTUAL FRAMEWORK: THE ROLE OF PARENTS' PERSONAL MORES AND TRUST IN A SCHOOL-BASED TELEMEDICINE PROGRAM

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### ABSTRACT

School telemedicine portals, by connecting the school nurse directly with a local children's hospital, allow a school nurse to provide many medical services on school premises. Such a service should have been welcomed by parents because it alleviates their need to take their children to a hospital for many services. Despite this promise, the adoption of such programs has been slower than expected. This research presents a conceptual framework to investigate whether parents' personal mores as beliefs of doing the right things alongside trust and time-flexibility possibilities explain some aspects of attitude toward adopting the program. Preliminary analyses of such a pilot school-based telemedicine portal provide initial support for the conceptual model. The conceptual framework and preliminary analyses are discussed.

**Keywords:** Personal Mores, School-based Telemedicine, Trust, Schwartz's Model of Altruistic Behavior

### 1. INTRODUCTION

Despite the emerging evidence of the potential benefits of deploying school-based telemedicine programs [Martin and North, 2021, Tye et al., 2020, Wenderlich et al., 2021], their adoption has been slower than anticipated, partly because parents have been reluctant to allow schools to use telemedicine services on their children [Johnson et al., 2021, MacGeorge et al., 2021]. This study hypothesizes the possible

importance of parents' personal mores in this process. In this respect, personal mores are defined as the positive beliefs of doing the right things to contribute to others' wellbeing. Past research has shown its efficacy in environmentally relevant behavior [Khan et al., 2019, Kim et al., 2022].

Parents or caregivers may feel satisfied to perform in conformity with what they believe is right about their children's wellbeing. This research posits that when parents or caregivers make their personal decision based on the belief that it is what has to be done, it increases a positive attitude toward their involvement. In fact, what is important is the conviction that parents or caregivers should act, which is assumed that this conviction derives from the moral side of their personal decision. This part of research is articulated from the morality perspective based on the model of altruistic behavior of Schwartz [1970], Schwartz [1977]. Trust in the hospital can be an alternative rational reason that may affect parents' attitude and their evaluation about what is the right thing to do when they believe that the hospital acts on their own moral beliefs. Thereby, school telemedicine, as a conduit to the healthcare organization behind the program, highlights the role of trust as the willingness to rely on core trusting beliefs: integrity, ability, and benevolence of the organization [Mayer et al., 1995]. Added to the model as a control is the actual benefit the telemedicine system was created to provide, time-flexibility to allow parents to save time and money by reducing parents' work absenteeism, alleviating its economic impact and the stress of missing work while assuring their children get medical care.

To the best of our knowledge, the concept of personal mores, as this research proposed, has not been applied in prior research to explain personal decisions about telemedicine programs. As a contribution of this research, we extend the model of altruistic behavior of Schwartz [1970], Schwartz [1977] to the context of parents' telemedicine engagement. This research developed a contextualized model by adding the moral perspective of personal decision as a conviction to engage in a telemedicine program. Moreover, contribution to theory is the inclusion of personal mores as mediation of trust beliefs on attitude. The proposed model provides a new perspective about how trust can affect attitude through the mediation effect. That is, when individuals are confronted with morally questionable decisions (i.e., trusting the hospital

about children's wellbeing), they may use their own personal mores as justifications about the situation for developing an attitude toward behavior. Thereby, individuals' decision may not always be purely rational, and moral beliefs are also involved. As a practical contribution of this research, triggering parents' personal mores as a conviction that supporting school telemedicine is the right thing to do, as revealed in the view of the model of altruistic behavior of Schwartz [1970], Schwartz [1977], should be considered. As such, it is a matter of convincing parents of the benefits of school telemedicine, as revealed through time-flexibility, and building and keeping a trustworthy reputation that can contribute to this mission, which can also be achieved by the mediation effect of personal mores on attitude.

This research proceeds in five sections. The background of the research and past literature on the school-based telemedicine program will be reviewed in the second section. The third section is dedicated to the theories and development of hypotheses. The fourth section will discuss the preliminary data analyses. Finally, the fifth section will present conclusions and this study's future direction.

## **2. BACKGROUND AND LITERATURE REVIEW**

### **2.1. Benefits of Children's Hospital of Philadelphia (CHOP)'s School-based Telemedicine Program**

CHOP's school telemedicine enables physicians and registered nurses to examine children physically with assistance from the school nurses who coordinate that interaction. Remote physicians and registered nurses can view students' skin, ears, throats, listen to their lungs and hearts, and provide healthcare for low-acuity issues. The CHOP physicians can then send CHOP and non-CHOP primary care physicians visit summaries electronically and e-prescribe medications through electronic health records. Parents can get their children's medications after work when real-time communication is not needed. This method of communication can allow more time-flexibility for parents to prevent scheduling conflict at their work and alleviate the need to take children to Pediatric Emergency Department (ED) for many services.

## 2.2. Current Research on School-based Telemedicine

A review of published research was conducted using google scholar's database. School, telemedicine, parents, moral behavior, and trust were among the researched keywords. One research theme discussed the benefits of school-based telemedicine/telehealth for children's wellbeing. Studies have shown that a school telemedicine program is one strategy to minimize the number of non-urgent ED visits [Izquierdo et al., 2009, McConnochie et al., 2009, Sanchez et al., 2019]. Research has shown that school-based telemedicine/telehealth programs are beneficial in delivering care to children [Martin and North, 2021]. In addition, school-based telehealth can provide significant health benefits to underserved regions and children in need [Bian et al., 2019, Whitten et al., 1998]. Kistler et al. [2019] showed that school telehealth reduced caregivers' and children's stress and improved timely access to health in a rural and poor area. Martin and North [2021] showed that minimizing the strain on parents who miss work is one of the significant benefits of a school-based telemedicine program. Tye et al. [2020] indicated that a perceived increase in health awareness and empowerment of children was a benefit of using school-based telemedicine program. Lessard and Rn [2000] indicated that telehealth provided students with more access to primary care. In another study, school-based health technology utilization was associated with a reduction in children's school absenteeism [Dougé et al., 2019, Lam et al., 2021]. In addition, McConnochie et al. [2010] indicated that applying the health-e-access program decreased illness-related absences and ED visits among young children. Moreover, Langkamp et al. [2015] showed that 85% of parents of children with developmental disabilities could stay at work after using a school-based telemedicine program. In another research theme, the role of parents in school telemedicine is discussed. Koren [2020] showed the importance of parents' and caregivers' participation in teen's care which can be applied through a school-based telemental health program. The results indicated that both parents and teens were satisfied with the program's quality of its convenience and accessibility. Young and Ireson [2003] showed that primary care provided by school-based telehealth was rated as an acceptable alternative to the current health care system by parents, nurses, children, and pediatric providers. Mackert and Whitten [2007] studied a school-based telemedicine project in Kansas University Medical Center called TeleKidcare and indicated that TeleKidcare makes it possible

for parents, school nurses, and important people, to engage with a child's wellbeing at the same time. In another line of related research, the barriers, and facilitators to implementing the school-based telemedicine program were evaluated. A lack of support and involvement of parents' or caregivers' participation in care planning was described as a barrier in school-based telehealth implementation for asthma care [Johnson et al., 2021, MacGeorge et al., 2021]. In addition, nurses noted that establishing trust with family was another significant barrier in telemedicine enrollment for asthma care [Johnson et al., 2021]. In a systematic review, Nelson and Rajan [2018] identified trust and effective collaboration as two of the substantial facilitators for implementing school-based health screenings. In another study, parents were asked to assess their ability to trust the school-based telehealth program for diabetic children's care. Results indicated an improvement in parental perception of trust [Damgaard and Young, 2014].

### **3. THEORY AND DEVELOPMENT OF HYPOTHESES**

#### **3.1. Attitude Toward a School-based Telemedicine Program**

The model developed for the current research was based on several theories. This research postulates that parents' personal mores, trust in hospital, and time-flexibility provided by telemedicine may affect parents' attitude toward school-based telemedicine adoption. Attitude refers to "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in the question" [Ajzen, 1991, p. 188]. Extensive studies have examined the role of attitude in the context of telemedicine adoption [Chau and Hu, 2002, Ramírez-Correa et al., 2020]. In the context of this research, parents or caregivers may have considered it is either a good or bad choice to enroll their children in the school-based telemedicine program, which is affected by different factors discussed in this section.

#### **3.2. Parents' Personal Mores**

Parents' personal mores are articulated from the morality perspective based on the model of altruistic behavior of Schwartz [1970], Schwartz [1977]. Schwartz [1970] developed a socio-psychological model to elucidate the role of a person's moral norms (i.e., moral obligation) as the motivational constructs affecting

behavior. Moral norms are regarded as individuals' self-evaluation measures, rising from the expectation of adhering to one's own set of moral principles [Schwartz, 1970, Schwartz, 1977]. Schwartz [1970] identified two necessary conditions that influence whether a person's moral norms will be triggered and affect behavior. First, individuals must be aware that their decision may have consequences for others' wellbeing, and second, individuals must take some responsibility for their decisions and consequences [Schwartz, 1970]. Therapy, individuals first feel a sense of responsibility which leads them to establish an obligation toward a particular behavior based on their assessment of whether it is the right thing to do for others' wellbeing (i.e., awareness of consequences). This obligation then leads individuals to involve in a particular behavior [Schwartz, 1970]. In the context of the school-based telemedicine program, the personal mores are operationalized as the positive feelings of doing the right thing that contributes to others' wellbeing. Past research has shown the effect of personal norms on environmentally relevant behavior [Khan et al., 2019, Kim et al., 2022].

Extending this model to telemedicine programs, this research hypothesizes that the same principle should be true in the case of the school-based telemedicine program. Parents and caregivers are responsible for their children's health and wellbeing. They can be psychologically affected if they perceive supporting school telemedicine as a moral act associated with children's health and wellbeing. They may feel satisfied to support the school telemedicine if they believe supporting is what should be done. If parents believe the hospital and the value it brings to the health of children, the community, and the school district, they may feel responsible for supporting this institution dedicated to the children's treatment. This responsibility toward the hospital and children's wellbeing leads them to develop a personal obligation based on their assessment (i.e., awareness of consequences) of whether supporting is the right thing to do. This obligation may affect parents' attitude toward school-based telemedicine, consistent with the altruistic behavior model of Schwartz [1970], Schwartz [1977]. Therefore, if parents feel supporting is the right thing, which can contribute to something good (e.g., benefits the community, school district, and children's wellbeing), this



belief will likely lead to a positive attitude toward telemedicine adoption. The following hypothesis about parents' personal mores is formulated to be tested.

H<sub>1</sub>: Parents' personal mores are associated with an increased positive attitude toward school-based telemedicine adoption.

### **3.3. Trust in CHOP**

Trust in the healthcare organization providing telemedicine is the second crucial area that needs to be evaluated. Trust is a willingness to rely on another party based on beliefs in the trustworthiness of that party. Trustworthiness is a set of beliefs, partly based on experience, defined as the combination of ability, integrity, and benevolence [Mayer et al., 1995]. Trust is the expectation that a person has on others not to betray him or her by being opportunistic and taking advantage of the situation, which that trusting person assumes that the organization is honest, caring, and able [Mayer et al., 1995]. Trust plays a critical role in the context where the users' security and privacy are at risk, such as IT-based medical services. Previous studies have stressed the importance of trust within the context of telemedicine adoption [Baudier et al., 2021, Kamal et al., 2020, van Velsen et al., 2017]. The inclusion of trust in a telemedicine program in the context of this research is important because telemedicine is a link to the healthcare organization behind the program; thereby, deciding about a portal may depend on what the people behind the program will do. This research has grouped trust and those three trustworthiness dimensions in one construct in school-based telemedicine program consistent with research in IT [Gefen et al., 2003, Jarvenpaa et al., 1999].

In the realm of this research, it is hypothesized that trust can be a critical antecedent of parents' personal mores. This research argues that trust can influence the domain of morality in parents' minds and their evaluation of what is right. As equivalent with the trust theory of Mayer et al. [1995], parents who trust CHOP do so partly based on their previous experience about the integrity, ability, and benevolence of CHOP personnel. It means that they are willing to accept risk and vulnerability in their relationship with the hospital personnel about their children's health and wellbeing. This "willingness to take risk (i.e., be vulnerable) in relationship" [Schoorman et al., 2007; p. 350], may involve individuals' own moral belief

about trustees to justify cooperating in a decision. If parents believe that CHOP personnel are trustworthy and act in the best interest of their children, this belief is expected to affect parents' personal mores by persuading them to support this institution which is dedicated to their children's treatment. Parents are unlikely to believe supporting the hospital is the right thing to do for the children's wellbeing if they do not believe in CHOP personnel's expertise to provide care for children. Contrarywise, parents who trust that hospital's personnel are honest and able, and act in their children's or the community's best interests may convince that supporting the hospital is the right thing. Thereby, in the realm of this research, the positive beliefs of supporting the hospital will be influenced if parents believe that CHOP personnel are trustworthy. This positive belief of doing the right thing then triggers parents' moral decision. As such, it is likely that trust influences parents' personal mores in favor of supporting CHOP's school telemedicine if they believe that the hospital will act on their own moral beliefs about children's health and wellbeing. The following hypothesis was formulated to be tested.

H<sub>2</sub>: Trust in Children's Hospital of Philadelphia (CHOP) is associated with increased parents' personal mores in favor of school-based telemedicine adoption.

In this research, it is also hypothesized that trust is associated with increased attitude toward school telemedicine. As equivalent with the trust theory of Mayer et al. [1995], parents who trust CHOP do so partly based on their previous experience about the integrity, ability, and benevolence of CHOP personnel. They are willing to accept risk and vulnerability in their relationship with the hospital staff about their children's health and wellbeing. This risk should be higher among parents or caregivers who have no previous experience with CHOP personnel's integrity, ability, and benevolence. Thereby, trust becomes crucial when the perceived risk increases. Applying the same logic to this research, consistent with research in IT adoption [Gefen et al., 2003], if parents believe that CHOP is less trusted they may be less inclined to be exposed to more risk via school telemedicine about their children's health. Thereby, they may have considered it is not a good choice to enroll their children in the telemedicine program. Contrarywise, parents who trust that hospital staff are competent and act in their children's or community's best interests may

have considered it a good choice to enroll their children in the telemedicine program. Research into trust and IT adoption has taken this scope of trust across many health-related IT types [Gao et al., 2016]. Therefore, we test this assumption through the following hypothesis.

H<sub>3</sub>: Trust in Children's Hospital of Philadelphia (CHOP) is associated with increased positive attitude toward school-based telemedicine adoption.

This research proposed that parents' personal mores as positive beliefs of doing the right thing can be thought of as mediation of trust on attitude in this process. That is, when parents are confronted with a morally questionable decision (i.e., trusting the hospital about children's wellbeing), they may use their own moral beliefs as justifications about their decision for developing a positive attitude toward school telemedicine. Therefore, parents' decision may not be purely rational alone, but moral beliefs may also be involved in their decision toward school telemedicine. Post hoc analysis will be implied to test this assumption.

### **3.4. Time-flexibility Provided by a School-based Telemedicine Program**

Examining children at school through school-telemedicine is a time-efficient method for parents or caregivers. The time-flexibility possibilities provided through school telemedicine/telehealth can allow parents to save time and money and eliminate the transportation or geographical barriers that parents or caregivers face when seeking health care for their children. Thereby, it is expected that the time-flexibility possibilities provided via school telemedicine have the potential to improve children's health and wellbeing by minimizing health disparities and enhancing access to care. Especially in our research, school telemedicine can benefit users by providing many medical services on school premises and alleviating parents' need to take their children to a hospital for those services. Parents' beliefs about the time-flexibility provided through school telemedicine can be explained by the expectancy-value model of Ajzen and Fishbein [1977]. Beliefs are formed when individuals associate them with certain outcomes. These outcomes can be either positive or negative. If an individual has a positive perspective of behaviors, they may produce positive outcomes; conversely, if an individual holds a negative view of behaviors, that may

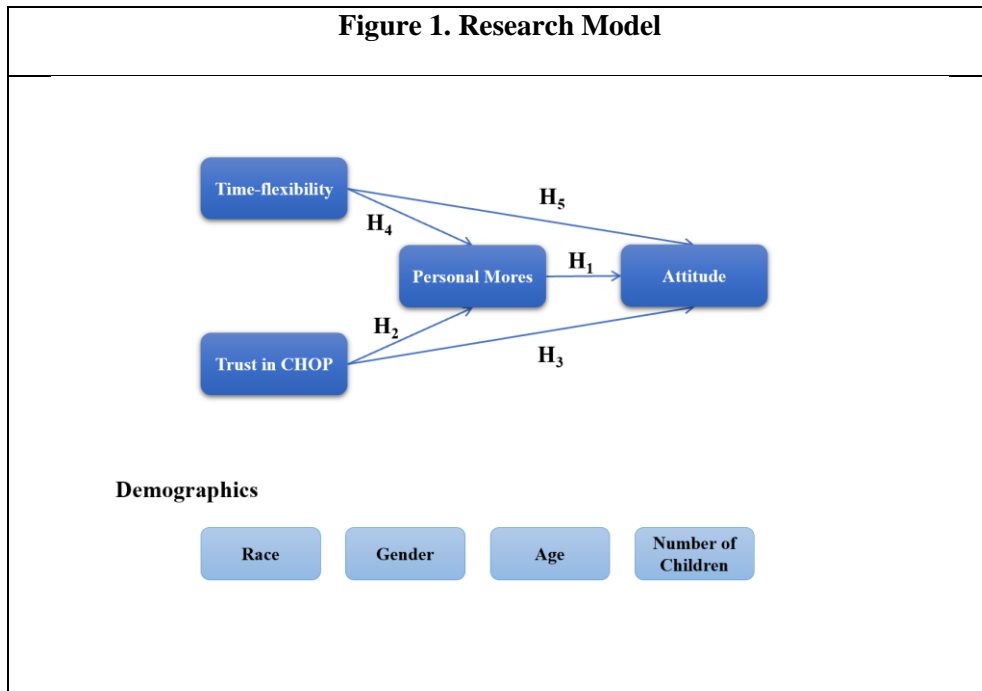
create negative outcomes [Ajzen, 1991]. Applying this logic to this context, this research argues that the belief about the benefits that such a time-saving system brings to the family and community may influence parents' personal mores by triggering positive feelings about supporting such a program that contributes to good causes (e.g., children's health and wellbeing). Thereby, if parents believe that enrolling their children in a telemedicine program allows them more time-flexibility or prevents scheduling issues at work, it is more likely they believe supporting such a system is the right thing to do. Such a belief can then trigger parents' personal mores. Thereby, we test this assumption through the following hypothesis.

H<sub>4</sub>: Time-flexibility provided by the school-based telemedicine program is associated with increased parents' personal mores in favor of its adoption.

In addition, it would be reasonable to expect that the time-flexibility provided by school-based telemedicine, which assists parents in saving time and money would meet with enthusiasm. It is rather apparent and can be rational to develop a positive attitude toward such a program when parents believe school telemedicine grants them more time-flexibility and prevents scheduling issues at work. Thereby, the model included the time-flexibility possibilities as a control to indicate that the conceptual framework holds even after accounting for the rational reason the system was created to support. Therefore, the following hypothesis was developed to be tested.

H<sub>5</sub>: Time-flexibility provided by the school-based telemedicine program is associated with increased positive attitude toward its adoption.

The research model is depicted in Figure 1.



#### 4. DATA COLLECTION AND ANALYSIS

##### 4.1. Data Collection

After receiving all legal and Institutional Review Board (IRB) approval, the survey was administrated in 2019. It began on June 6, 2019, and closed on October 28, 2019, just before the onset of the COVID-19 pandemic. Online invitations were sent to participants explaining the research’s rationale and the necessity for responses by the family members. Participants were encouraged but not forced to complete the questionnaire. The only inclusion criteria in selecting the sample were that the participants must be any parent with a child in grade K-12 attending school in either Norristown or Philadelphia districts. Community leaders (such as groups with strong relationships to undocumented individuals residing in the specified districts), parent groups, teachers, and administrators were encouraged to share the questionnaire with parents of children who satisfied the inclusion criteria. Of the 403 total responses to the survey, 230 responses were complete and included in the analysis. The survey began with questions about the demographics and ended with the 7-point Linkert scale questions about attitude, time-flexibility, personal

mores, and trust in CHOP items. The name and email address of participants were removed before the data was shared with the authors to avoid Protected Health Information (PHI) issue in this research.

The demographics show that 88.51% of the participants were female, and 11.49% were male. 68.39% were Caucasian and 31.61% others (African American, Asian, Hawaiian, American Indian, and mixed). The demographic variable of race is heavily skewed; however, that is the reality in this population. Their age groups were 2.11% Gen Z (18-25), 6.02% Gen Y2 (26-30), 36.75% Gen Y3 (31-40), 51.81% Gen X (41-55) and 3.31% baby boomer. 50.29% of participants had one child, 35.63% had two children, 10.63% had three, 1.72% had four, and 1.72% had five children.

#### 4.2. Measurement Model

A Principal Component Analysis (PCA) was conducted on the measurement items. One of the survey questions (Attitude4) was dropped due to the low item loading, and the final PCA indicated 4 factors with eigenvalues above 1.0 (factor 1: 7.89, factor 2: 4.22, factor 3: 1.50, and factor 4: 1.06), accounting for 77.19% of the cumulative variance. The standardized loading after a Varimax rotation is depicted in Table 1 and the survey items in Table 2. Descriptive statistics and reliability analysis are shown in Table 3 and the correlation matrix in Table 4. Cronbach's alphas of the constructs are acceptable [Nunnally, 1994].

	<b>Factor1</b>	<b>Factor2</b>	<b>Factor3</b>	<b>Factor4</b>
<b>Attitude1</b>	-0.03825	0.50695	0.76361	-0.04757
<b>Attitude2</b>	-0.12071	0.37852	0.8172	-0.14948
<b>Attitude3</b>	-0.08466	0.42183	0.7621	-0.16663
<b>Time_flex1</b>	0.09118	-0.16681	-0.37723	0.54289
<b>Time_flex2</b>	0.11362	-0.22647	-0.00978	0.77128
<b>Time_flex3</b>	0.1333	-0.01377	-0.47024	0.68897
<b>Time_flex4</b>	0.06257	-0.22726	0.03458	0.78955
<b>PersonalMores1</b>	-0.10766	0.7976	0.28148	-0.16218
<b>PersonalMores2</b>	-0.15043	0.85988	0.28668	-0.15897
<b>PersonalMores3</b>	-0.12414	0.85464	0.29152	-0.24853
<b>PersonalMores4</b>	-0.17031	0.79828	0.17099	-0.1835

T_CHOP1	0.90076	-0.21061	-0.00738	0.0083
T_CHOP2	0.90292	-0.16242	0.04872	0.05783
T_CHOP3	0.78919	-0.16191	0.04982	0.01545
T_CHOP4	0.81833	-0.02957	-0.06348	0.14224
T_CHOP5	0.91049	-0.12127	-0.02825	0.04798
T_CHOP6	0.90421	-0.06279	-0.12175	0.07321
T_CHOP7	0.89746	-0.05325	-0.18968	0.10613
T_CHOP8	0.86183	0.02894	-0.20876	0.1714

Table 2. Survey Items	
Items	Wording
<b>Attitude</b> adapted from DeMaria et al. [2019]	
<b>Attitude1</b>	Using a school-based Telemedicine service is a good idea.
<b>Attitude2</b>	Using a school-based Telemedicine service is a good way to take care of my child’s health.
<b>Attitude3</b>	The advantages of using school-based Telemedicine service outweigh the disadvantages.
<b>Attitude4</b>	A school-based Telemedicine service does not offer me a new benefit.
<b>Personal Mores</b> created based on the literature on moral norms, including Davies et al. [2002]	
<b>PersonalMores1</b>	My supporting this CHOP initiative is the right and proper thing to do.
<b>PersonalMores2</b>	My supporting this CHOP initiative will benefit community healthcare.
<b>PersonalMores3</b>	My supporting this CHOP initiative is good for the school district.
<b>PersonalMores4</b>	My supporting this CHOP initiative will enable better healthcare in Norristown.
<b>Time Flexibility</b> adapted from Knabe [2012]	
<b>Time_flex1</b>	Enrolling in or having my child use school Telehealth program in the next 12 months would allow more flexibility with my time.
<b>Time_flex2</b>	More flexibility with my time is...
<b>Time_flex3</b>	Enrolling in or having my child use a school Telehealth program in the next 12 months could prevent scheduling issues at work.
<b>Time_flex4</b>	To me preventing scheduling at work is ....
<b>Trust in Children’s Hospital of Philadelphia (CHOP)</b> adapted from Gefen et al. [2003]	
<b>T_CHOP1</b>	Based on my experience with CHOP in the past, I know it is honest.
<b>T_CHOP2</b>	Based on my experience with CHOP in the past, I know it cares about patients.
<b>T_CHOP3</b>	Based on my experience with CHOP in the past, I know it is not opportunistic.
<b>T_CHOP4</b>	Based on my experience with CHOP in the past, I know it is predictable.
<b>T_CHOP5</b>	Based on my experience with CHOP in the past, I know it knows its patients.
<b>T_CHOP6</b>	CHOP has nothing to gain by being dishonest in its interactions with me.
<b>T_CHOP7</b>	CHOP has nothing to gain by not caring about me.
<b>T_CHOP8</b>	CHOP has nothing to gain by not being knowledgeable when helping me.

<i>Items</i>	<i>Mean</i>	<i>Standard Deviation</i>	<i>Cronbach's Alpha</i>
<i>Attitude</i>	2.2902	1.1148	0.9114
<i>Personal mores</i>	2.1639	1.1658	0.9262
<i>Time-flexibility</i>	5.353	1.302	0.7321
<i>Trust in CHOP</i>	5.6386	1.4476	0.9602

	<i>Attitude</i>	<i>Personal mores</i>	<i>Time-flexibility</i>	<i>Trust in CHOP</i>	<i>Age</i>	<i>Gender</i>	<i>Race</i>	<i>Number of Children</i>
<i>Attitude</i>	1							
<i>Personal mores</i>	0.654***	1						
<i>Time-flexibility</i>	-0.497***	0.481***	1					
<i>Trust in CHOP</i>	-0.193**	0.288***	0.226***	1				
<i>Age</i>	0.115	0.069	-0.045	0.009	1			
<i>Gender</i>	-0.109	-0.141*	0.071	0.092	-0.168*	1		
<i>Race</i>	-0.088	-0.155*	0.073	-0.087	0.141**	0.0403	1	
<i>Number of Children</i>	-0.171**	-0.061	-0.011	0.058	-0.11*	-0.025	-0.051	1

\* Significant at the .05 level, \*\* at the .01 level, \*\*\* at the .001 level

Harman's single factor test was conducted to check Common Method Bias (CMB) [Podsakoff et al., 2003]. According to the assumption of this test, CMB is a critical issue when a single latent construct accounted for a considerable amount of covariance among the measures. The PCA analysis indicated that all the measurement items did not load in a single factor, and the single factor did not account for more than the threshold 0.5 of total covariance among all the measures.

<sup>1</sup> Note that Personal mores and Attitude were reverse coded.



## 5. CONCLUSION AND FUTURE WORK

Because of its potential benefits and impacts, school-based telemedicine programs have become a remarkably important topic to study. An unexpected challenge to engage parents and caregivers to support the school telemedicine services suggests a need to study the factors that may persuade parents to support such a program. Based on the review of previous studies, this research was designed as a theoretical framework to address this challenge by stressing the need to study parents' personal mores in this process. Personal mores are defined as the positive beliefs of doing the right thing which contributes to good causes (e.g., benefits the community, school district, and children's wellbeing), which is articulated from the morality perspective based on the model of altruistic behavior of Schwartz [1970], Schwartz [1977]. In fact, what matters is the conviction that parents or caregivers should take action, which is presumed that this conviction derives from the moral side of their parents' personal decision. However, triggering parents' personal mores to engage in school telemedicine is not only a matter of convincing them of the actual benefit the telemedicine system was created to provide (i.e., time-flexibility). Nor is it only also a matter of building trust. This research argues that parents may not believe supporting the hospital contributes to good causes for children and the community if they do not believe that the hospital's personnel are trustworthy, or do not believe in the actual benefits that time-saving possibilities bring to their children's wellbeing and health. Thereby, one of the primary contributions of this research is to extend the model of altruistic behavior of Schwartz [1970], Schwartz [1977] to the context of parents' telemedicine engagement. In addition, the proposed model provides a new perspective about how trust can affect attitude through a mediation effect of personal mores. This study asserts that when parents are confronted with a morally questionable decision (i.e., trusting the hospital about the benefit it brings to children's health and wellbeing), they may use their own moral beliefs as justification for their decision for developing attitude toward school telemedicine. As such, parents' decisions may not always be purely rational, and moral beliefs are also involved. From a practical standpoint, addressing the need to morally convince parents or caregivers about school telemedicine should be considered. The hospital can trigger parents' personal mores as a conviction to engage in school telemedicine. However, it is a matter of convincing parents of the

benefits of school telemedicine and building and keeping a trustworthy reputation that can contribute to this mission, which can also be achieved by the mediation effect of personal mores on attitude. Preliminary analyses of such a pilot school-based telemedicine portal provide initial support for the conceptual model.

This study has limitations that offer future research directions. First, the demographic variables of race and gender are heavily skewed; however, that is the reality in this population. Moreover, online invitations were sent to the participant's email address to complete the questionnaire. There was a possibility that the lack of digital literacy, proper technology, or access to the internet connection hindered parents from participating in this survey. Third, this study examined only one pediatric medical institution. Additional studies will be recommended regarding other pediatric medical institutions across the country.

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## 2022 NORTHEAST DECISION SCIENCES INSTITUTE

### Climate Change Impacts on Boston Hospitals

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#### Abstract

Climate change is one of the growing risk factors for businesses. Extreme weather events such as hurricanes, storms, coastal flooding, and extreme heat are some of the results of climate change, which impact human well-being as well as business operations. This paper aims to understand the impact of climate change risk on the hospitals around Boston, MA. We created a comprehensive list of risk factors that are intensified by climate change. The interactions between the risk factors are studied. The severity of risks in the current time and in the near future are evaluated using Kaiser Permanente's Hazard Vulnerability Analysis tool, and implications of these risks on Boston hospitals are discussed.

#### 1. Introduction

IPCC (2000) defines climate change as “a change in the state of the climate that can be identified by changes in the mean and variability of its properties and persists for extended periods decades or longer.” Extreme weather events such as hurricanes, floods, droughts, storms, and earthquakes as well as change in water resources and coastal flooding are results of climate change (Howard-Grenville et al., 2014). According to the *WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes* (1970-2019), weather related disasters increased five-fold over the past 50 years leading to over 2 million deaths and \$3.64 trillion in losses (World Meteorological Organization, 2021). In 2021 alone, there were 18 weather related disasters in the USA from January to October (Figure 1). This is a significant number compared to the number of events in previous years, which was 7.1 on average from 1980 to 2020, and 16.2 on average from 2016 to 2020.

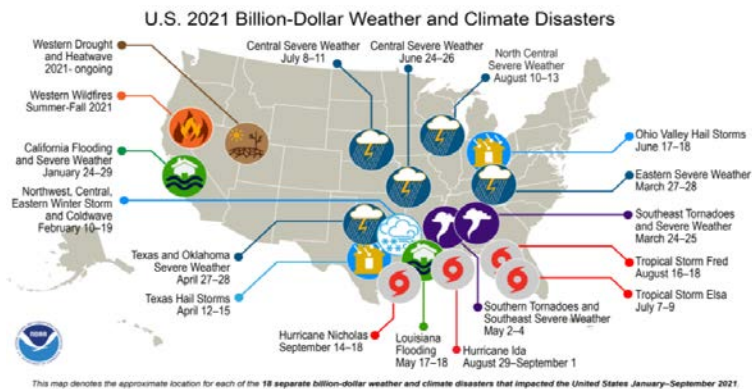


Figure 1: Weather related events in the USA in 2021.

Source: <https://www.ncdc.noaa.gov/billions/overview>

Climate change has numerous adverse impacts in our daily lives. For example, droughts and floods greatly influence food supply chains by reducing food availability (Conway et al., 2015). Flooding and sea-level rise also destroy the transport systems in terms of long trips and transport performance (Han et al., 2017). Climate change also has significant impacts on business performance. Ghadge et al. (2020) provides a comprehensive review of challenges faced by businesses due to climate change issues. Among the noted challenges are raw material supply problems, relocation of production, changes in product quality, decrease in labor performance, facility damage, transportation problems, extra costs, increasing mortality rates, decreased financial performance, and damage to the reputation of the company.

Climate change threatens universal health care in several ways (Salas and Jha, 2019). Rising temperatures have a direct impact on cardiovascular mortality, respiratory mortality, and cerebrovascular mortality (Bunker et al. 2016), as well as increase in hospital admissions (Bai et al. 2018). They also increase the spread of infectious diseases. Another impact is the rising migration from risky countries to less risky countries. Increasing demand for healthcare along with increasing population in certain areas due to migration, leads to shortage of healthcare workers and low-quality health care. Extreme weather-related events may destroy healthcare facilities and may lead to power outages. These events usually have a cascading impact amplified through the supply chain. For example, Hurricane Maria that hit Puerto Rico in 2017 led to damages in the factory that produces 44% of the US intravenous fluid, which subsequently led to intravenous fluid shortages across the US and other countries for several months (Salas and Jha, 2019). This shows the vulnerability of healthcare supply chains and emphasizes the importance of risk management.

This paper focuses on hospitals, which is one of the key fields of the healthcare system across the world. The hospital component of the health expenditure in the U.S. in 2019 was 31% or \$1.2 trillion (Centers for Medicare & Medicaid Services, 2020). Severe weather events and serious supply chain issues are found to be high probability and high impact events that the hospital sector has been facing (DRI Trends Report, 2020). Our ultimate goal is to understand the implications of climate change on Boston area hospitals and their supply chains. To this end, we took a phased approach in this project. In Phase 1, which is the topic of this paper, we created a comprehensive list of risk factors for Boston area hospitals, many of which will be intensified by climate change, and study the interactions among them. Phase 2 will be studying the risk mitigation approaches focusing on specific structures of hospitals and their supply chains.



## 2. Impact of Climate Change in Boston Area

The City of Boston is one of the most vulnerable cities in the United States to climate change and sea level rise. In fact, a study led by a World Bank economist ranked Boston as the eighth city most vulnerable to flooding worldwide (Hallegatte et al., 2013). Many of the hazards that Boston commonly experiences are projected to occur more frequently and more intensely due to climate change.

The City of Boston’s Climate Vulnerability Assessment Report (Climate Ready Boston, 2016) lists extreme heat, stormwater flooding, and coastal and riverine flooding as the major impacts of climate change in the Boston area. According to the report “Stormwater flooding and extreme heat are evaluated as frequent or chronic hazards that gradually degrade personal and economic well-being and directly expose parts of every neighborhood in Boston. Coastal and riverine flooding is expected to be an acute hazard for much of the remainder of the century, experienced through major storm events with immediate and long-lasting impacts. Moreover, as sea levels continue to rise, coastal flooding from high tides is expected to become a chronic hazard, potentially flooding many low-lying neighborhoods along the waterfront on a monthly basis. This is in addition to acute storm events, which are expected to become more severe and cause greater damage over time.”

More specific potential climate change impacts identified in *Climate Vulnerability Assessment* (Climate Ready Boston, 2016) and *Natural Hazard Mitigation Plan Update* (City of Boston, 2021), include the following:

**Extreme Heat & Droughts:** A 300% increase is expected in the mortality rate due to extreme heat; a 75% increase in droughts lasting for 1-3 months is also expected.

**River & Stormwater Flooding:** Over 11,000 structures and 85,000 people will be directly exposed to frequent flooding by 2070.

**Sea Level Rise & Coastal Flooding:** Major floods will increase from a 1% annual chance to a monthly reality; if a storm surge of 5 feet coincided with the high tide, over 132 miles of roadway could be flooded. Currently, 245 essential and public facilities lie within late century coastal flood areas. Several Boston Medical buildings and hospitals will face exposure to sea level rise in the near future.

Much of the academic research on the impact of climate change on the Boston area focused on the impact of sea-level rise and coastal flooding (Kirshen et al., 2008) in the city and in particular its transportation network (Han et al. 2017). To the best of our knowledge, this paper is among the first to study the impact of climate change on Boston hospitals.

## 3. Boston Hospitals Current Threat Landscape

To identify the current threats that Boston hospitals are facing, we used information from the *Natural Hazard Mitigation Plan Update* (City of Boston, 2021) as well as other agencies. We then grouped these threats into categories and summarized them in Table 1. It is important to note that this is a compilation of most of the threats that hospitals are facing, not just those that have climate change implications. The ones in italic are those directly impacted by climate change.

<b>Severe Weather – Seismic Events</b>	<b>Public Utilities Outages</b>	<b>IT Operational Failures</b>
<i>Hurricanes</i>	<i>Power</i>	Hardware
Tornados	<i>Water</i>	Software
<i>Windstorms</i>	Sewer	Network
<i>Snow/Ice Storms</i>	Gas	Communications Systems
<i>Wildfires</i>	<b>Public Infrastructure Failures</b>	Web Presence
<i>Floods – Coastal and Rivers</i>	<i>Public Transportation</i>	Data and Storage

<i>Floods – Stormwater</i>	<i>Bridges/Roadways</i>	<b>IT Cyber Events</b>
<i>Droughts</i>	HAZMAT	Denial of Service Attacks
<i>Temperature Extreme – Heat</i>	Nuclear Power Plant	Data Breaches
Temperature Extreme – Cold	Fuel Shortages	Ransomware/Malware
<i>Sea Level Rise</i>	Internet	Theft of Proprietary Information
<i>Air Quality</i>	Food Insecurity	<b>Infectious Disease Outbreaks</b>
Earthquakes	<b>Internal Operational Events</b>	Pandemics
<b>Internal Structural Events</b>	Quality Control	<i>Epidemics</i>
Building Structural	Workplace Violence	<b>Terrorism</b>
Fires	Malpractice	CBRN Attack
Explosion	<i>Patient Surge</i>	Mass Casualty Event
Radiation	<i>Staffing Availability</i>	Isolated Event
Gas	<i>Critical Care Services</i>	<b>Activism and Civil Unrest</b>
Chemical	<i>Support Services</i>	Strikes and Labor Actions
Water	<i>Pharmacy Services</i>	Social Media Attacks
HVAC	<i>Supplies Availability</i>	Bomb Threats

Table 1: Boston Hospitals Current Threats

There are two additional factors to consider when assessing these threats and associated impacts. The first is that there is often a relationship between two or more of the threats, which is illustrated in Figure 2. In the figure, the arrows connecting each event together are given a certain color relating to the main event they stem for. For example, “Hurricane” in the yellow box has yellow lines, one of which leads to “floods” in the purple box. Floods may lead to epidemics, power outages, sewer outages, and gas outages. They may further impact the availability of hospital supplies and staffing levels.

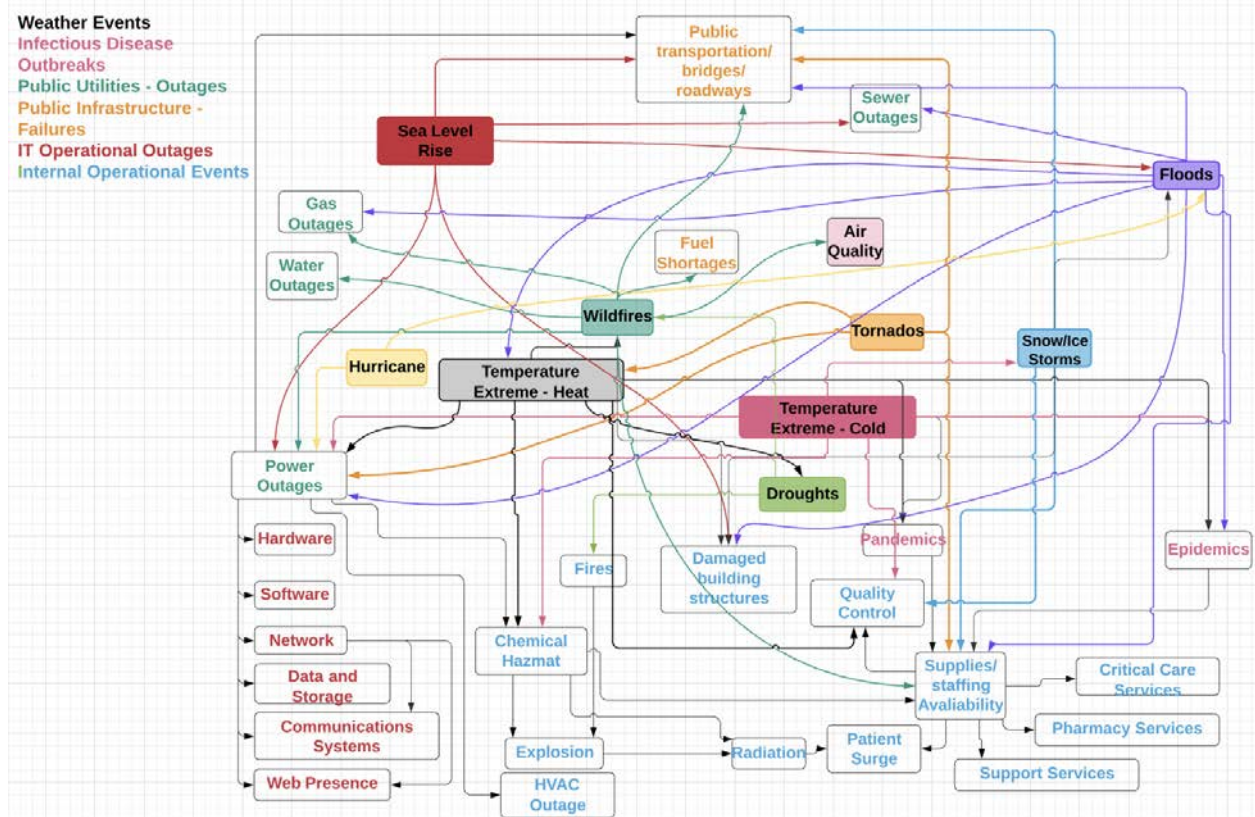


Figure 2: Interactions among climate change risks



The second factor is that the current vulnerabilities within the public infrastructure will exacerbate these climate change impacts. Two of the more significant conditions are summarized as follows:

- Boston's energy systems are critical and most essential operations rely on private companies. Vulnerabilities continue to exist within the energy generation and distribution systems.
- Telecommunications operations in Boston also rely on private companies and sometimes share critical infrastructure to provide service. Few redundancies exist, other than those built directly by these providers.

Other vulnerabilities identified in *the Climate Vulnerability Assessment* (Climate Ready Boston, 2016) as well as the *Natural Hazard Mitigation Plan Update* (City of Boston, 2021) include: an aging transit system; extensive filled land vulnerable to hazards; old buildings that pre-date building codes; waterfront development that may be subject to future sea level rise and coastal storms; narrow streets and congestions; critical equipment rooms in public buildings that are in basements and vulnerable to flooding; existing emergency stations located in low lying areas; public buildings that do not have air conditioning and are in need of repair; bridges that are underbuilt or need maintenance, some critical for reaching vulnerable populations; numerous water main breaks that led to water advisories; wastewater pump stations that service large areas and are vulnerable to flooding.

#### **4. Risk Assessments and Hazard Vulnerability Analysis (HVA)**

Many organizations address evolving threats through programs involving preparedness, mitigation, and business continuity. One of the key components of these programs is the risk assessment. The Disaster Recovery Institute International (2017) defines risk assessment as a two-step process; first, to identify risks that can adversely affect an entity's resources or image; and second, to assess these risks to determine their potential impacts to the organization, enabling it to identify the most effective use of resources to reduce these potential impacts.

Organizations use several different models to perform their risk assessments, ranging from the Threat and Hazard Identification Assessment (THIRA) model used by many state and local government entities to the Hazard Vulnerability Analysis (HVA) tool utilized by many businesses. Most of these models incorporate two basic metrics into their framework; probability and impact. The probability is simply the likelihood that a threat will materialize or an event will occur. Impact is a measurement of severity, for example, the amount of damage that is likely to be suffered.

One of the more popular risk assessment tools is the one developed by the healthcare company Kaiser Permanente (KP). Although the KP – HVA is used by organizations across many industries, it has particular significance for the healthcare industry. The US Department of Health and Human Services (HHS) provides access to the KP-HVA as a technical resource on its website. Reference to the tool on the HHS website indicates: "This tool provides a systematic approach to analyzing hazards that may affect demand for hospital services, or a facility's ability to provide those services, helping to prioritize planning, mitigation, response, and recovery activities."

Hospitals in general, have been longtime practitioners of risk assessments. This, in part, dates back to the Health Insurance Portability and Accountability Act of 1996 (HIPAA) Security rule; which requires hospitals to perform periodic assessments to evaluate risks and vulnerabilities in their environments and to implement policies and procedures to address those risks and vulnerabilities. Although the focus of these assessments is on information-security related risks, they are often expanded to include other types of threats.

### 4.1 Boston Hospitals HVA (2021)

Using the KP – HVA model, we performed an assessment of the above mentioned threats facing major Boston Hospitals as of December 2021. Figure 3 represents a brief sample of our assessment. The total score for each threat is based on the likelihood of the risk (1=low risk, 2=moderate risk, 3=high risk), and the severity of the risk, which is calculated based on the impact of the human, property, and business impacts of the threat (1=low impact, 2=moderate impact, 3=high impact).

Not surprisingly, infectious disease outbreaks – pandemics, had the highest total risk score of 10. There were a number of pandemic-related threats that were scored as an 8 including patient surge, staff availability, critical care services, and the availability of supplies. Other threats that scored as an 8 were cyber- security related events such as data breaches and ransomware/malware attacks, and severe weather such as hurricanes.

	PROBABILITY in 2021	SEVERITY in 2021			Total Score
		HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	
	Likelihood this will occur	Possibility of death or injury	Physical losses and damages	Interruption of services	
SCORE	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	
Threats					
<b>Severe Weather - Seismic Events</b>					
Hurricanes	2	2	2	2	<b>8</b>
Windstorms	2	2	2	2	<b>8</b>
Snow/Ice Storms	3	1	1	2	<b>7</b>
Wildfires	1	1	2	1	<b>5</b>
Floods - Coastal and Rivers	2	1	2	2	<b>7</b>
Floods - Stormwater	2	1	2	2	<b>7</b>
Droughts	1	1	1	1	<b>4</b>
Temperature Extreme - Heat	1	1	1	1	<b>4</b>
Sea Level Rise	1	1	1	1	<b>4</b>
Air Quality	1	1	1	1	<b>4</b>
<b>Infectious Disease Outbreaks</b>					
Pandemics	3	3	1	3	<b>10</b>
Epidemics	1	1	1	2	<b>5</b>
<b>Public Utilities - Outages</b>					
Power	3	1	1	2	<b>7</b>
Water	2	1	1	2	<b>6</b>

Figure 3: Partial HVA for Boston Hospitals (2021)

### 4.2 Boston Hospitals HVA (2030-2050)

We present a similar assessment exercise for the major Boston Hospitals with our KP – HVA model projecting into the 2030 – 2050 time period, when many of the climatologists believe the impacts of climate change will be evident. Figure 4 represents a brief sample of our projections. Our assessments are based, in part, on the *Natural Hazard Mitigation Plan Update* (City of Boston, 2021) and *Climate Vulnerability Assessment* (Climate Ready Boston, 2016).

SCORE	SEVERITY in 2030 - 2050				Total Score
	PROBABILITY in 2030 - 2050	HUMAN IMPACT	PROPERTY IMPACT	BUSINESS IMPACT	
	Likelihood this will occur	Possibility of death or injury	Physical losses and damages	Interruption of services	
	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	0 = N/A 1 = Low 2 = Moderate 3 = High	
Threats					
<b>Severe Weather - Seismic Events</b>					
Hurricanes	3	2	2	2	9
Windstorms	3	2	2	2	9
Snow/Ice Storms	3	2	1	2	8
Wildfires	2	1	2	1	6
Floods - Coastal and Rivers	3	2	2	2	9
Floods - Stormwater	3	2	2	2	9
Droughts	2	2	1	1	6
Temperature Extreme - Heat	2	2	1	1	6
Sea Level Rise	3	1	2	2	8
Air Quality	2	2	1	1	6
<b>Infectious Disease Outbreaks</b>					
Pandemics	2	3	1	2	8
Epidemics	2	2	1	2	7
<b>Public Utilities - Outages</b>					
Power	3	1	2	2	8
Water	2	1	2	2	7

Figure 4: Partial HVA for Boston Hospitals (2030-2050)

A comparison of the 2021 HVA with the 2030-2050 HVA indicates the following for selected threat categories (Figure 5):

Threat	Risk Score 2021	Risk Score 2030 - 2050
Hurricanes	8	9
Windstorms	8	9
Floods – Coastal and Rivers	7	9
Floods – Stormwater	7	9
Snow/Ice Storms	7	8
Sea Level Rise	4	8
Power Outages	7	8
Water Issues	6	7
Epidemics	5	7
Droughts	4	6
Extreme Temperature – Heat	4	6
Air Quality	4	6

Figure 5: Comparison of the 2021 HVA with the 2030-2050 HVA for Boston Hospitals

- Although the 2030 – 2050 HVA has no threats with risk scores of 10, there are several threats with risk scores of 9. These are all severe weather – seismic events that have been exacerbated by the changes in climate.
- For some threats, risk scores increased 2 points or more from their 2021 assessment, due directly to climate change factors.
- There is also a correlation or connection between several of the threat categories. As an example, an increase in extreme weather events will also result in an increase in power outages and water issues. An increase in extreme heat brought on by climate change will also result in power outages as well as increased illness levels.
- Ironically, the risk score for Pandemics went down, however the score for Epidemics went up. The thought being that there will be an increase in infectious and respiratory diseases brought on by higher temperatures and more extreme weather.

## 5. Analysis and Recommendations

From our research and associated risk assessments, the recommendations for hospitals arise:

1. It is essential that climate change adaptation be a board of director's level priority with the appropriate allocation of financial and other resources. At a minimum, we believe that this subject should be an agenda item at hospital board meetings; supported by a separate corporate program and/or project that focuses on climate change adaptation.
2. As a starting point, hospitals should identify the key objectives of the State and City hazard mitigation plans, "internalize" these and apply them to the hospital environment. As an example, the *Natural Hazard Mitigation Plan Update* (City of Boston, 2021) establishes five goals for hazard mitigation and climate adaptation:
  - Equitably protect the health and safety of the public through awareness, preparedness, and connections.
  - Increase resilience by protecting and enhancing natural resources.
  - Implement hazard mitigation and climate adaptation projects that meet strategic priorities.
  - Invest in protecting properties and structures.
  - Ensure that essential services and infrastructure will function during and after a hazard event and prepare essential services for projected climate change impacts.
3. Hospitals need to perform an annual risk assessment and/or HVA with climate change as a focus. Our research indicates there are good methodologies and associated tools in the public domain that will help facilitate this effort.
4. In performing these assessments, it is essential that hospitals include their key suppliers in this process and integrate their resiliency programs to the extent possible.
5. Hospitals should also be currently addressing some of these impending threats through preparedness and mitigation efforts. For example, Boston hospitals located near the Muddy River should address building related flood mitigation. Hospitals should also consider enhanced generator capacity or perhaps even their own power generation capabilities.

Effective risk management within hospitals will also depend upon how successful preparedness and mitigation is at the local, state and federal government levels. It is very important that hospitals become part of the public sector decision making process.

## 6. Conclusions and Future Work

In this paper, we studied the impact of climate change on Boston hospitals. We created a list of threats for Boston area hospitals and studied the interactions among them. We utilized the Hazard and Vulnerability Assessment (HVA) tool developed by Kaiser Permanente, which provides a systematic approach to recognizing current risk factors that may affect hospital services or hospitals' ability to provide those services. Finally, we projected our HVA to 2030-2050 and provided recommendations for hospitals to handle risk factors in the future that will be exacerbated by climate change.

In the second phase of this project, we will review the results of our assessments and associated recommendations with management in major Boston hospitals. Of particular interest will be the risk mitigation strategies that these hospitals are adopting to address the climate change impacts on their infrastructure and supply chains. We will further map out the supply chain structure of major Boston hospitals and study the vulnerabilities of the supply chains to climate change related threats.

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## Using Data Analytics to Improve Nursing Home Performance

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### Abstract

**Background:** There exists an array of quality performance measures for nursing homes. They can confuse consumers, administrators, and government regulators. Our methodology provides a unified multidimensional evaluation.

**Objective:** To methodology that performs a multidimensional assessment of each nursing home within any specified group of nursing homes to aid policymakers, administrators and consumers with a clear, easy to interpret evaluation of a nursing homes quality performance.

**Methods:** We use Data Envelopment Analysis to integrate several quality measures into a comprehensive benchmarking model. We present statewide results comparing DEA performance scores with the Five-Star rating using data from New York State Department of Health.

**Results:** 212 of the 526 nursing homes performing as well as possible. Public nursing homes are most likely to lie on the frontier and have the highest average performance scores. The relationship between the DEA-based performance scores and the NYS Five-star quality ratings is very weak.

**Conclusion:** DEA is a comprehensive methodology for measuring nursing home quality. The DEA factor performance scores provide detailed information for individual nursing homes, enabling administrators to benchmark their facility's quality performance and to focus quality improvement efforts more effectively.



## Introduction

The quality of care provided in a nursing home is a primary concern for both the consumer in their selection of a home and the health care administrator when identifying areas of improvement. However, there is no universally accepted measure of nursing home quality. There exist indicators that measure specific aspects of quality, such as fall and vaccination rates. While recent data for these indicators may be available to the public, consumers may be unable to effectively integrate multiple indicators as they decide on a nursing home. While an administrator can evaluate one individual indicator at a time, it is considerably more difficult to create an overall evaluation of the nursing home's quality performance. We present a methodology that performs a multidimensional assessment of each nursing home within any specified group of nursing homes. Our model uses the Data Envelopment Analysis (DEA) methodology. It differs from earlier DEA models of nursing homes in that it measures quality performance rather than operational or economic efficiency. Our results can assist consumers in selecting a nursing home and enable administrators to benchmark their facility's quality and focus resources on measures that most need attention.

## Background

In 1961, the U.S. Department of Health, Education and Welfare began studying nursing home problems reported by the Commission on Chronic Illness. The Institute of Medicine report of 1986 reported severe deficiencies in nursing home regulations and recommended that regulations focus on outcomes instead of assessment.<sup>1</sup> This prompted the development of a set of quality measures (QMs), addressing a broad range of functions and health status indicators.

The 1987 Nursing Home Reform Act imposed regulatory controls on nursing homes requiring the development of resident-level assessment and care planning systems. In 2002, the Center for Medicare and Medicaid (CMS) released "Nursing Home Compare," a guide that describes inspection results and details the quality of care for CMS-certified nursing homes.<sup>2</sup>

### The Five-Star Rating System

The Centers for Medicare & Medicaid Services (CMS) introduced its Five-Star rating system for nursing homes in 2008.<sup>2</sup> The intent was to provide residents and their families with an easy way to understand nursing home quality assessment, and to make meaningful distinctions between



high and low performing nursing homes. The CMS Five-Star rating system features an Overall Quality Rating of one to five stars based on nursing home performance in three domains: Health Inspections, Staffing, and Quality Measures, each of which has its own rating.

### Health Inspections Score

The Health Inspections score is based on a point system that assigns points to deficiencies according to their severity and scope. CMS bases Five-Star quality ratings in the health inspection domain on the relative performance of facilities within a state. This approach helps control for variation among states.

CMS determines facility ratings using these criteria:

- The top 10 percent (with the lowest health inspection weighted scores) in each state receive a health inspection rating of five stars.
- The middle 70 percent of facilities receive a rating of two, three, or four stars, with an equal number (approximately 23.33 percent) in each rating category.
- The bottom 20 percent receive a one-star rating.

### Staffing Score

CMS states “There is considerable evidence of a relationship between nursing home staffing levels and resident outcomes. The CMS Staffing Study (<https://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/NursingHomeQualityInits/Staffing-Data-Submission-PBJ>), among other research, found a clear association between nurse staffing ratios and nursing home quality of care.” (Reference: Design for Care Compare Nursing Home Five-Star Quality Rating System: Technical Users’ Guide (January 2022)). The rating for staffing is based on two quarterly case-mix adjusted measures:

1. Total nursing hours per resident day (RN + LPN + nurse aide hours)
2. RN hours per resident day

The daily resident census, used in the denominator of the reported nurse staffing ratios, is derived from MDS resident assessments.

A rating of 1 to 5 stars is assigned for both RN staffing and total staffing. Rating cut points are set using a percentile-based method based on clinical evidence on the relationship between staffing and quality. For each nursing home, the overall staffing rating is assigned based on the combination of the total and RN staffing ratings.

### Quality Measures Score

CMS uses a set of quality measures that address a broad range of function and health status indicators (some of which are risk adjusted) to describe the quality of care provided in nursing homes. Most nursing homes will have three QM ratings – an overall QM rating, a long-stay (over 100 days) QM rating, and a short-stay QM rating.

Using a complex weighting method based on points assigned to various dimensions and using cut points of the national distribution of scores, each nursing home receives quality rating stars based on its total points for long-term stay residents and short-term stay residents, and an overall quality measure.

### Overall Nursing Home Rating

Starting with the star ratings for the health inspection domain, the staffing domain and the quality measure domain, CMS adjusts the overall Five-Star rating by:

1. Adding one star if the staffing rating is four or five stars and greater than the health inspection rating or subtracting one star if the staffing rating is one star.
2. Adding one star if the quality measure rating is five stars or subtracting one star if the quality measure rating is one star.

However, if the health inspection rating is one star, then the overall rating cannot be upgraded by more than one star based on the staffing and quality measure ratings.<sup>2</sup>

NYS does not provide five-star ratings for staffing, quality measures, or overall ratings. NYS adjusts the CMS health inspections rating by calculating cut points for each region in the state (Metropolitan Area, Western New York, Capital District, and Central New York) such that, within each region, the top 10% of nursing homes receive five stars, the middle 70% receive four, three, or two stars (equally distributed), and the bottom 20% receive one star. This distribution mirrors the CMS approach nationwide.

The Quality Initiative 2012-2018 was a national effort by CMS to improve the quality of care in long-term and post-acute care facilities. The initiative was extended to 2021 challenging providers to show quantifiable results linking financial outcomes to quality performance.

Performance outcomes and quality assessment in healthcare involve a complex array of variables making it difficult to compare the performance of one nursing home to another. Donebadian showed that quality can be measured by the institution's structure, processes and outcomes, each of which can be measured along multiple dimensions. Doing so requires a multidimensional benchmarking model.<sup>4</sup>

Benchmarking is a process of comparative evaluation and a method of identification of causes that lead to high level of performance in healthcare.<sup>5</sup> Benchmarking includes comparing performance outcomes, analyzing processes meeting customer expectations, and leads to the adaptation of best practices.<sup>6</sup> Thonon, Watson and Saghatchian state "the rationale for health-care benchmarking is that institutions with excellent performance for a given outcome apply specific clinical practices that are most effective."<sup>7</sup> Quality of care was cited as the most important motivation for healthcare administrators to develop benchmarking projects. They found a lack of clarity regarding the calculation of benchmarking indicators and an increasing demand for accountability and transparency. Thus, the literature identifies the need for a clear multidimensional quality benchmarking model that uses easily understood quality indicators.

## Methodology

DEA is an appropriate multidimensional performance benchmarking tool that has been used since the 1950s in a wide variety of applications, including healthcare. The technique is well documented in the management science literature.<sup>8,9,10,11,12,13,14</sup> Emrouznejad and Yang provide a review of more than 4,000 DEA articles.<sup>15</sup> Liu et al. use a citation-based approach to survey the DEA literature and report finding 4,936 DEA papers in the literature.<sup>16</sup>

DEA empirically identifies best performers by constructing the quality performance frontier based on observed indicators from all units. DEA bases quality performance scores and potential quality performance improvements entirely on the actual quality performance of other units, free of any questionable assumptions regarding the mathematical form of the underlying tradeoffs among the observed indicators.

Several authors have applied DEA to measure nursing home *efficiency* from a financial or operational perspective.<sup>17, 18, 19, 20</sup> To our knowledge, this paper is the first to use DEA to measure nursing home *performance* from a quality perspective. To do so, we treat quality measures for which smaller values are preferred as inputs; we refer to these as SIPs (smaller is preferred). We treat quality measures for which larger values are preferred as outputs; we refer to these as LIPs (larger is preferred).

Our model uses 8 quality dimensions in the NYS DOH database that pertain to nursing home quality of care. Five of these are SIPs:

Percent of long stay residents with:

- Depressive symptoms
- One or more falls with major injury
- Pressure ulcers
- A urinary tract infection
- Excessive weight loss.

Three of these measures are LIPs:

Percent of:

- Employees vaccinated for the flu
- Long stay residents who received the seasonal influenza vaccine
- Long stay residents who received the pneumococcal vaccine

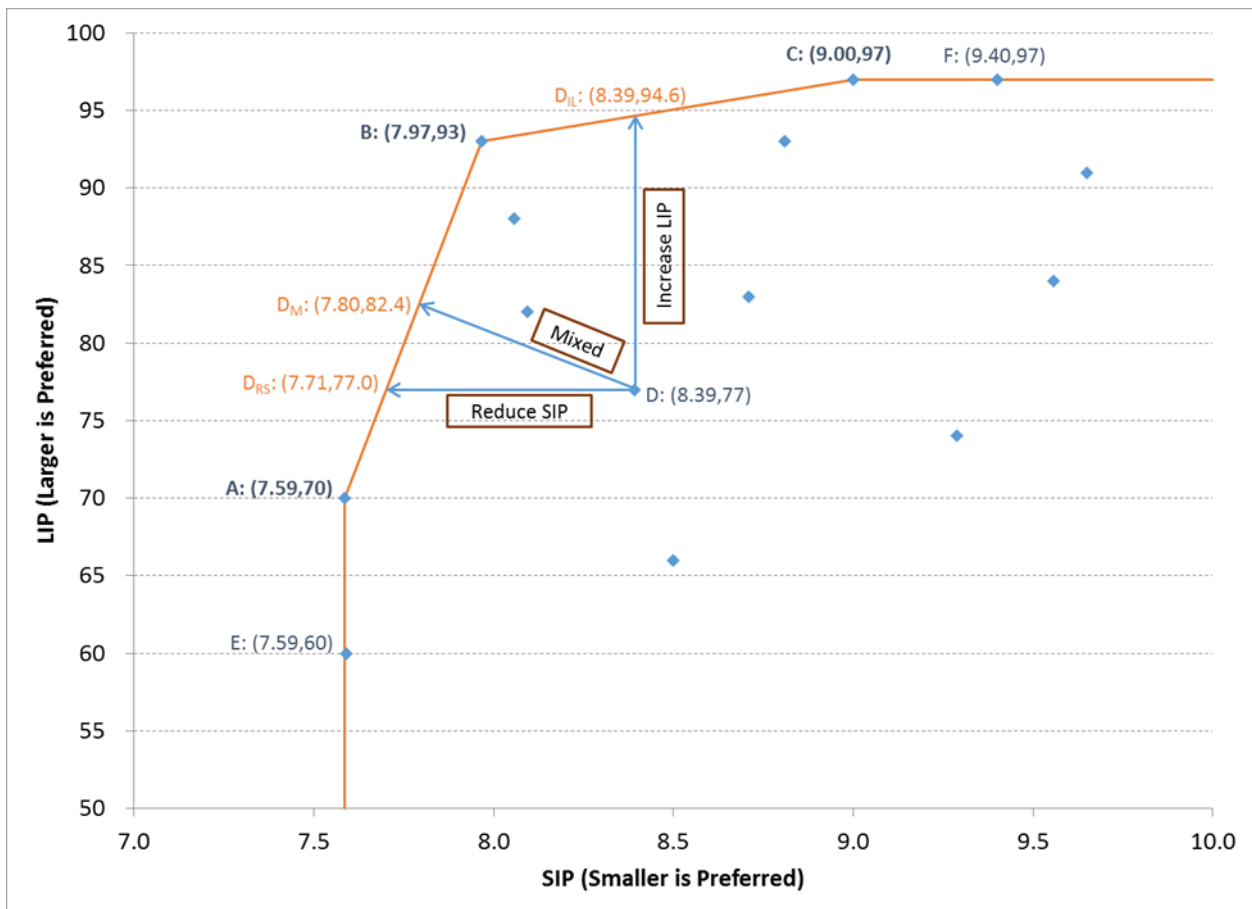
Our model incorporates one site characteristic (SC), ownership type, coded using three indicator variables for public, voluntary, and proprietary.

We also select the most appropriate set of nursing homes against which each nursing home will be evaluated, called the *reference set*, which should be large enough to provide robust comparisons. In our application, we use the set of nursing homes in New York State.

Our DEA model estimates a *quality performance frontier*, like the concept of an efficient frontier in economics. A nursing home is on the frontier if it has the same or lower level of each SIP and the same or higher level of each LIP.

DEA requires that we solve one linear program for each nursing home in our reference set. The solution to the linear program provides a benchmark, or target, for that nursing home. The target is a weighted average of the nursing homes in the reference set, with the weights chosen by the linear program. The target nursing home will have the same or lower value for each SIP, the same or higher value of each LIP, and each of its SCs will be the same as that of the evaluated nursing home.

To demonstrate fundamental concepts, Figure 1 illustrates the quality performance frontier for a simple model of nursing home quality. Assume that there is only one SIP (percentage of residents with depression, on the horizontal axis), only one LIP (percentage of residents with flu vaccine, on vertical axis) and no SCs. Each nursing home is represented by a point in the scatterplot.



**Figure 1:** An illustration of DEA using one SIP (percentage of residents with depression) and one LIP (percentage of residents with flu vaccine).

In Figure 1, nursing homes A, B, and C define the quality performance frontier. In each case, there is no nursing home (or weighted average of nursing homes) that has both a smaller SIP and a larger LIP. Therefore, we say that nursing homes A, B, and C each serve as their own targets; each has a quality performance score of 100%.

Nursing home D does not lie on the performance frontier and therefore we can identify a nursing home or combination of nursing homes to serve as its quality performance target. For example, nursing home B has both a smaller percentage of residents with depression and a larger percentage of residents with the flu vaccine, and therefore could serve as a target nursing home for nursing home D.

Since nursing home D is interested in both increasing its percentage of residents with the flu vaccine and decreasing its percentage of residents with depression, its target could lie anywhere on the frontier. We set the target at the point at which the percentage reduction in the SIP equals the percentage increase in the LIP. Consider the point  $D_M$ . This hypothetical nursing home had a lower percentage of residents with depression (7.80 versus 8.39) and a larger percentage of residents with the flu vaccine (82.4 versus 77.0) than did nursing home D. We would say that nursing home D's *factor quality performance score* for the SIP equals 93.0%, the ratio of 7.80 to 8.39, and its factor quality performance score for the LIP equals 91.4%, the ratio of 77.0 to 84.2.

Similarly, nursing home E's target is nursing home A and its quality performance score would be 85.7%, the ratio of 60 to 70. Nursing home F's target is nursing home C and its quality performance score would be 95.7%, the ratio of 9.00 to 9.40.

We recognize that a quality performance score of 100% does not mean that a nursing home cannot improve. The score is a relative measure based on the reference set.

### Model Formulation for Nursing Homes

The previous model fails to capture the complexity of nursing home quality. Let  $n$  be the number of nursing homes in the reference set and index the nursing homes by  $j = 1, 2, \dots, n$ . Let the subscript 0 refer to the nursing home under analysis (either 1, 2, ...,  $n$ ). Let  $\lambda_j$  be the weight placed on nursing home  $j$  by nursing home 0, and let  $E_0$  and  $\theta_0$  represent the largest ratio of target SIP to actual SIP and the smallest ratio of target LIP to actual LIP for nursing home 0, respectively. For example, if  $E_0 = 0.9$ , then the nursing home can reduce each of its SIPs by at

least 10%. Similarly, if  $\theta_0 = 1.2$ , then the nursing home can increase each of its LIPs by at least 20%.  $E_0$  is the nursing home's *quality performance score* and  $\theta_0$  is the nursing home's *quality nonperformance score*. The DEA quality performance model is:

$$\begin{aligned}
 & \text{Min } E_0 \text{ (or Max } \theta_0) && (1) \\
 & \text{subject to} \\
 & \sum_{j=1}^n \lambda_j X_{ij} \leq E_0 X_{i0} \text{ for } i = 1, 2, \dots, S && (2) \quad \text{Target SIP} \leq E_0 * (\text{Actual SIP}) \\
 & \sum_{j=1}^n \lambda_j Y_{rj} \geq \theta_0 Y_{r0} \text{ for } r = 1, 2, \dots, L && (3) \quad \text{Target LIP} \geq \theta_0 * (\text{Actual LIP}) \\
 & \sum_{j=1}^n \lambda_j Z_{pj} = Z_{p0} \text{ for } p = 1, 2, \dots, C && (4) \quad \text{Target SC} = \text{Actual SC} \\
 & E_0 + \theta_0 = 2 && (5) \quad \text{Balanced SIP/LIP Orientation} \\
 & \sum_{j=1}^n \lambda_j = 1 && (6) \quad \text{Weights Must Sum to 1} \\
 & \lambda_j \geq 0 \text{ for } j = 1, 2, \dots, n && (7) \quad \text{Nonnegative Weights} \\
 & E_0, \theta_0 \geq 0 && (8) \quad \text{Nonnegative Improvements}
 \end{aligned}$$

The left-hand-sides of constraints (2), (3) and (4) represent the values of the SIPs, LIPs and SCs at the target nursing home. Constraints (2) and (3) ensure that each target SIP (LIP) is less (greater) than its actual SIP (LIP) by as much as possible. These constraints work with constraint (5) so that minimizing  $E_0$  also maximizes  $\theta_0$ . Constraint (5) also ensures that the reductions in SIPs are balanced with the increases in LIPs. Constraint (6) ensures that the weights sum to one while constraints (7) and (8) guarantee that the weights and the improvement proportions are nonnegative. Constraint (4) requires that each nursing home is compared to a linear combination of nursing homes all with the same ownership type.

At optimality, the left-hand-sides of constraints (2) and (3) represent the *target values* for the SIPs and LIPs. At a given nursing home, the *factor performance score* of each SIP and LIP is the ratio of the target value to the actual value. Specifically,

$$\text{For SIP } i, \text{ Factor Performance Score} = \frac{\sum_{j=1}^n \lambda_j X_{ij}}{X_{i0}} (\leq E_0)$$

$$\text{For LIP } r, \text{ Factor Nonperformance Score} = \frac{\sum_{j=1}^n \lambda_j Y_{rj}}{Y_{r0}} (\geq \theta_0)$$

These represent the proportional improvements possible for nursing home 0; they often go beyond the improvements indicated by  $E_0$  and  $\theta_0$  and allow a more detailed examination of the performance improvements possible at nursing home 0. For example, we may find that nursing home 0 may be able to reduce all SIPs by at least 10%, as indicated by  $E_0$ , but that it may be able to reduce a given SIP even more, say 25%. This is critical information in designing an improvement program for nursing home 0 by allowing it to focus its efforts where they are most needed.

## Results

We obtained data from the NYS Department of Health for the year 2015.<sup>21</sup> We downloaded data for 589 nursing homes and removed 63 with missing data. There were no other exclusion or inclusion requirements.

### Statewide Results

Overall, 212 of the 526 nursing homes (40.3%) lie on the frontier. See Table 1, Panel A. We note that public nursing homes are most likely to lie on the frontier, with voluntary nursing homes second most likely and proprietary nursing homes least likely. The average performance scores follow the same pattern.



*Table 1: Breakdown of the nursing homes by ownership type. The odds ratios from a logistic regression model estimate that public nursing homes are 2.44 times as likely (95% CI = (1.04, 5.71)) and voluntary nursing homes are 1.62 times as likely (95% CI = (1.07, 2.44)) as proprietary nursing homes to lie on the frontier in the full model.*

<b>Panel A: Using DEA Model with Ownership Constraints</b>					
<b>Ownership</b>	<b>Number of Homes</b>	<b>Number on Frontier</b>	<b>Percent on Frontier</b>	<b>Average Performance Score (%)</b>	<b>Average Number of Beds</b>
<b>Public</b>	24	17	70.8	98.6	281.8
<b>Voluntary</b>	171	81	47.4	96.8	196.7
<b>Proprietary</b>	331	114	34.4	93.4	189.3
<b>Total</b>	<b>526</b>	<b>212</b>	<b>40.3</b>	<b>95.1</b>	<b>199.5</b>
<b>Panel B: Using DEA Model without Ownership Constraints</b>					
<b>Ownership</b>	<b>Number of Homes</b>	<b>Number on Frontier</b>	<b>Percent on Frontier</b>	<b>Average Performance Score (%)</b>	<b>Average Number of Beds</b>
<b>Public</b>	24	10	41.7	97.1	281.8
<b>Voluntary</b>	171	55	32.2	95.6	196.7
<b>Proprietary</b>	331	75	22.7	91.8	189.3
<b>Total</b>	<b>526</b>	<b>140</b>	<b>26.6</b>	<b>93.3</b>	<b>199.5</b>

It is easy to misinterpret these observations. We have constraints that ensure that the target nursing home is a weighted average of only homes of the same ownership type as nursing home 0. Thus, our model is equivalent to performing three separate DEA models, one for each ownership type. Therefore, each public (voluntary, proprietary) nursing home is measured

relative to a set of 24 (171, 331) homes. Generally, a home's performance score will be greater and its likelihood of being on the frontier will be higher if the reference set is smaller. Therefore, the pattern of performance scores may be caused by the sizes of the comparison pools.

We executed the DEA model without the ownership constraints so that each nursing home's target may include nursing homes in any ownership category. Table 1, Panel B, shows that the same pattern persists.

Next, we performed a logistic regression analysis using the Frontier binary indicator (1 = on frontier in full model; 0 = not on frontier in full model) as the dependent variable. The predictor variables are the ownership indicator variables for public and voluntary ownership. We find that both public and voluntary nursing homes are more likely than proprietary nursing homes to be on the frontier.

We performed a series of ANOVAs in which the dependent variable was (the natural logarithm of) the overall or factor performance score. In each case, ownership was the factor. We found that proprietary nursing homes perform worst overall. There is evidence that voluntary nursing homes have a higher average performance score relative to proprietary nursing homes; there is insufficient evidence that the other two differences are nonzero. We find a similar pattern with respect to depression.

There is evidence that proprietary nursing homes have a lower average factor performance score for weight loss relative to nursing homes in each of the other ownership categories. There is no evidence for a difference between voluntary and public nursing homes. There is no evidence that the factor performance scores for falls, pressure ulcers or UTI are associated with ownership type. For each of the three vaccines, we again find that proprietary nursing homes perform worst.

*Table 2: Average overall and factor performance scores by ownership type.*

Ownership Type	Average Performance Score (%)					
	Overall	Depression	Weight Loss	Employee Flu Vacc	Resident Flu Vacc	Pneum Vacc
<b>Public</b>	97.1	80.5	89.0	104.0	103.4	103.8
<b>Voluntary</b>	95.6	86.8	86.9	107.0	106.1	108.6
<b>Proprietary</b>	91.8	70.0	78.7	118.8	111.8	115.8

### DEA Performance Scores vs. CMS 5-Star Ratings

We use a nonparametric analysis of variance (Kruskal-Wallis test<sup>22</sup>) to examine the relationship between the DEA-based performance score (with ownership constraints included) and the NYS regionally-adjusted Five-star quality rating for health inspections. We find that the mean performance scores among the five groups defined by the CMS Five-Star ratings are statistically significantly different with  $P < 0.00005$ . Using Dunn's post-hoc all-pairwise comparisons test, we find three groups of CMS Five-Star ratings within which the mean performance scores are statistically indistinguishable. They are (1) 1-Star and 2-Star, (2) 2-Star, 3-Star, and 4-Star, and (3) 3-Star, 4-Star, and 5-Star. Thus, the mean performance score of nursing homes with a 5-Star rating is higher than that of nursing homes with a 2-Star or 1-Star rating. Similarly, the mean performance score of nursing homes with a 4-Star rating or a 3-Star rating is higher than that of nursing homes with a 1-Star rating.

The mean performance score of nursing homes with a 5-Star rating is not statistically significantly different than that of nursing homes with a 4-Star or 3-Star rating. Similarly, the mean performance score of nursing homes with a 4-Star rating is not statistically significantly different than that of nursing homes with a 3-Star or 2-Star rating. Finally, the mean performance score of nursing homes with a 2-Star rating is not statistically significantly different than that of nursing homes with a 1-Star rating.

Thus, while the CMS Five-Star health inspection rating (as modified by NYS) awards more stars, on average, to nursing homes with better performance as measured by our more comprehensive DEA model, it explains less than 4% of the variation in the DEA performance scores.

### Individual Facility Reporting

Table 3 shows how the overall and factor performance scores may be presented to each of four nursing homes. Nursing Home A is on the performance frontier; there is no evidence that it can improve its performance. Nursing Home B has excellent overall performance and factor performance scores but needs to improve with pressure ulcers. Nursing Home C also has excellent overall performance scores. However, it performs very poorly with respect to depression, UTI, weight loss, and pressure ulcers, and it can do better with resident pneumonia vaccines. Nursing Homes B and C illustrate the importance of the factor performance scores in

revealing significant areas for improvement that are masked by the overall performance scores. Nursing Home D is performing very poorly overall, particularly with resident pneumonia vaccines. Benchmarking information like this can assist nursing home operators in focusing on specific areas of improvement and in addressing the causes of inferior performance.

*Table 3: Sample reports for four individual nursing homes showing the DEA overall and factor performance scores.*

Home	Overall Performance Score (%)		SIP Factor Performance Scores (%)					LIP Factor Performance Scores (%)		
	SIP	LIP	Depress	Falls	Press Ulcers	UTI	Wgt Loss	Employee Flu Vacc	Resident Flu Vacc	Pneum Vacc
<b>A</b>	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
<b>B</b>	97.5	102.5	97.5	97.5	<b>50.8</b>	97.5	97.5	102.5	102.5	102.5
<b>C</b>	98.5	101.5	<b>19.3</b>	98.5	<b>62.2</b>	<b>39.2</b>	<b>44.5</b>	101.5	101.5	<b>122.4</b>
<b>D</b>	47.3	152.7	47.3	47.3	47.3	47.3	47.3	152.7	152.7	<b>198.4</b>

## Discussion and Conclusion

Nursing homes are complex operations, and we should not expect to capture their quality performance on a single scale with only 5 values. We recognize that NYS reports only its regionally-adjusted rating for health inspections and ignores the CMS ratings for staffing and quality measures and does not, therefore, report an overall five-star rating. It is possible that the inclusion of such information might improve the strength of the relationship between the five-star system scores and those developed using DEA which is weak. However, in our opinion, it is unlikely that even the overall five-star rating would explain appreciably more of the variation in the DEA scores, especially since CMS bases its overall rating by starting with the health inspections rating and then adjusting upward or downward based on the staffing and quality measures. In short, NYS presents consumers of nursing home services with a five-star rating that is only one component of the CMS evaluations and one that does not correspond very well with the more comprehensive DEA-based performance score.

We disagree with CMS's decision to include staffing as a performance measure. The objectives of the nursing home are patient-centric and therefore, while the quality of its performance may depend on its staffing level, we cannot argue that a nursing home with a higher staffing level

must be providing higher quality care. Staffing would be a sensible measure to include in a model that seeks to measure the efficiency of resource consumption. The purpose of our model is to measure performance with respect to the quality of resident care. However, the DEA model could include staffing as a SIP if so desired as a measure and therefore could be used by CMS.

Existing applications of DEA to nursing homes focus on operating or economic efficiency. To our knowledge, this paper is the first to use DEA to measure nursing home *performance* from a *quality* perspective. Our model provides benchmarking information to individual nursing home operators that enables them to focus on specific areas of improvement. For each nursing home not on the frontier, the model identifies an efficient target. By considering the nursing homes with the highest weights in their target, the nursing home in need of improvement can perhaps adapt their management techniques. While the model cannot tell an inefficient nursing home how to become efficient, it can provide guidance on who to emulate. For example, the model cannot tell a nursing home how to reduce falls, only that it needs to look for ways to do this. The nursing homes that comprise its reference set may be able to provide ideas.

We understand that alternative DEA models may be preferred in other states or even nationally. We selected our SIPs and LIPs based on common quality measures used for nursing homes and data availability. We would encourage others who wish to apply such a model to think carefully about the SIPs and LIPs and to consider the inclusion of SCs. The flexibility of selecting the SIPs and LIPs makes the DEA model applicable for any quality measure under evaluation. A description of the different measurements and how they are calculated is provided by CMS but to the ordinary consumer these can be quite complicated. The DEA model provides a clear description of the measures included and fairly compares each nursing home to each other regardless of nursing home size. Policy makers and administrators may determine the SIPs and LIPs they consider important to evaluate and may apply the DEA model. The results may aid them in improving the quality of a nursing home and directing resources to areas where they are needed the most. Consumers can better understand the categories under evaluation and how well the nursing home under their consideration scored. The limitations that may be encountered using the DEA model or any model is the quality measures data available for nursing

The Authors declare that there is no conflict of interest.

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# **Human-Technology Interface**



# Mobile Based Augmented Reality Games: A Study from Hedonic Motivation System Adoption Model Perspective

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## ABSTRACT

Although mobile-based augmented reality games (MBARG) are destined for a steady rise in terms of the market size in coming years and have been termed as 'the next big thing in mobile gaming', their acceptance from a hedonic motivation perspective hasn't received much attention among information system researchers. The purpose of the study is to propose a theoretical model based on the Hedonic motivation systems adaptation model (HMSAM) to explain the predictors that influence users' intention to engage with MBARG for enjoyment. The model based on HMSAM with new dependencies between the construct is proposed based on an extensive literature review. An online survey was conducted for data collection. The study will help us uncover important predictors about intrinsic motivation which influence users' intention for usage. Moreover, it will provide invaluable insights for MBARG designers for increasing the acceptance of their games among the target audience.

**Keywords:** Technology acceptance, model, Augmented Reality, Hedonic Motivation System Adaption Model

## INTRODUCTION

The augmented reality (AR) market is destined to grow rapidly. As per a forecast by 2025, AR marketed size will reach \$200 Billion (Liu, 2019). Whereas, the size of the AR-based gaming industry is expected to cross \$280 Billion by 2023 (Costello, 2017). Mobile-based AR is also showing an upward trend and is expected to reach \$90 Billion by 2024 ("Proliferation of Mobile App Stores and Rapid Technological Innovation Drives the Global Mobile Augmented Reality Market," 2019). With companies like Apple, Google, Microsoft leading this charge in terms of AR hardware the industry is set to witness more investment and innovation in the coming years (Aluri, 2017; Hamari, Malik, Koski, & Johri, 2019; Jang & Liu, 2020; Li & Fang, 2020). All this has caught the attention of researchers in various domains, some have studied its, application in their discipline, some have studied AR as the technology itself, however, we in the information systems area are more concerned with finding answers to why people use mobile AR Games, what is propelling their inherent motivation (Dahabiyeh, Najjar, & Agrawal, 2021; Laato, Rauti, Islam, & Sutinen, 2021; Qin, 2021).

Cheah, Shimul, and Phau (2021) have identified six motivations for playing digital games viz, immersion and flow, gratification and affect, escapism, social interaction, identification, and goal orientation. Several research has been conducted from the uses and gratification perspective (Alha, Koskinen, Paavilainen, & Hamari, 2019; Hamari et al., 2019; Jang & Liu, 2020; Rauschnabel, Dieck, & Rossmann, 2017). The uses & gratification theory argues that people are goal-oriented and are actively involved in selecting media that satisfy a particular need. But, the immersion and flow in MBARG have received comparatively lesser attention. The objective of our research is to uncover the intrinsic (hedonic) factors influencing the acceptance of MBARG using the hedonic motivation system adoption model (HMSAM) developed by Lowry, Gaskin, Twyman, Hammer, and Roberts (2013). The contribution of this research will have a major bearing on game developers and gaming companies. The following discussion is divided into 5 sections. First, we will cover literature regarding HMSAM, and Augmented Reality (AR). Then in the hypothesis development section, we will talk about the gaps and the proposed research model. In methodology, we have discussed the data collection methods and data analysis techniques. In the result and discussion section, we talk about the result obtained from the data and their interpretation. Finally, in conclusion, we have discussed the implication of our research.

## **LITERATURE REVIEW**

### **Hedonic Motivation System Adoption Model (HMSAM)**

This model, first proposed by Lowry, Gaskin, et. al (2013) was a departure from the traditional way of looking at technology acceptance in simple utilitarian terms. The authors have claimed that with the advent of technologies like social media, video gaming, and virtual reality, it would be rude to study and understand their acceptance among users from a utilitarian perspective only. These technologies which have more to do with experience, immersion, and mental devotion (Jegers, 2007; Sherry, 2004) should be studied from a hedonic motivation system (HMS) perspective. Heijden (2004) theorized that if the purpose of the system is productivity enhancement, then the utilitarian approach is more suitable, however, if the purpose of the system is prolonged use, then the hedonic approach is more suited for adaption of the system. He mentioned that systems present in the workplace have the agenda of improving productivity, but those which are present in the home of individuals are related to providing entertainment and self-fulfilling value. Furthermore, developer of hedonic systems should use attractive images, colors, sounds and appealing layouts.

Lowry et al. (2013) extended Heijden (2004) model, arguing that joy (perceived enjoyment) only doesn't represent all the intrinsic motivation, they mentioned a list of literature that talked about other intrinsic motivations apart from joy such as the desire to play and have fun, become immersed in recreation, discover a novel thing, to name a few among many. Agarwal and Karahanna (2000) have identified five sub-construct of cognitive absorption., control, curiosity, heightened enjoyment (joy), focused immersion, and temporal disassociation. However, instead of combining these five elements under a second-order construct the (Lowry et al., 2013) insisted on taking them individually, positing that flow theory, which is the parent theory of cognitive absorption haven't done so, also that it is necessary for capturing the asynchronous nature of the effect they have on behavioral intention to use. The final HSMAM model looks like as shown in figure 1. One notable thing in the figure is that it doesn't have a temporal disassociation sub-

construct of cognitive absorption because it has been merged with immersion due to its synchronous nature.

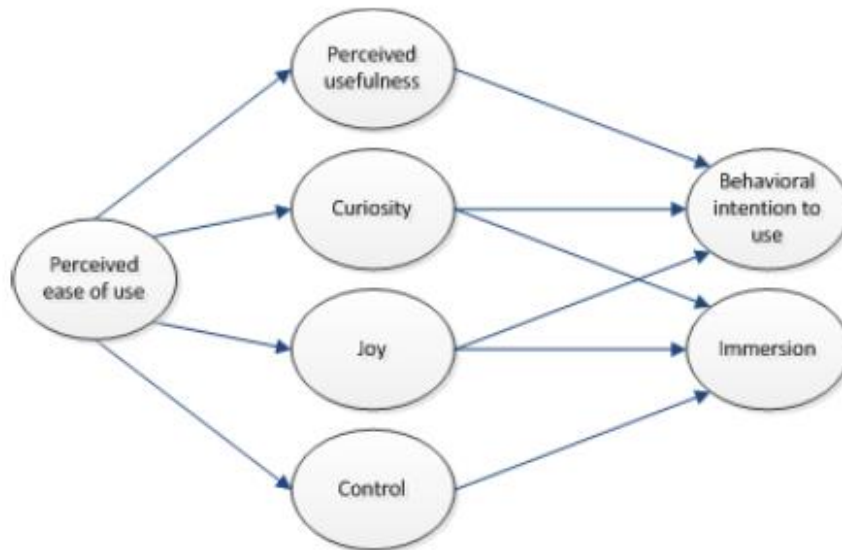


Figure 1: Hedonic-Motivation System Adoption Model

**Augmented Reality (AR)**

The idea of augmented reality (AR) was first introduced by SUTHERLAND (1968), who demonstrated a three-dimension image rendering apparatus that can change the rendered information as the user moves. But, it wasn't till the 1990s when Tom Caudell coined the term "Augmented Reality" (Motte, 2018). In other words, AR can blend the physical world with the virtual (non-existent) world and present it to the user as it's part of the environment. AR systems have three defining characteristics, they join real and virtual worlds, they enable interaction on a current basis, and they render a three-dimensional image (Azuma, 1997). Milgram et al. (1994) introduced the 'virtuality continuum' (VC) to ease the confusion among the mind of readers regarding reality and virtuality. As shown in Figure 2, towards the very left is the real environment, as we move towards the right, we first come across augmented reality (AR) (our area of interest), then when we move further to the right pass-through augmented virtuality (AV) and towards the very right end of the continuum, we have a total, pure virtual environment. All these four paradigms come under the gamut of Mixed Reality (MR).

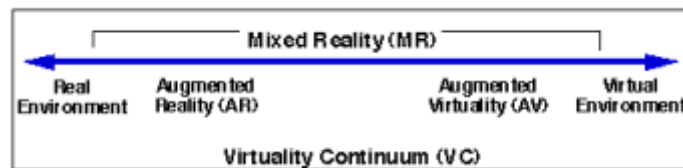


Figure 2: Milgram's Virtuality Continuum

Since then AR has opened a door for a researcher from different domains to explore its application. AR has recently gained more interest with the advancement of technology, especially computing power. The AR-related industry is believed to grow to be \$200 billion (Hyman & Paul, 2013). Azuma (1997) in his review work has highlighted the application of AR in various domains, which include medical, manufacturing and repair, annotation and visualization, robot path planning, entertainment, and military training. Recently other domains have also applied AR such as the construction industry (Chi, 2013; Tabrizi & Sanguinetti, 2018), education (Cabero Almenara & Barroso Osuna, 2016), tourism (Kounavis, Kasimati, & Zamani, 2012), e-commerce (Zhang, Navab, & Liou, 2000), employee onboarding (Newman, 2016), gaming (Szalavári, Eckstein, & Gervautz, 1998), retailing (Applefled, 2013), and cosmetics (Javornik, Rogers, Moutinho, & Freeman, 2016), to mention few among many.

In recent years AR technology has also evolved, with big players like Microsoft, Sony, Samsung launching their AR headsets. Prominent AR headsets available in the market are Microsoft HoloLens, Magic Leap One, Epson Moverio, Google Glass Enterprise Edition, Daqri Smart Glass, and Vuzix Blade (John, 2019). Similarly, the AR software development kit (SDK) has ushered. Some major AR SDKs are Appy Pie's AR/VR App Builder, ARToolKit, Vuforia, EasyAR, Google ARCore, and Wikitude SDK (Kumar, 2017).

## **RESEARCH MODEL and HYPOTHESIS DEVELOPMENT**

As apparent from the above discussion, AR is the next big trend in technology, various industries have found the application of AR bringing them closer to their audience or consumers. However, one noticeable fact is that even though AR is assumed to be immersive which is an intrinsic factor of motivation, most of the studies were conducted using TAM, and even TOE (technology-organization-environment) were focused on utilitarian aspects rather than hedonic aspects. Hence, we propose that we take a look at mobile-based augmented reality application games from a hedonic perspective. To examine the gap, we will use the modified Hedonic Motivation System Adaption Model (HMSAM) proposed by Lowry et al. (2013), our hypothesis will also be the same as HMSAM baring few changes. Figure 3 shows the proposed model. Since it's a game we expect that the PU component will not add much value, contrary to Lowry et al.'s (2013) findings. Moreover, per HMSAM findings, PEOU has no direct influence on BIU (behavioral intention for use), and control will not impact BIU. In the gaming context the greater the enjoyment (joy) a player is having the more curious will the player be to explore the game and achieve higher levels. Whereas, it has been reported that if the player doesn't find the game easy to play and control, they will show lesser enthusiasm (curiosity) in playing the game (Li & Fang, 2020). Harder games generally have lesser players (Alexander, Sear, & Oikonomou, 2013). Shin (2019) haver investigates the role of immersion in gaming and found it as a key variable in explaining the continuance usage of augmented reality games. Based

Based on the discussion following hypotheses have been proposed.

*Hypothesis 4: An increase in Joy will increase curiosity*

*Hypothesis 5: An increase in control will increase curiosity*

*Hypothesis 10: An increase in immersion will increase BI*

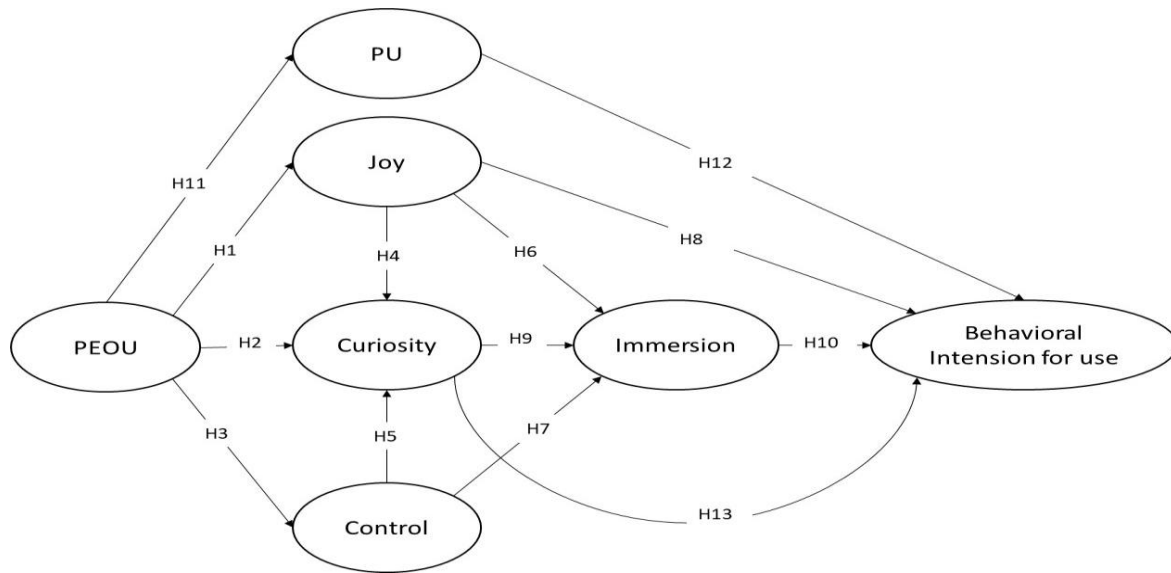


Figure 3: Proposed Research Model

### RESEARCH METHODOLOGY

To validate the model, we have used the PLS-SEM technique. We collected the data from MBARG players. We contacted them via various online communities, where they interact with each other. Before conducting the survey, we conducted a pre-test to examine the reliability and validity of the instruments. The pre-test was conducted on 33 respondents. Several refinements and modifications were performed before beginning the main survey. The demography of the respondents is shown in table 1. In the final survey, we contacted 504 gamers out of which 203 responded, we deleted some of the responses as they were partially filled, finally leaving us with 197 valid responses. Reverse coding was used to ensure that the respondents are paying attention while filling the responses. The survey was conducted online on a 5-point Likert scale. The instrument to measure the construct was taken from previous literature.

Table 1: Demographic details

Characterstics	Frequency	<i>Prior experience</i>	Frequency
<i>Age</i>		1-3 months	43
under 19	40	2-6 months	57
20-30	87	6-9 months	56
31-40	67	greater than 9 months	41
41-50	3		197
	197		
<i>Gender</i>			
Female	56		
Male	141		
	197		

## RESULT AND DISCUSSION

With an adequate measurement model and a suitably low level of multicollinearity, the proposed hypotheses are tested with PLS. The path coefficients, t-values, and R-squares for testing the structural model are shown in Table 2. Tests of significance of all paths in the research model were performed using the PLS bootstrap resampling procedure. As shown in Table 2, all paths within the model were supported at the 0.01 level except Hypothesis 12, Perceived use to Behavioral intention to use. Furthermore, it is critical to note that the proposed model accounted for a 39.1% variance in MBARG intention to use. Table 2 shows that PEOU had a significant positive effect on Joy ( $\beta=0.518$ ;  $p<0.01$ ). Thus, H1 was supported. PEOU was positively related to curiosity ( $\beta=0.876$ ;  $p<0.01$ ), providing support for H2. Furthermore, PEOU is directly related to control ( $\beta=0.661$ ;  $p<0.01$ ), proving H3. Thus, PEOU has a positive impact on players while playing MBARG for their intention for usage.

Table 2:Hypothesis result

Hypothesis	Beta	Estimate	SE	CR	p	Supported
H1: PEOU → JOY	0.518	0.409	0.11	8.61	0.001	Yes
H2: PEOU → Curiosity	0.876	0.688	0.08	14.488	0.001	Yes
H3: PEOU → Control	0.661	0.46	0.032	13.247	0.001	Yes
H4: JOY → Curiosity	0.765	0.421	0.043	12.748	0.001	Yes
H5: Control → Curiosity	0.629	0.561	0.103	12.976	0.001	Yes
H6: JOY → Immersion	0.691	0.82	0.09	5.049	0.001	Yes
H7: Control → Immersion	0.521	0.772	0.026	11.086	0.001	Yes
H8: JOY → BIU	0.643	0.244	0.08	9.735	0.001	Yes
H9: Curiosity → Immersion	0.806	0.239	0.061	14.238	0.001	Yes
H10: Immersion → BIU	0.775	0.238	0.073	10.05	0.001	Yes
H11: PEOU → PU	0.262	0.571	0.058	9.04	0.001	Yes
H12: PU → BIU	-0.441	0.267	0.375	12.795	0.614	No
H13: Curiosity → BIU	0.512	0.226	0.037	13.842	0.001	Yes

Our results also show that the effect on curiosity is more in the case of MBARG as compared to JOY and control, proving that curiosity is the main driver for MBARG adaption. Table 2 also presents that the Joy, curiosity and control had significant positive effects on immersion ( $\beta =0.691$ ;  $p<0.01$ ;  $\beta =0.598$ ;  $p<0.01$ ;  $\beta =0.521$ ;  $p<0.01$ ), supporting H6, H9, and H7, respectively. The path coefficient between joy and immersion was greater than the causal relationship between curiosity/control and immersion. The path coefficient between joy/control and curiosity is positively related, where joy has a higher impact on curiosity than control, supporting H4 and H5. The results also show that joy, immersion, and curiosity have significant positive effects on BIU ( $\beta =0.643$ ;  $p<0.01$ ;  $\beta =0.775$ ;  $p<0.01$ ;  $\beta =0.806$ ;  $p<0.01$ ), providing support for H8, H10, and H12. However, there was no significant connection between PU and BUI thus rejecting H12, respectively. The highest loading of immersion indicated a strong impact on BIU, whereas control had the lowest impact. Finally, PEOU has a weak yet significant impact on PU ( $\beta =0.262$ ;  $p<0.01$ ).



Figure 4 shows the final model. Joy and immersion are important predictors for BIU. Immersion is a comparatively stronger predictor for the BIU.

Using the model tested by path analysis using the PLS 3.29 series shows that the model built meets the goodness of fit criteria. The convergent validity that reflects the correlation between the indicator score and its construct score was valid with the outer loading value of  $\geq 0.7$  and an AVE value  $\geq$  of 0.5. The discriminant validity test that ensures that each variable has a unique value shows that the construct has an adequate discriminant in the sense that all constructs have better discriminant validity than the indicators in the other blocks. The composite reliability test that shows the reliability of indicators that tested by Cronbach's alpha, correlated item-total correlation, Composite Reliability, and Composite Reliability also shows consistently, the indicators on variables studied are consistently reliable. It has Cronbach's Alpha  $\geq 0,70$ , a correlation value and Average Variance Extracted (AVE)  $\geq 0.50$ , and Composite Reliability  $\geq 0.6$ . Evaluation of structural models in SEM with PLS that reflected by the coefficient of determination shows that the model has an R-Square of 39.10 percent (0.391). It means that aggregately the independent variables could explain the model variation moderately at 39.20 percent (.391). Meanwhile, the Context variable only explains the variation of the Perceived Ease of Use variable by 32.3 percent and Perceived Usefulness by 50.7 percent

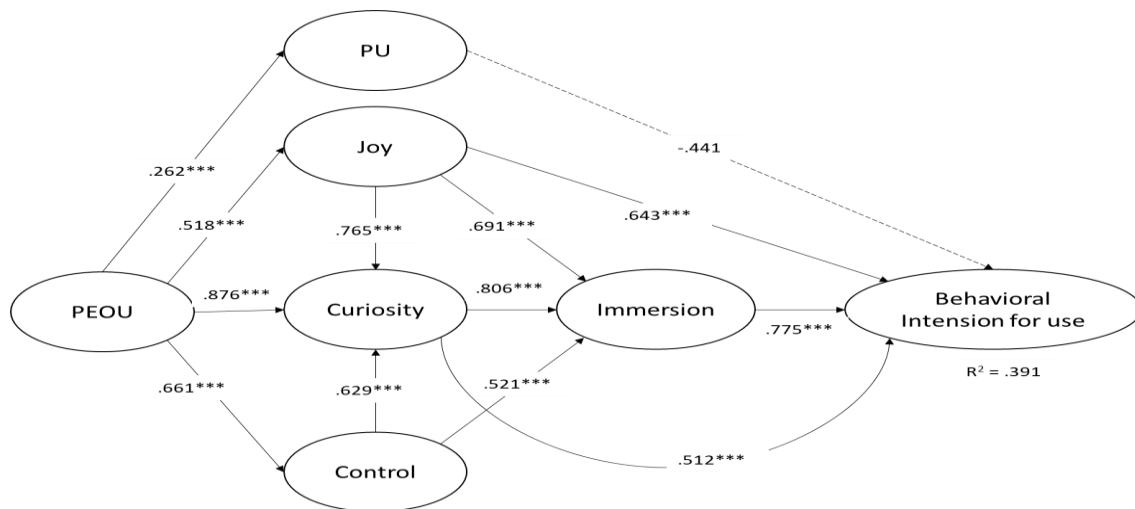


Figure 4: Final model of MBARG adoption

### CONCLUSION

We believe that finding from this work will help the game developer and gamers in making and enjoying a more immersive and playful experience as per their target audience (Male/Female or based on age group). The game developer will be able to develop games that will appeal to the hedonic motivation, thus designing more engaging games. This engagement can be leveraged through various means such as by cross and upselling other offerings of the company, by deploying an in-app purchase model which will positively impact the company's top-line items directly. Furthermore, immersion has an important role in MBARG adoption. Creating more immersive games with achievable levels or game design may attract more players.

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# **Innovation and Creativity**

## **Creativity and Innovation: A Critical Review**

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### **Abstract**

The academic study of creativity and innovation has a lengthy history. Organizational creativity and innovation constitute a significant portion of the literature, especially in business. The influence of organizational bias towards the status quo, conforming thereto, and the accompanying underrepresentation of individuals that can be categorized as “other” in organizations does not appear in the literature. This author believes it is a potentially important area of study.

*Keywords:* Creativity, Innovation, Diversity

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## **Creativity and Innovation: A Critical Review**

The importance of creativity and innovation in business has grown over time, such that successful implementation of these two concepts is now regarded as important characteristics of many successful enterprises. However, the literature points out that there is a strong tendency in organizations to retain the status quo, which creativity and innovation by necessity require going against. Those rising to positions of power and influence in business, and therefore possessing a greater impact on organizational creativity and innovation, may be less diverse, nonconformist, or “other”. Those in power also may be less likely to value creativity and innovation over those skills which allowed them to rise in their organizations. This author, in reviewing 60+ years of literature, has not found any work in this area. It is suggested that this could be a meaningful gap in the literature.

This paper is not a research summary but rather a position paper.

### **Literature Review**

Creativity as a field of study has a lengthy history. A review of literature published in the last 60+ years allows us to put together a timeline of some major developments.

Campbell (1960, p. 380) put forth the notion that creativity can be viewed in the perspective of “a blind variation-and-selective-retention process”. Stein (1967, p. 109) gave us the following full definition of creativity: “The creative work is a novel work that is accepted as tenable or useful or satisfying by a group in some point in time.”

Staw (1990, p. 288) tweaked Campbell’s blind-variation-and-selective-retention process by positing that “...[p]eople may consciously alter the creative process.” Stating this another way, Staw continues (p. 289): “...[i]n short, variation need not be completely blind nor retention entirely fortuitous.” Strengthening the evolutionary argument Staw also states (p. 290) that “...[a]lthough the absolute levels of variation and selective retention are no doubt important to creativity, so too are the ways these evolutionary processes combine over time. ...the appropriate sequencing of variation and selective retention may determine whether a creative product will be evoked or not.”

In Staw's (p. 293) analysis of creativity, the individual certainly plays a large role:

Variables such as cognitive skills, technical training and background are all obvious contributors to the reservoir of knowledge from which one can draw alternative solutions. Likewise, having domain-relevant skills (including those in ancillary areas) will no doubt improve one's chances of selecting a useful solution from among the many alternatives. Without substantial task knowledge, the choice of potential solutions would be largely arbitrary, resembling blind trial and error rather than an ordering based on the prospects for success.

Once the individual generates a creative idea, however, and according to Staw (p.293), "...[t]he individual's response to the situation will determine whether a given solution will be discarded in favor of other alternatives or retained over time."

As related by Staw (1990, pp. 294-5), it takes power and to move creative ideas forward. As Staw states:

...[i]nnovations, as Kanter describes them, move over time from an idea generation stage in which an issue is introduced by internal or external change agents, to a coalition building stage in which power is required to move an idea forward, to an implementation stage in which prototypes are developed and eventually put into full-fledged production. Innovation is therefore much more than the summation of the creativity of individuals making up the organization. Questions of organizational structure, power, communication and external economic conditions are just a few of the situational factors that affect innovation over time.

But it is relatively common for organizations to struggle to make sense of, value, and operationalize creative ideas. For, as Staw notes (p. 295): "Innovation does not, for example, come out of the everyday administration of organizations and the enforcement of its procedures (Scott, 1981). It is something distinct from the natural effect of the system to limit uncertainty and place order on the behavior of its participants." Going further, Staw (p. 295) continues:

...[a]s shown in several normative studies (e.g. Jacobs and Campbell, 1961; Weick and Gilfillan, 1971; Zucker, 1977), common frames of reference can become institutionalized over time. Even when they have little basis in fact, norms for behavior can persist if they have become legitimized and supported by the power structure.

Individuals, alone or in concert with others are, Staw (p. 296) believes, the drivers of creativity and innovation. But given some level of inherent organizational bias against change, "...individuals are often foiled in their capacity as carriers of ideas and as sources of diversity,

yet they do have inherent capacity to recognize problems and gaps that are not addressed by the order of things.”

As Staw relates it (p. 297), many organizations exhibit the following behaviors that work against creativity and innovation:

As Schneider (1987) has noted, heterogeneity is commonly reduced through personnel selection, self-selection of individuals into the organization, peer pressure, and socialization. Deviants are seldom promoted and are usually kept on the periphery of organizational power. In addition, most of the organization’s efforts to make the system more productive and efficient drive out deviant behavior.

Staw then continues (p. 297-8), summarizing conclusions reached by Kanter and other organizational theorists: “Even if some deviant ideas do get generated, most firms are not supportive of products or courses of action that break with tradition. Basically what happens is that domain-relevant skills used by the organization to keep itself on-track tend to kill off the more innovative ventures.” This author would like to posit that, instead of deviant idea vs. non-deviant idea, it might be appropriate to think about a continuum that goes from deviant idea to nonconforming idea to conforming idea. Is it possible that individuals with nonconforming ideas find themselves (Staw, 1990, p. 297) “...on the periphery of organizational power.”? Especially given that some individuals that have had a notable impact in history due to the creativity of their ideas and research have struggled in gaining acceptance due to traits not related to their creativity? For instance, Stein (1974, p. 257), as Barnett and Stern did before him, reports that Louis Pasteur struggled to gain acceptance in the medical community at the time, “[getting elected] to the Free Association of the Academy of Medicine by only one vote...” because “[his] manner was so offensive and people responded violently to him.” Or, this author would like to posit, a creative person possesses strengths in some areas (i.e., generating creative ideas), but is weak in one or more areas necessary to fully implement creative ideas. Or, as Guilford (1959, p. 390) states, “We should not forget, however, that other abilities outside the divergent-thinking category play significant roles in creative, productive work in everyday life.” And the fact that the educational system doesn’t develop all factors equally also has impacts. Guilford (1959, p. 368), for instance, speaks of the overemphasis of verbal comprehension resulting in “...serious neglect of other desirable qualities in the general population.” Or maybe a creative individual simply fails to fully develop the full variety of skills generally accepted as those which are required for someone to excel in their chosen field.

As West (2002, p. 356) writes:

Three themes dominate the writings of researchers investigating creativity and innovation among work teams. The first is the importance of the group task and the demands and opportunities it creates for creativity and innovation. The second is the theme of diversity in knowledge and skills among team members, which researchers suggest is related to both team creativity and innovation. And the third is the theme of team integration—when team members work in integrated ways to capitalise on their diverse knowledge and skills, researchers believe that both creativity and innovation implementation result.

West then states (p. 356) “...[i]n this paper I argue that what is neglected in the literature and in research designs is a focus on an important fourth element—the extent of external demands, threat or uncertainty and consequent effects upon creativity and innovation implementation in teams.” West (p. 362) continues:

Diversity of knowledge and skills, it is proposed, will contribute to team innovation, dependent upon the sophistication of group processes. Groups composed of people with differing professional backgrounds, knowledge, skills and abilities, will be more innovative than those whose members are similar, because they bring usefully differing perspectives on issues to the group (Paulus, 2000).

Furthermore, West (p. 365) states:

The external context of the group’s work, be it organisational climate, support systems, market environment, or environmental uncertainty, is likely to have a highly significant influence both on its creativity and innovation implementation. People, groups, and organisations will innovate partly in response to external threats. But such threats or demands will inhibit creativity. A wealth of evidence suggests that, in general, creative cognitions occur when individuals are free from pressure, feel safe, and experience relatively positive affect (Claxton, 1997, 1998).

West concludes by stating (p. 368) that “External demands, threats, and uncertainty motivate groups to innovate at work.” This author would like to ask whether these “...external demands, threats, and uncertainty...” might motivate individuals in their lives outside organizations.

West, in citing Claxton (1997, 1998) states that “...market environment [and] environmental uncertainty” are two of the components of “external context” that “...[are] likely to have a highly significant influence both on [a group’s] creativity and innovation implementation.” During economic downturns, both of these components are enhanced. This author has written that during such economic downturns the teaching of business ethics customarily receives increased



attention (Desnoyers, 2014, p. 183), as oftentimes economic downturns occur in concert with scandals of one type or another.

Such was the case during the downturn of 2007-2008, when Baucus et al. (2008, p. 97) write:

Many prescriptions offered in the literature for enhancing creativity and innovation in organizations raise ethical concerns, yet creativity researchers rarely discuss ethics. We identify four categories of behavior proffered as a means for fostering creativity that raise serious ethical issues: (1) breaking rules and standard operating procedures; (2) challenging authority and avoiding tradition; (3) creating conflict, competition and stress; and (4) taking risks.”

The authors continue, stating (p. 101) that issues can arise when “...employees are told to relax standards as they seek to innovate.” So in the pursuit of creativity and innovation, it seems that breaking some rules is acceptable. But breaking which rules? And how significantly? I will revisit this thought later in the paper.

Paulus & Dzindolet (2008, pp. 229-231), noting that diversity influences creativity and innovation, go on to state:

It is also important that the group climate is psychologically safe and participative (e.g., high levels of trust and support for full participation by all members). The group should be structured to enhance communication and exchange of diverse perspectives (e.g., diverse backgrounds, effective communication channels). Other team members will only attend to the shared ideas (cognitive process) if they are motivated to do so. This attention is affected by how similar or diverse the group member who shared the idea is perceived to be (group structure variable).

So a team member perceived as an outsider or different in some way will struggle to get their ideas valued by the group. I shall revisit this idea later in the paper.

Paulus & Dzindolet continue by reviewing the research on the impact of team diversity on the performance of teams in their efforts towards creativity and innovation (p. 235). The authors note that some research has found team diversity to have a positive effect and some research has found team diversity to have a negative effect. The authors importantly note (pp. 235-236) Nakui and Paulus’s (2007) finding that

...only groups composed of those who had a positive attitude towards diversity demonstrated higher-quality ideas in ethnically diverse groups. Possibly, those with a positive attitude toward diversity are more intrinsically motivated to process and elaborate the ideas shared by their diverse group members.

It is this author's experience that "doing diversity well" requires significant support and resources. It is reasonably likely that an organization that "does diversity well" has a higher portion of members that "...ha[ve] a positive attitude towards diversity". This author would like to surmise that some might argue resources put into diversity initiatives by a business either reduce profits or increase costs. This can impact the value of any such diversity initiative in the organization.

Hunter, Thoroughgood, Myer, and Ligon (2011, p. 54) discuss how "...[l]eading innovative pursuits requires a unique set of leadership behaviors—behaviors that are frequently at odds with traditional forms of management and organizational functioning." Is it possible that individuals that conform to organization norms have an easier time rising to leadership positions?

Amabile (2012, p. 4) has written that

A central tenet of the componential theory is the intrinsic motivation principle of creativity: People are most creative when they feel motivated primarily by the interest, enjoyment, satisfaction, and challenge of the work itself – and not by extrinsic motivators. Because, as research has shown, salient extrinsic motivators can undermine intrinsic motivation, their presence or absence in the social environment is critically important. So, too, is the presence or absence of forces that can support intrinsic motivation."

The author continues (p. 4):

Research in organizational settings has revealed a number of work environment factors that can block creativity, such as norms of harshly criticizing new ideas; political problems within the organization; an emphasis on the status quo; a conservative, low-risk attitude among top management; and excessive time pressure.

Amabile correctly notes the long history of research into creativity and innovation. At least when it comes to creativity and innovation in organizations. But are individuals who haven't found success in organizations different, in some or many ways, than individuals who have figured out how to succeed in organizations? Are those who haven't found success in organizations more diverse? ...more nonconforming? ...more deviant? To state that "...people are most creative when they feel motivated primarily by interest, enjoyment, satisfaction, and challenge of the work itself..." and that "...extrinsic motivators can undermine intrinsic motivation..." (thereby reducing creativity?) is to ignore the creativity of those who haven't figured out how to succeed in organizations because they are more diverse, more nonconforming, more deviant, ...in short

more “other”. Individuals that identify in this “other” category may exhibit tremendous creativity. These individuals respond to significant extrinsic motivators and can exhibit high levels of creativity to, for example, secure basic needs (income, food, shelter, clothing, transportation, etc.). These individuals don’t have the luxury of using their creativity for socially-accepted purposes and thus don’t appear in the creativity and innovation literature, as heavily focused on organizations as it is.

And are individuals that are more “other” likely to be more negatively affected by Amabile’s “...work environment factors that can block creativity, ...”? This author believes so.

Hughes, Lee, Tian, Newman, and Legood (2018, p. 565) state that “...[i]n particular, there is clear theoretical and empirical evidence demonstrating that leadership is an important variable that can enhance or hinder workplace creativity and innovation.” Yes, but those in leadership are less likely to be “other”. So how does that impact the organization’s creativity and innovation?

Creative ideas are just that. Ideas. Where do ideas come from? They come from an individual’s imagination. What role does imagination play in creativity? Horng, Wang, Yen, Lu & Li (2021, p. 376) investigated imagination vs. performance on a creative task and found that...

The results of validity studies show that one’s originality of imagination when measured by conceptual combination can contribute to the prediction of one’s creative performance in design. The construct measured by conceptual combination is also shown to be distinctively different from divergent thinking ability and creative personality. Although the fluency and flexibility measures of divergent thinking ability shared a little common variance with design performance, their contributions disappeared when originality of imagination was added as a predictor. There was no relation between originality of imagination and creative personality. Imaginative ability when measured by conceptual combination thus appears to be a unique component in human creative thinking ability.

Topaz et. al. (2022) undertook an empirical study of the underrepresentation of individuals from marginalized groups to four creative domains: contemporary art, fashion, box office film, and popular music. The researchers found that marginalized communities are underrepresented as creative contributors. They conclude (p. 1) that

...[t]hese are challenges that, if addressed, would enhance our collective understanding of diversity in creative fields. Efforts taken by executives, influencers, and other power brokers to make creative fields more diverse,

equitable, and inclusive would amplify the many well-documented benefits of art to individuals and to society.

And that (p. 10) "...[t]o change these numbers would require the intervention of executives, influencers, and other power brokers."

This author believes that the historical exclusion of diverse, nonconforming, or otherwise "other" individuals from organizational power and its impact on creativity and innovation in organizations is an area worthy of research. For turning a creative idea into reality requires, among other things, influence and power. Those historically lacking in these two domains have had limited ability to influence organizations. Such influence may have resulted in (possibly meaningfully) different organizational outcomes and different results in the field of creativity and innovation.

So, as stated by Hughes, et. al. (2018, p. 565)):

We call upon researchers to look afresh at things often taken for granted and in doing so, follow the wisdom of Albert Einstein: "To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

### **Conclusion**

In conclusion, I would like to propose that characteristics that have historically identified an individual as "other" may reduce their success in organizations, notably businesses. Such historical lack of success may have impacted organizational creativity and innovation and, therefore, the literature. This gap in the literature warrants study.

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# **Legal, Ethical, and Social Issues**

## Corporate Social Responsibility and Prosocial Motivation in the Workplace During Covid-19 Pandemic

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### ABSTRACT

The main objective of this study is to gain insight into whether a company can create an atmosphere and environment that fosters prosocial motivation for its employees through increased corporate social responsibility (CSR). Our study collected the sample data from questionnaires on Amazon. We used the environment, human rights and labor relations, product responsibility, community engagement, and corporate governance as independent variables. Prosocial motivation was used as a dependent variable. This study employed multiple regression analysis to test the hypotheses. The analysis shows that companies can increase the prosocial motivation in employees by engaging in CSR, specifically in the areas of environment and community engagement. We also discovered that even though younger generations are motivated prosocially, older generations tend to give more to benefit the whole and work better when motivated by group dynamics. This research provides insight on which specific corporate social responsibilities yield the largest increases in motivation and can be used to help guide organizations to better performance and a more cohesive prosocial dynamic. The most significant corporate social responsibilities were community engagement, environment, human rights, and labor relations.

**Keywords:** Prosocial responsibility, generation, environment, human rights, labor, product responsibility, community engagement, corporate governance.

### 1. INTRODUCTION

Prosocial motivation is focused on being able to benefit others and adding to the overall goal of a team/social situation with proven sustainable results. According to Grant (2008), prosocial motivation is an individual personality trait that refers to a person's desire to promote the well-being of others. Prosocial motivation is an important determinant of performance: it affects how individuals exert effort toward completing tasks and facilitate increased persistence and performance (Grant, 2008). Tsachouridi and Nikandrou (2020) investigated how the perception of a company's organizational virtuousness affects its employee's willingness to support the organization, time commitment, and work intensity. The organizational virtuousness was broken up into mediators, prosocial motives, and social exchange. The results indicate that prosocial motives have a positive and significant relationship with the employees' motivations to help and work intensely. Therefore, employees who are pro-socially motivated will be willing to help more and do so more intensely than an employee who is not pro-socially motivated. As popular as the subject of motivation is, prosocial motivation, or the desire to exert efforts to benefit others, is another important form of motivation that is rarely discussed yet is essential to teamwork (Grant, 2008). The omission of prosocial motivation at the team level is problematic as motivation researchers have discovered that individuals can be motivated to work for different reasons. Many people engage in their work not just for self-advancement, but more importantly for the opportunity to have a positive impact on the lives of others (Grant, 2008).

This research intends to identify what corporate social responsibility (CSR) factors affected prosocial motivation in the workplace during the pandemic period. Additionally, we speculated if there were any differences among three employee generations in the workplace in terms of the impacts of CSR on prosocial motivation. More specifically,

this study questioned (1) if environment-related CSR had any impacts on prosocial motivation, (2) if human rights and labor-related CSR had any impacts on prosocial motivation, (3) if product responsibility-related CSR had any impacts on prosocial motivation, (4) if community engagement-related CSR had any impacts on prosocial motivation, and (5) if corporate governance-related CSR had any impacts on prosocial motivation.

There have been many studies on the impacts of CSR on prosocial motivation (Hu & Liden, 2015; Tsachouridi & Nikandrou, 2020). Much research has investigated the positive impacts of environment-related CSR on prosocial motivation (Bendell, 2015; Damiano & Luigi, 2020; Otaye-Ebede et al., 2019; Tao et al., 2018). There have been numerous studies on the positive relationship between human rights and labor-related CSR on prosocial motivation (Einolf, 2016; Lockwood et al., 2021; McDougle et al., 2011). Many articles have reported empirical evidence of the positive impacts of product responsibility-related CSR on prosocial motivation (Zacharatos & Barling, 2005; Mauricienė & Paužuolienė, 2013; Ross & Kapitan 2018; Patil & Lebel, 2019). Numerous studies showed a positive relationship between community engagement related to CSR work and prosocial motivation (Esteve et al., 2015; Santana, 2015; Piatak, 2016; Eva et al., 2020). In addition, articles have reported the significant impacts of corporate-governance-related CSR on prosocial motivation in the workplace (Zeitoun & Pamini, 2015; Schaltegger & Burritt, 2018; Nawawi & Salin, 2019).

However, not many studies have been completed on how all five factors – environment-related CSR, human rights & labor-related CSR, product responsibility-related CSR, community engagement-related CSR, and corporate governance-related CSR – together affect employees’ engagement in the workplace. Few studies examined the differences of such impacts of the five factors among three generations – Gen X, Gen Y, and Gen Z employees. No article reported the generational differences in the impacts of the five CSR variables on employees’ prosocial motivation in the workplace during the Covid-19 pandemic. Such a lack of studies motivated this research project.

Prosocial motivation is important to study as employees who enjoy their work are more productive, have a higher output, and have better performance. Increasing employee satisfaction can therefore strengthen the relationship between motivation, performance, and productivity. Prosocial motivation study can help to understand the number of employees needed, how to maintain the enthusiasm of the workforce, and improve the quality of work. This can allow the creation of a positive prosocial environment within a company. Understanding which factors contribute most to getting co-workers involved and part of an invested, unified team can lead to increased productivity and can achieve higher levels of output. This can be taken even further as now these teams are more likely to serve their community as part of community engagement initiatives and various other philanthropic activities initiated by the workplace. Unmotivated employees waste time and resources. Through efficient usage techniques to increase prosocial motivation, companies can increase productivity and reduce waste by using fewer resources. Prosocial motivation works to create a greater level of accountability and autonomy amongst workers with less managerial control behavior. Grant (2008) showed that prosocial motivation can impact employee persistence, performance, and productivity. If companies can encourage workers through a common goal, then they can use prosocial motivation to boost job performance. Motivated employees who enjoy their work are naturally drawn to completing it and pushing themselves further. The study of motivation is a foundational topic in psychology and organizational studies because it describes the reasons that drive actions, and an understanding of motivation is central to explaining both individual and organizational behavior.

To answer the research questions, this paper conducted an empirical study and investigated the generation and gender differences of the impact on the employees’ prosocial motivation in the workplace during the Covid-19 pandemic. The results would fill the gap in workplace management. This paper developed research hypotheses based on scholarly journals and created a survey instrument in line with the hypotheses. This research collected sample data from Amazon Mechanical Turk in 2020. To test the hypotheses, this study ran a statistical analysis of the survey data using regression analysis.

In section 2, prior academic journals were reviewed and used to develop the hypothesis. Section 3 presents the research methodology, followed by statistical results on hypothesis testing in section 4. Section 5 discusses the results, comparing the literature and the potential managerial implications. Finally, section 6 concludes this study.

## 2. LITERATURE REVIEW

### **Environment-related CSR and Prosocial Motivation**

Bendell (2015) explored how business owners weigh the tradeoffs associated with embracing an increasingly “green,” environmentally friendly world by examining the role of prosocial motivation in their decision-making process. The article chose to evaluate the dry-cleaning industry. With a single entity of 27,000 dry cleaners throughout



the U.S., it provided many opportunities to acquire data from decision-makers. It was discovered that higher prosocial motivation among business owners leads to a decrease in the adoption of environmentally-friendly changes. Bendell (2015) suggests this is because business owners must weigh their moral obligations with their desire to earn profits. Those with stronger initial prosocial motivation are less likely to take steps to increase it. Business owners with lower prosocial motivation were more apt to adopt environmental changes to increase it.

Otaye-Ebede et al. (2019) investigated the impact of workplace spirituality, encompassing both prosocial motivation and ethical climate, on performance outcomes. The data that they gathered, from surveys and questionnaires, were from 51 branches of a retail organization in the UK. There were three significant findings from their study; one being that workplace spirituality was positively related to ethical climate, prosocial motivation, and moral judgment. Also, ethical climate partially influenced the relationship between workplace spirituality and prosocial motivation and moral judgment, and finally, an aggregated ethical climate has a significant relationship to the branch-level helping behavior and service performance.

Tao et al. (2018) conducted an empirical study on how a company can motivate employees to be consistently involved in prosocial behavior while also building positive relationships with the organization through the efforts of CSR. The study reported that employee participative decision making in CSR, along with its impact on the prosocial behavioral outcome among employees affected the relational outcome for the organization and its sustainability. Additionally, employees' "perceived need satisfaction" was examined as the underlying explanation which in turn drives the effectiveness of the managerial approach. The results of the study supported the idea of empowering employees to work alongside management when it comes to CSR decisions and effectively satisfies basic psychological needs for autonomy, competence, and relatedness; ultimately increasing the employees' intention to maintain long-lasting involvement in CSR and improving their relationships with the company.

In sum, high prosocial motivated organizations/owners have high employee engagement but are less likely to make changes to decrease waste and become more sustainable due to the high costs associated with these changes. If an organization practices more environment-related CSR, then employees will be more prosocially motivated in the workplace.

*Hypothesis 1a: Environmental CSR is positively related to the prosocial motivation of employees.*

### **Environment-related CSR, Prosocial Motivation, and Employee Generation**

Lockwood et al. (2021) introduced the idea that social cohesion relies on prosociality as populations age. Helping others requires effort and not much is known about how ideas and behaviors shift over a person's life. Using computational modeling and data collection, the study tested the willingness of 95 young adults (18-36) and 92 older adults (55-84) to put physical effort into "self" and "others" benefiting acts. It was found that younger adults were somewhat selfish, choosing to work harder for themselves than others while older people were more willing to help others. This increased prosociality in older generations has important implications for social cohesion.

Einolf (2016) compared the two generations of Millennials against Generation X to see if public service motivation, along with prosocial behaviors, perceptions of the three sectors, and career plans, differed from one generation to the other. The data was collected from a group of professors at six universities, where they distributed them to their new master's degree students, with a sample size of 194. The research found that there were few differences between the Millennial and Generation X students. The Millennial students had a higher level of parental education and volunteered more to work in college but were less interested in religion and politics as opposed to the other students. These findings show that there is little difference between the generations when it comes to public service motivation, prosocial behaviors, perceptions of the three sectors, and career plans.

Rani and Samuel (2019) studied the joint effect of personal and organizational prosocial identities on employee commitment and the differences between 3 generations; Baby Boomers, Generation X, and Generation Y. Data from 613 respondents were gathered through a random sampling technique conducted via a questionnaire that was distributed through social media and HR heads of organizations. The data was examined using ANOVA testing, the Tukey post hoc test, and polynomial regression testing. The results indicate that Gen Y employees have a higher prosocial identity than the older generations. This would be contrary to Lockwood's (2021) results and indicate younger generations are more likely to put in the effort needed to help others.

With data extracted using environmental attitudes and behaviors of college students at a large Canadian university containing over 1300 participants, McDougle et al. (2011) studied the motivations and mechanisms which influence young adults' environmental volunteerism. The researchers were able to assess why today's young adults vote and volunteer for the environment along with their motivational factors and commitment. This study points to the fact that the social aspect of volunteering is the biggest motivation for young adults.

In this research, we want to study if a generation's age controls the effect of environment-related CSR on employees' prosocial motivation in the workplace.

*Hypothesis 1b: Generation controls the effect of environment-related CSR on employees' prosocial motivation in the workplace, such that human rights and labor-related CSR are more positively related to the prosocial motivation of younger generations.*

### **Human Rights and Labor-related CSR and Prosocial Motivation**

Hossain et al. (2014) discussed how the relationship between prosocial motivation and monetary rewards affects the labor market, what type of employees are available, and their production levels. They found that monetary rewards can "crowd out" employees who wish to work specifically for prosocial reasons, causing increased payroll for decreased production. The study recruited 193 students for a part-time data entry job. At the end of their "shift," workers asked to stay longer 1) as a "favor" to the employer or 2) as simply more work, representing a prosocial and a monetary motivation. It was found that mostly equal amounts of employees participated in the extra work. However, it was easier to find employees when the extra pay was known. In effect, employees seeking monetary compensation crowded out those looking for prosocial motivation.

Maneotis et al. (2014) explored, through prosocial motivation, why employees work and how they were working by looking at emotional labor. There should prove to be a positive relationship between prosocial motivation and performance. They took a field sample of 214 grocery clerks and the supervisor ratings of interpersonal performance with customers as their data set. They looked at deep acting and surface acting as indicators of influencing performance and found that there is a relationship between prosocial motives and emotional labor that has a positive effect on performance.

Glavas and Kelley (2014) explored the impacts on employee attitudes due to their perceptions of how the outside world is affected by the organization while they mention the impact of employee treatment by the organization specifically related to their rights and benefits. Their data was retrieved from a study involving 827 employees across 18 different organizations. The results of their empirical study showed the employees' perceptions were positively related to an organizational commitment with the relationship being partially mediated by work meaningfulness and perceived organizational support and job satisfaction, prosocial motivation.

Soumayaja and Kuriakose (2020) studied the effect of an employee's psychological safety on an employee's prosocial voice. That is the employees' voice that contributes and helps their coworkers and the organization in a positive way. The data in this study was gathered through a questionnaire that was sent to 161 IT professionals and then analyzed using the Statistical Package for the Social Sciences and the Hayes Process Macro. The results indicated that the employee's psychological safety/emotional safety is positively correlated to their prosocial voice.

Employers' acknowledgment of emotional labor effects, psychological safety needs, and work meaningfulness is positively related to employees' prosocial motivation and has a positive effect on employee performance. Literature also suggests that while safety and meaningfulness are big indicators for improved employee performance, it is not the single best motivator (Hossain et al., 2014). We hypothesize that if a firm can consider and take heed to employee human rights and labor as it relates to their experiences within the firm, they will exhibit more prosocial motivation in the workplace.

*Hypothesis 2a: Human Rights and Labor-related CSR are positively related to the prosocial motivation of employees*

### **Human Rights and Labor-related CSR, Prosocial Motivation, and Employee Generation**

Klimchak et al. (2019) studied how age-related demographic shifts in the labor market require multiple approaches to leading and motivating the labor force. Surveys were given to 252 employees in the development program of large utility companies in the southeast. The survey includes questions at the beginning, middle, and end of the program and included questions on the motivations of employees and perceived recognition. The study found that what others in your organization think of you is an important factor in motivating employees. Age controls the impact of various motivating forces with monetary, prosocial, and recognition being important at various stages of life. Younger generations seek more external, monetary motivations, while older ones generally pursue more internal, prosocial motivations.

Kunreuther (2003) looked at the future of leadership in social change organizations, specifically non-profits, and how there will be a huge change when the leaders from one generation step down and new leaders from the younger

generation step up. She conducted herself with older and younger people working in these types of organizations to determine if there was a generational gap and how it could affect the social change movement. Her findings were that, while there are a lot of similarities between the older and younger generation, there are major differences in how each generation goes about conducting business in the fact that the newer generation is much more concerned with human rights and labor associated practices while the older generation did not see this as a priority.

Young et al. (2013) study investigated the attitudes towards motivation levels of different generational cohorts in campus recreational sports settings. The study discusses the three current generations found in a workplace, *i.e.*, Baby Boomers, Generation X, and Generation Y. According to the results of the study, there were attitude differences toward job satisfaction in three areas: working conditions, work environment, and employee benefits. The study pointed out that Baby Boomers are more satisfied with their jobs than the two younger generations. The research also explains there are no statistically significant differences in overall job satisfaction between Generations X and Y.

Akter et al. (2020) studied the effect between work-life programs and an organization's performance. The data was collected from 192 organizations in Australia using data from HR manager surveys and archived data from 2017 and 2018. A hierarchical multiple regression analysis was used to test the data. Within the data, the study found that the results could be used to help managers of the millennial workforce as 64% of millennials prefer organizations that have a social and environmental commitment and 83% are more committed when they offer flexible work options.

Our literature review showed that younger generations seek more external, monetary motivations, while older ones generally pursue more internal, prosocial motivations (Klimchak et al., 2019). However, younger generations were much more concerned with human rights and labor-associated practices while the older generation did not see this as a priority (Akter et al., 2007; Young et al., 2013). Positive prosocial environments were important to all age ranges, but the specifics of priorities were complex and interconnected. However, according to Akter et al. (2020), 83% of millennials surveyed had a strong preference for organizations that have a flexible work schedule. Therefore, we would expect to see younger generations more impacted by human rights and labor-related CSR than older generations, confirming our hypothesis which states that generation controls the effect of human rights and labor-related CSR on employees' prosocial motivation in the workplace, such that human rights and labor-related CSR are more positively related to the prosocial motivation of younger generations.

*Hypothesis 2b: Generation controls the effect of human rights and labor-related CSR on employees' prosocial motivation in the workplace, such that human rights and labor-related CSR are more positively related to the prosocial motivation of younger generations*

### **Product Responsibility-related CSR and Prosocial Motivation**

Patil and Lebel (2019) concluded that prosocial motivation was positively correlated with employee proactivity but is contingent on things like public safety and how the public views a person's job. Studies were conducted involving 183 police officers across six agencies and 238 firefighters across eight stations to find out if interactions between employees and the public relate to the employee's prosocial motivation. The studies found that there is a strong relationship between an employee's prosocial motivation and the perceived image of the public (customer safety), especially in jobs that have high visibility in the public eye.

Zacharatos and Barling (2005) investigated the relationship between trust in management's commitment to overall safety climate (knowledge, compliance, motivation, and initiative) and the effects it had on a high-performance workforce. The first part of the study obtained data from company safety directors across 138 different organizations while the second user data was from 189 front-line employees in 2 organizations. They found that trust in management and its commitment to product responsibility has a strong effect on an employee's prosocial motivation.

Mauricienė and Paužuolienė (2013) claimed that organizations ultimately had a responsibility to their customers and must constantly improve products and services to fit those ever-changing needs and values. This research was conducted using a questionnaire. Organizations that consider the effect their products have on the environment can improve the image of the organization to consumers, boosting CSR while simultaneously strengthening the brand. This study also mentioned that an organization that focuses on products' sustainability, reliability, and quality encourages its employees to prefer those products over substitutes increasing prosocial motivation.

Literature study showed that product responsibility plays an important role in fostering prosocial motivation in the workforce. There was a high correlation between police officers' and firefighters' prosocial motivation and how the public views the public safety services they provide (Patil & Lebel 2019). Other studies showed trust in management and its commitment to product responsibility has a strong relationship to an employee's prosocial motivation (Zacharatos & Barling 2005). Respondents of an online panel indicated managers with prosocial tendencies were more likely to protect consumers' data privacy. Product sustainability, reliability, and quality all have a positive

effect on prosocial motivation (Mauricienè and Paužuolienè, 2013). Therefore, this study hypothesizes that product responsibility CSR has a positive relationship with prosocial motivation.

*Hypothesis 3a: Product responsibility-related CSR is positively related to the prosocial motivation of employees*

### **Product Responsibility-related CSR, Prosocial Motivation, and Employee Generation**

Eger et al. (2021) researched the different impacts the COVID-19 pandemic had on consumer buying behavior across different generations. They developed a questionnaire survey that was distributed online, to Baby Boomers, as well as Generations X and Y, to see if their shopping behaviors had changed during the pandemic. Using multiple regression analysis, they found that there were significant differences in consumer behavior between the generations, showing that the older generation was much more willing to be normal in terms of consumer behavior, while the younger generation was more conservative.

Markiewicz (2020) examined the research of the four generations (Baby Boomers, Gen X, Millennials, and Gen Z) and found that Boomers rely on outside agencies to decide on health and safety issues while Millennials and Gen Z were more socially conscious and want to be more engaged in their organization's attitudes toward a more holistic health and safety conformance which includes both product safety responsibly, workplace safety, and stakeholder attitudes.

Bordonaba-Juste et al. (2020) studied the importance of cloud storage data privacy among different generations: the Silent Generation, Baby Boomers, Generation X, Generation Y, and Generation Z. The data used in this study was taken from the Community Survey on ICT Usage in Household and Individuals performed by the European Commission in Spain during 2014. The results indicated that baby boomers were the most concerned about data loss protection. This would indicate that product responsibility-related CSR would be more positively correlated with older generations.

Jancourt (2020) studied the ever-growing reality of a post-baby boomer workforce. Gen Z currently makes up about 20 percent of the US population and 32 percent of the entire global population. By 2030, Gen Z is estimated to take up about 30 percent of the entire global workforce, making the knowledge of that workforce and its preferences increasingly valuable to leaders and employers. Data for the study was gathered through focus groups and design charrettes. The major themes of the study point out that Gen Z prefers high prosocial environments creating a sustainable work-life balance while also being concerned with nature, technology, and convenience factors relating to the CSR of products or services offered, a clear picture of the future of the workplace environment. Gen Z, just like other generations, moderates the effect of product responsibility-related CSR on their prosocial motivation, confirming product responsibility-related CSR is more positively related to younger employees than older employees.

The age diversity within a workplace will positively affect younger employees' product responsibility-related CSR along with increasing their prosocial motivation. There are significant differences in consumer behavior between the generations, showing that the older generation was much more willing to be normal in terms of consumer behavior, while the younger generation was more conservative (Eger et al. 2021). Markiewicz (2020) explained younger generations are more socially conscious and value health and safety conformance which includes both product safety responsibility, workplace safety, and stakeholder attitudes. Jancourt (2020) also supported that Gen Z prefers high prosocial environments, creating a sustainable work-life balance while also being concerned with nature, technology, and convenience factors relating to the CSR of products or services offered, a clear picture of the future of the workplace environment. While Bordonaba-Juste et al. (2020) indicated that baby boomers were the most concerned about data loss protection, making their generation more positively correlated.

*Hypothesis 3b: Generation controls the effect of product-responsibility-related CSR on employees' prosocial motivation in the workplace, such that product responsibility-related CSR is more positively related to the prosocial motivation of younger generations.*

### **Community Engagement and Prosocial Motivation**

Esteve et al. (2015) researched whether prosocial motivation is associated to prosocial behavior within communities and public service. In addition to reviewing National Election studies, public schools in the Republic of Korea, and other outside studies, Esteve et al. (2015) collected data from 263 undergraduate business students at various stages of tutorial groups to determine the effects of prosocial motivation and how it affected behavior. They

concluded that employees with high levels of prosocial motivation are more likely to devote time and effort to helping their communities if they are grouped with other employees who behave prosocially.

Santana (2015) focused to understand the nature of motivations behind social practices used by firms. His study argued that the goal of all motivation mixed for all social/community engagements taken on by an organization is extracted from the company's overall motivation position. Santana goes on to state the connection between motivational mix and business community involvement and CSR while also outlining its positive relationship to prosocial motivation.

Piatak (2016) examined how public service motivation relates to prosocial behaviors, and career ambitions to work in the government or the nonprofit business field among a sample size of graduate students. The data was collected from an online survey given to 122 graduate students. The results that came from this study were that people with higher levels of public service motivation are more likely to want to work in public service and in turn have higher prosocial motivation.

Eva et al. (2020) investigated how prosocial motivation mediates the effect of ethical leadership of senior management and an employee's community citizenship behavior. The data for this investigation was collected via 187 survey responses that were collected from small and medium-sized enterprises in 2015-2016 in the city of Ningbo, Zhejiang Province, China. The survey data was then analyzed using a multi-level structural equation modeling using maximum likelihood estimation. The results indicated that the ethical leadership of senior management influences employees' prosocial motivation.

Corporate cultures and organizations that encourage community engagement had a positive effect on the company's prosocial motivations (Nathen et al., 2020; Piatak, 2016). While community engagement has a positive effect on prosocial motivation within a company, it is also found that the reverse is true. A company with high prosocial motivation is more engaged in the community (Esteve et al., 2015; Santana, 2015). As a result, we hypothesize that if an organization encourages both prosocial environments and community engagement, it will have an additive effect on the prosocial corporate culture.

*Hypothesis 4a: Community Engagement CSR is positively related to the prosocial motivation of employees.*

### **Community Engagement, Prosocial Motivation, and Employee Generation**

Mahmoud et al. (2015) examined the generational differences in the overall employee motivation in the workplace across generation X, generation Y, and generation Z. A study was conducted in Canada using an online survey to be administered between the fourth quarter of 2017 and the end of January 2020. They found that while the overall employee motivations differed from each generation, both generations X and Y valued regulation as a source of overall work motivation, while intrinsic motivation, which can be seen as prosocial motivation, shows that there is a positive correlation between the younger generations having prosocial motivation, aligning with community engagement.

Ertas (2016) investigated whether millennials or their older counterparts are more likely to participate in public service volunteer events in the public sector or the private sector. The study used data from the Current Population Survey from the US in 2010. A logistic regression model was used to analyze the data from the survey. The study found that millennials had lower public service participation rates in the public sector than their older counterparts. However, when we look at the private sector, millennials had higher public service participation rates than their older counterparts.

de Mello (2021) examined the effects of population aging across generations and the effects it had on participation and involvement with local community governments. The study found that both attachment and involvement increase with age. The researcher used information from the World Values Survey, a global research project run since 1981 in over 100 countries that explores people's values and beliefs and how they change over time. The primary driver is that people who are more attached to their communities tend to be more involved both socially and politically.

English and Olsen (2009) discussed corporations' transition of labor throughout the company's history. They specifically mentioned that to replace the Baby Boomers with Gen Y the article focused on what attracts younger generations. They observed the recruits were attracted to firms pushing for social responsibility and green initiatives and well-emphasizing community engagement. They further confirmed that the effects of community engagement related to CSR in the workplace are dependent on the situation and the goals of the firm but ultimately each generation is motivated differently by community engagement.

Our literature review found that younger generations are more inclined toward community engagement by prosocial motivations (Mahmoud et al., 2015) while older generations become more attached to communities over time and become more involved as they age (Mello, 2021). Ertas (2016) confirmed this theory by showing that millennials participate in lower amounts in public service but higher amounts than older generations in private sector



service. As the population moves through its lifecycle, community engagement becomes important for different reasons. Prosocial motivations were dominant in the young while connections to the community become more important as the population ages. English and Olson (2009) went even further to demonstrate how younger generations can replace old ones by altering the goals of the firm.

*Hypothesis 4b: Generation controls the effect of community engagement-related CSR on employees' prosocial motivation in the workplace, such that community engagement-related CSR is positively related to the prosocial motivations of younger generations.*

### **Corporate Governance and Prosocial Motivation**

Zeitoun and Pamini (2015) examined corporate governance structure and its relationship with corporate managers having self-interested vs. prosocial orientations. Using both multivariate regression analysis and profile deviation analysis on publicly traded corporations on the Swiss Stock Exchange, results show that the internal ownership of a company is associated with more prosocially oriented managers, whereas external ownership is related to more self-interested managers. Their study showed that corporate governance structure had a direct impact on its employees and managers and their motivational orientation.

Nawawi and Salin (2019) looked at the perceptions of employees regarding business culture in an organization and how this corporate culture (governance) impacted an employee's decision to whistle-blow, which can also be interpreted as prosocial motivation. Mixed-method method of data collection was used in this study, mainly questionnaires, and interviews. The results confirmed that corporate culture had an impact on whether an employee is willing to be a whistle-blower.

Schaltegger and Burritt (2018) explored the ethical motivations paired with CSR activities as they are related to sustainability during business applications and related to various business cases. Their findings showed that the design of the CSR and goals of corporate sustainability may vary from firm to firm as they are based on different foundations and motivations. The research distinguished four different ethical management versions of CSR. Businesses are created to be successful in the long term and be able to provide long-lasting benefits and returns for stakeholders but to do so, they must be able to motivate their employees to carry out the tasks and be motivated to work hard. In this study, we ultimately want to point to four business situations related to sustainability and corporate governance that further confirm corporate governance and sustainability efforts are positively related to workplace motivation.

Kong and Volkema (2015) examined if prosocial leadership had a negative relationship with corporate corruption. The data was collected from 53 societies around the world and a regression analysis was used to determine the correlation between corruption and prosocial leadership. Surprisingly and in contrast to their hypothesis, the results indicated that cultural endorsement of prosocial leadership was not significantly related to corruption.

In conclusion, corporate governance can have a significant impact on a company's prosocial culture (Zeitoun and Pamini, 2015; Schaltegger and Burritt, 2018) and a direct effect on workplace motivation. Corporate governance can even go so far as to help employees stand up for the company by empowering whistleblowers to speak out (Nawawi and Salin 2019) and even reducing corporate corruption (Kong and Volkema 2015). As a result, we hypothesize that corporate governance style has an impact on the motivation of the entire company and that employees are affected by the leadership and the example and tone they set.

*Hypothesis 5a: Corporate Governance CSR is positively related to the prosocial motivation of employees.*

### **Corporate Governance, Prosocial Motivation, and Employee Generation**

Waelchli and Zeller (2012) investigated corporate governance and whether chairmen and boards imposed different visions based on their age. As corporate leadership aged, there was a significant shift in motivations. Using a large sample of unlisted firms in Switzerland and Germany, it was found that there is a large negative correlation between a chairmen's age and the company's performance. As leadership aged, motivations changed. Younger individuals were more likely to strive for gains as a prosocially motivated team whereas older leadership sought to maintain the status quo through clearly defined tasks.

Casematis and Wortley (2013) investigated if an employee's age could predict if they would be a whistleblower when they see wrongdoing occur within the company. Data was gathered from 3232 employees from 118 Australian public sector organizations who partook in the Whistling While They Work (WWTW) project. The data was analyzed using a binary logistic regression. The results of the binary logistic regression indicated that age could not be used to

predict whether a person would be a whistleblower which would indicate that age does not moderate the effect of corporate governance-related CSR on an employee’s prosocial motivation.

Schullery (2013) examined workplace engagement which affected an organization’s financial results and individuals’ personal lives across four different generations. Surveys were taken by 16,000 high school seniors and then given to those of other generations as well. There were generational differences when it came to workplace engagement and the younger generation was more likely to seek promotion in a company, while the older generation did not have the same desire to move up.

Stankiewicz and Lychmus (2017)’s article was aimed at answering the questions having to do with the role of ethics programs of businesses, the professional values of employees, and how organizations developed agendas of corporate values based on the individual preferences of their workforce. They go on to say business activities were only ethical when the employees entrusted with the tasks have the suitable ethics required. As we experience these ongoing generational changes, the values and the resulting standards of ethical behavior must also be adjusted to effectively embrace/respect young people entering the labor market. Conclusively this confirms our hypothesis and points to the fact that corporate governance CSR is more positively related to the prosocial motivation of younger generations as these firms look to attract and transition into this new labor market.

Corporate governance and motivation were impacted by age, as we see younger generations more prosocially engaged and more motivated to pursue promotion opportunities (Schullery, 2013). Conversely, we see that as leadership ages their motivations change towards more individuality and maintaining the status quo (Waelchli & Zeller 2012). Corporate governance is not a strong enough (Cassematis & Wortley 2013).

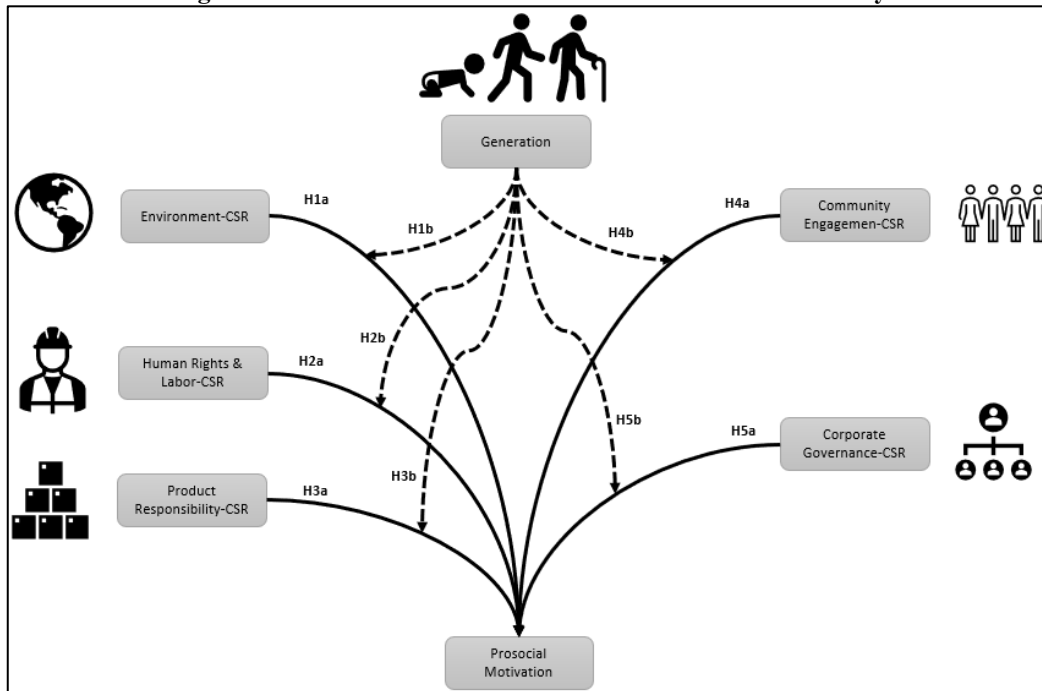
*Hypothesis 5b: Generation controls the effect of Corporate Governance-related CSR on employees’ prosocial motivation in the workplace, such that Corporate Governance-related CSR is more positively related to the prosocial motivation of younger generations.*

### 3. METHODOLOGY

#### Research Framework

We developed a research hypothesis on the employee's prosocial motivation. Figure 1 shows the research framework that illustrates the hypothesis.

Figure 1. Research Framework for Prosocial Motivation Study



### **Prosocial Motivation Variable**

Grant (2018) measured the three dimensions of employee motivation – intrinsic motivation, extrinsic motivation, and prosocial motivation. We chose the prosocial motivation dimension as the dependent variable. We selected the following question to assess prosocial motivation:

*Why are you motivated to do your work?*

- *Because I want to help others through my work*
- *Because I want to have a positive impact on others*
- *Because it is important to me to do good for others through my work*

### **Environment-related CSR Variable**

Woo (2013) described the environmental dimension as material, energy, and water use, biodiversity, emissions, effluents, and wastes. The study also included broader issues such as environmentally friendly products and services. They developed the CSR variable, using the Global Reporting Initiative. In the variable, he included five dimensions – environment, human rights & labor, product responsibility, social, and economic. Among the five dimensions, we picked the environment dimension to measure the environment-related CSR variable in this study as follows:

*I think the company I work for tries to*

- *Take care of water, energy, and material uses.*
- *Minimize pollution when producing products and services.*
- *Invest to protect the environment.*

### **Human Rights & Labor-relate CSR Variable**

For the human rights related to CSR variable, Woo (2013) described this category as dealing with the general issues of non-discrimination, freedom of association and collective bargaining, child labor, and forced or compulsory labor in workplaces. While the labor category covers more specific issues related to employees, such as welfare, health and safety, education and training, and diversity and equal opportunity in hiring. They also used examples like “Protect human rights in factories” and “Not use child labor or forced labor.” As for the labor-related dimension, items such as “Clarify health care benefits for employees” and “Offer education/training programs to employees” were used. The following question was used:

*I think the company I work for tries to*

- *Protects human rights at the workplace.*
- *Allows the freedom of labor unions to prevent discrimination.*
- *Clarify health care benefits for employees.*

### **Product Responsibility-related CSR Variable**

The product responsibility related to CSR is the corporation's responsibility to make the customer aware of how their product or service may impact the customer. Woo (2013) provided the following exemplary issues to describe product responsibility: customer health and safety, honest product labeling, considerable marketing communications, customer privacy, and compliance with regulations. Thus, product responsibility also included how marketing communications can affect potential customers even if they don't purchase the product or service. Additionally, it can encompass the customer information that might be collected during and after the product or service was purchased. A company that practices good product responsibility gains the trust of its customers and its employees. The following question was used:

*I think the company I work for tries to*

- *Clearly label and explain products and services for customers.*



- *Take care of customer complaints.*

### **Community Engagement Variable**

Community engagement can take many forms including local community welfare, public policy, and compliance with social regulations. Commitment to the community can bring a wide variety of benefits including improved business reputation, new sales, and networking opportunities. It can improve relationships with local authorities and government. From Woo (2013), this study picked one item from the society-related dimension (Invest in the local community's welfare) and one item from the economic-related dimension by considering the direct impact of marketing programs on society, to measure the community engagement variable. The following question was used:

*I think the company I work for tries to*

- *Invest in the local community's welfare.*
- *Consider the direct impact of marketing programs on society.*

### **Corporate Governance Variable**

When a company practices good internal governance, they are more likely to have a good social conscience. The role of the board of directors and management is critical to setting the agenda of their organizations. Good corporate governance includes concepts such as corruption management, and anti-competitive behavior, and can set the tone in all other CSR variables. A company cannot in the long run operate in isolation from the community and corporate governance must make a conscious decision to have a positive impact. From Woo (2013), this study selected one item from the society-related dimension and one item from the economic-related dimension, to measure the community engagement variable. The following question was used:

*I think the company I work for tries to*

- *Avoid corruption in business*
- *Provide company financial information to the public.*

### **Employee Generation Control Variable**

Dhopade (2016) defined Gen Z as employees who were born from 1993 to 2011. Other studies described Gen Z as people born after 1994, born from 1995 to 2015, from born 1996 to 2010, or from born 1997 to 2013. In short, most of the literature suggested Gen Z employees were born anytime between 1993 to 1997. It appeared fair to use a middle value from 1993 to 1997 for the beginning of Gen Z employee birth year. Accordingly, this research used the middle value, 1995. Thus, employees were categorized into three generations in this study, as of April 2020, as follows: Gen Z (18 to 24 years old), Gen Y (25 to 39 years old), and Gen X (40 to 55 years old).

### **Analytical Models**

This study proposed to build a prosocial motivation model using a regression analysis. Prosocial motivation was used as the dependent variable in the proposed regression model while the five CSR factors of environment, human rights & labor, product responsibility, community engagement, and corporate governance served as independent variables. The multiple regression model was expressed as follows:

$$Y_1 = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5$$

where  $Y_1$  = Prosocial Motivation  
 $X_1$  = Environment-related CSR  
 $X_2$  = Human Rights & Labor-related CSR  
 $X_3$  = Product Responsibility-related CSR  
 $X_4$  = Community Engagement  
 $X_5$  = Corporate Governance

### **Sample Data Collection**

This research created a survey questionnaire using the variable items based on the literature. The questionnaire was posted on *Google Form*. We collected the survey data using *Amazon Mechanical Turk*. We required three conditions. The Amazon Mechanical Turk workers had to be employed, aged from 18 to 55 years old, with equal sampling among the three generations – Gen Z, Gen Y, and Gen X. We ran the survey for a week in the third week of April 2020. The online survey received 220 responses. In the fourth week of August 2020, we ran the survey again. The second survey collected 350 responses. In addition, we collected 39 surveys from senior students and MBA students in a public university in the New England region. In sum, we collected 609 valid responses. We deleted 9 repeated responses and 24 responses with multiple missing values, which resulted in 576. From the 576 responses, we excluded the bad responses with poor response quality, which ended up with 546 sample cases for this research.

## **4. RESULTS**

### **Sample Data Description**

The sample data included 546 valid responses from the online survey via Amazon Mechanical Turk. Table 1 reported the sample data in which 136 responses were from Gen Z employees (24.9%), 307 from Gen Y (56.2%), 87 from Gen X (15.9%), and 16 from Boomers (2.9%).

**Table 1. Employee Generations**

	Frequency	Percent
Gen Z (18 to 24)	136	24.9
Gen Y (25 to 39)	307	56.2
Gen X (40 to 55)	87	15.9
Boomers ( $\geq 56$ )	16	2.9
Total	546	100.0

### **Descriptive Statistics & Correlation Analysis Results**

The descriptive statistics showed the mean averages of all the variables were above 4.5 on a 1 to 7 Likert scale (1 strongly disagreed and 7 is strongly agreed). The human rights and labor-related CSR variables, product responsibility-related CSR variables, and corporate governance variables were above 5 on average. The averages of the prosocial motivation variable, environment-related CSR variable, and community engagement variable were close to 5. The data showed that correlations between the prosocial motivation variable and each of the five CSR variables were statistically significant ( $p < 0.001$ ). The prosocial motivation variable was most correlated with the community engagement variable, followed by environment-related CSR, human rights and labor-related CSR, corporate governance, and product responsibility-related CSR. Table 2 reported the descriptive statistics and correlations.

**Table 2. Descriptive Statistics and Correlation Analysis for All Data (N = 546)**

	Mean	SD	N	(1)	(2)	(3)	(4)	(5)	(6)
(1) Y_PSM	4.924	1.715	546	1					
(2) X1_ENV	4.535	1.584	546	.390***	1				
(3) X2_HRL	5.334	1.324	546	.363***	.540**	1			
(4) X3_PR	5.664	1.139	546	.224**	.263**	.533**	1		
(5) X4_CE	4.807	1.538	546	.420**	.644**	.655**	.366**	1	
(6) X5_CG	5.082	1.358	546	.312**	.487**	.623**	.449**	.666**	1

\*\* $p < 0.01$ , \*\*\* $p < 0.001$

### **Regression Analysis Results for All Generations**

The first regression model tested all the data ( $N = 546$ ). It included five independent variables – environment-related CSR ( $X_1$ ), human rights and labor-related CSR ( $X_2$ ), product responsibility-related CSR ( $X_3$ ), community engagement ( $X_4$ ), and corporate governance ( $X_5$ ) – that estimate the dependent variable, prosocial motivation in the workplace. The model was statistically significant [ $R^2 = 0.209$ ,  $R^2_{adj} = 0.202$ ,  $F(5, 540) = 28.559$ ,  $p < 0.001$ ; Condition

Index (CI) = 18.646]. The regression model explained 20.9% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.209$ ). Environment-related CSR and community engagement were significantly related to prosocial motivation ( $p < 0.001$ ) while other independent variables showed no statistical significance. Environment-related CSR impacted the most on the employee's prosocial motivation (0.186), followed by community engagement (0.227), human rights and labor-related CSR (0.092), product responsibility-related CSR (0.046), and community engagement (-0.007). No serious multicollinearity was present in the regression model because all VIFs were less than 10 (Vittinghoff et al., 2012), and the condition index (CI) was less than 30 (Kennedy, 2003). Model 1a in Table 3 reported the results on all the employee data.

To get further analysis, this study developed the best-fit regression model for all employee generations via SPSS software, using the stepwise method. The results showed the best-fit model was a regression model with only three independent variables – community engagement, environment-related CSR, and human rights and labor-related CSR because it had the highest adjusted  $R^2$  (0.203). The best-fit model was statistically significant [ $R^2 = 0.208$ ,  $R^2_{adj} = 0.203$ ,  $F(3, 542) = 47.355$ ,  $p < 0.001$ ; CI = 13.473]. The best-fit regression model explained 20.8% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.208$ ). Prosocial motivation was significantly related to community engagement ( $p < 0.001$ ) and environment-related CSR ( $p < 0.001$ ), and human rights and labor-related CSR ( $p = 0.030$ ). According to the standardized regression coefficient BETA, community engagement impacted employee's prosocial motivation (0.226) the most, followed by environment-related CSR (0.183), and human rights and labor-related CSR (0.114). No serious multicollinearity was present in the best-fit model. Model 1b in Table 3 showed the best-fit model results.

### **Regression Analysis Results for Gen X Employees**

A regression model tested the data for Gen X Employees ( $N = 87$ ). The model was statistically significant [ $R^2 = .344$ ,  $R^2_{adj} = .303$ ,  $F(5, 81) = 8.4585$ ,  $p < 0.001$ ; CI = 22.361]. The regression model explained 34.4% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.344$ ). Environment-related CSR was the only significant variable related to prosocial motivation ( $p < 0.05$ ) while Community Engagement-related CSR was only marginally significant ( $p < 0.10$ ). The other independent variables showed no statistical significance. According to the standardized regression coefficient BETA, environment-related CSR impacted the most on the employee's prosocial motivation (0.272), followed by community engagement (0.248), human rights and labor-related CSR (0.141), product responsibility-related CSR (0.010), and corporate governance (0.003). No serious multicollinearity was present in the regression model. Model 2a in Table 3 reported the results on all the employee data.

To get further analysis, this study developed the best-fit regression model for the Generation X employees via SPSS software, using the stepwise method. The results showed the best-fit model was a regression model with only two independent variables – community engagement and environment-related CSR because it had the highest adjusted  $R^2$  (0.318). The best-fit model was statistically significant [DV = Prosocial Motivation;  $R^2 = .333$ ,  $R^2_{adj} = .318$ ,  $F(2, 84) = 21.004$ ,  $p < .001$ ; CI = 8.685]. The best-fit regression model explained 33.3% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.333$ ). Prosocial motivation was significantly related to community engagement ( $p = 0.011$ ) and environment-related CSR ( $p = 0.006$ ). Community engagement impacted the most of the employee's prosocial motivation (0.333) and environment-related CSR (0.303). No serious multicollinearity was present in the best-fit model. Model 2b in Table 4-3 showed the best-fit model results.

### **Regression Analysis Results for Gen Y Employees**

A regression model tested the data for Gen Y Employees ( $N = 307$ ). The model was statistically significant [ $R^2 = .208$ ,  $R^2_{adj} = .195$ ,  $F(5, 301) = 15.811$ ,  $p < 0.001$ ; CI = 19.310]. The regression model explained 20.8% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.208$ ). Environment-related CSR and Community Engagement-related CSR were the only significant variable related to prosocial motivation ( $p < 0.01$ ). The other independent variables showed no statistical significance. According to the standardized regression coefficient BETA, community engagement-related CSR impacted the most on the employee's prosocial motivation (0.251), followed by environment (0.214), product responsibility (0.071), corporate governance (-0.017), and human rights & labor (0.014). No serious multicollinearity was present in the regression model. Model 3a in Table 4-3 reported the results on all the employee data.

To get further analysis, this study developed the best-fit regression model for the Generation Y employees via SPSS software, using the stepwise method. The results showed the best-fit model was a regression model with only two independent variables – community engagement and environment-related CSR – because it had the highest adjusted  $R^2$  (0.198). The best-fit model was statistically significant [DV = Prosocial Motivation;  $R^2 = .203$ ,  $R^2_{adj} = .198$ ,

$F(2,304) = 38.768, p < 0.001; CI = 10.183$ ]. The best-fit regression model explained 20.3% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.203$ ). Prosocial motivation was significantly related to community engagement ( $p = 0.002$ ) and environment-related CSR ( $p < 0.001$ ). Environment-related CSR impacted most of the employee's prosocial motivation (0.271) and community engagement (0.219). No serious multicollinearity was present in the best-fit model. Model 3b in Table 4-3 showed the best-fit model results.

### **Regression Analysis Results for Gen Z Employees**

A regression model tested the data for Gen Z Employees ( $N = 136$ ). The model was statistically significant [ $R^2 = .195, R^2_{adj} = .164, F(5, 130) = 6.287, p < .001; CI = 17.409; N = 136$ ]. The regression model explained 19.5% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.195$ ). Human rights and Labor-related CSR was the only marginally significant variable related to prosocial motivation ( $p < 0.10$ ). The other independent variables showed no statistical significance. According to the standardized regression coefficient BETA, human rights and labor-related CSR impacted the most on the employee's prosocial motivation (0.236), followed by community engagement (0.113), environment (0.089), corporate governance (0.089), and product responsibility (0.006). No serious multicollinearity was present in the regression model. Model 4a in Table 4-3 reported the results on all the employee data.

For further analysis, this study developed the best-fit regression model for the Generation Z employees via SPSS software, using the stepwise method. The results showed the best-fit model was a regression model with only one independent variable – Human Rights and Labor-related CSR because it had the highest adjusted  $R^2$  (0.161). The best-fit model was statistically significant [DV = Prosocial Motivation;  $R^2 = .167, R^2_{adj} = .161, F(1, 134) = 26.959, p < .001; CI = 10.5$ ]. The best-fit regression model explained 16.7% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.167$ ). The prosocial motivation was significantly related to human rights and labor ( $p < 0.001$ ). According to the standardized regression coefficient BETA, human rights and labor-related CSR impacted the employee's prosocial motivation with a BETA value of (0.271). No serious multicollinearity was present in the best-fit model. Model 4b in Table 4-3 showed the best-fit model results.

**Table 3. Summary of Regression Models**

<b>Model #</b>	<b>1a</b>	<b>1b</b>	<b>2a</b>	<b>2b</b>	<b>3a</b>	<b>3b</b>	<b>4a</b>	<b>4b</b>
<b>Model</b>	All Data	All Data	Gen X -	Gen X	Gen Y -	Gen Y	Gen Z	Gen Z
<b>Specification</b>	- Full	Best-Fit	Full	Best-Fit	Full	Best-Fit	- Full	Best-Fit
Constant	1.817 (0.359)	2.028 (.278)	1.428 1.006	1.869 .507	1.959 .465	2.388 .297	1.552 .751	1.898 .594
X1_ENV	.201*** (.055)	.198*** (.055)	.278 .125	.369*** .130	.222** .075	.297*** .078	.109 .120	
X2_HRL	0.119 (0.076)	.147* (.068)	.168 .185		.018 .098		.333# .175	.578*** .111
X3_PR	0.069 (0.069)		.019 .190		.102 .090		.010 .147	
X4_CE	.253*** (0.069)	.252*** (.064)	.274# .161	.311* .120	.275** .094	.227** .073	.128 .145	
X5_CG	-0.009 (0.070)		.004 (.169)		-.022 .088		.100 .172	
R <sup>2</sup>	0.209	0.208	.344	.333	.208	.203	.195	.167
R <sup>2</sup> <sub>adj</sub>	0.202	0.203	.303	.303	.195	.198	.164	.161
F	28.559	47.355	8.4585	21.004	15.811	38.768	6.287	26.959
N	546	546	87	87	307	307	136	136

Note: # $p < 0.10$ , \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ ; Standard errors of the regression coefficient estimates are reported in parentheses; N = # of observations.

## **5. DISCUSSION**

### **Impacts of Environment Related-CSR on Prosocial Motivation**

Evidence supported Hypothesis 1A – Environmental CSR is positively related to the prosocial motivation of employees. Evidence in the multiple regression model results showed that environment-related CSR was significantly related to prosocial motivation for all employee generations ( $p < 0.01$ ). The results were consistent with the literature

which supported the claim that the environment had a positive impact on prosocial motivation (Otaye-Ebede et al., 2019; Tao et al., 2018). However, our findings revealed an even stronger correlation than was suggested in the existing literature. We feel the correlation was stronger in our data set because of society's evolving feelings on environmental concerns. Many of our studies referenced are before the new global emphasis being placed on climate change and the environment in the last few years. As our world becomes more impacted by climate change and environmental concerns, we would expect to see the environment become even more significantly related to prosocial motivation over time.

Evidence on Hypothesis 1B – Generation controls the effect of environment-related CSR on employees' prosocial motivation in the workplace, such that environmental CSR is more to the prosocial motivation of younger generations is inconclusive. Evidence showed Gen Y was related to the impacts of environment-related CSR on prosocial motivation while Gen X and Gen Z were not. Thus, data supported that a younger generation, Gen Y was more related than the older generation, Gen X, but the youngest generation, Gen Z was not more related than the older generation, Gen Y. Thus, this hypothesis is inconclusive. A generation's age controls the effect of environment-related CSR on employees' prosocial motivation in the workplace. We discovered that environmental CSR was one of the strongest factors in creating prosocial motivation in the workplace. Although a very strong modifying force, it was even stronger when observing the younger generations.

### **Impacts of Human Rights & Labor-Related CSR on Prosocial Motivation**

The evidence is inconclusive on Hypothesis 2A - human rights & labor-related CSR are positively related to employee prosocial motivation. The results showed that there was no statistical significance ( $p = .121$ ) between human rights and labor CSR and employees' prosocial motivations in the multiple regression model. This included the five CSR moderators, which indicated that human rights & labor-related CSR were not good prosocial motivators for employees regardless of their generation. However, the correlation between the human rights & labor-related CSR was statistically significant ( $p < 0.01$ ). The results were inconsistent with literature that supported the claim employer's acknowledgment of psychological safety needs and emotional effects of labor positively relate to employees' prosocial motivation (Maneotis et al., 2014). While these were significant indicators, it was not the best motivator (Hossain et al., 2014), the statistical data further confirmed. Ultimately, we decided that human rights and labor-related social responsibility were weak prosocial motivators compared to the other variables. The reason was that employees of all generations are moved willingly to forgo certain work benefits such as PTO, paid leave, paid breaks, flexible work schedule, etc., depending on compensation or their reward. A manager is important to understand that employees of all generations are not motivated by doing good and being in an ideal working environment but rather motivated by their compensation. This incentive as a business owner is easy because higher prosocial motivation increases productivity and ultimately increases profits and revenues for the firm.

Hypothesis 2B states that generation controls the effect of human rights and labor-related CSR on employees' prosocial motivation in the workplace, such that human rights and labor-related CSR are more positively related to the prosocial motivation of younger generations. Evidence does support the hypothesis. Evidence confirms there was the marginal statistical significance of human rights & labor being to prosocial motivation for only Gen Z ( $p < 0.10$ ) while the other generations showed no statistical significance; Gen X ( $p = .367$ ) and Gen Y ( $p = .853$ ) on their regression models. Literature supported the results of hypothesis testing and suggested that the younger/newer generation, Gen Z, were more positively affected by good human rights and labor associated practices while older generations, Gen X and Gen Y did not see this as a priority (Kunreuther, 2007; Young et al., 2013). This is an important concept for a business manager to understand when considering the shifting ages of the labor force. The younger generation is growing and expanding while the older generations Gen X and Gen Y are being phased out of the work and labor force. Previous studies did not include Gen Z as this was the newest generation entering the labor market. These shifts will ultimately manipulate employers' hiring tactics, benefits, and attractiveness to the current labor market. Successful business owners must consider this new dynamic and ensure the firm is attracting the highest quality talent for continued profits and growth.

### **Impacts of Product Responsibility-Related CSR on Prosocial Motivation**

Evidence does not support Hypothesis 3A – Product responsibility CSR appears to have no relationship to the prosocial motivation of employees. Evidence showed no statistical significance ( $p > 0.05$ ) in the correlation as well as the multiple regression model results. Our research concludes there was no statistical significance, product responsibility is not a valid prosocial motivator for employees of any generation. Our literature was not consistent with our data as (Zacharatos & Barling 2005; Patil & Lebel 2019; Ross & Kapitan 2018) showed product responsibility



played an important role in fostering prosocial motivation in the workforce. Our study shows no statistical relationship. This variable appears to be a case of a “solved problem.” Many of our studies referenced how important product responsibility is concerning prosocial motivation. Our expectation is that product responsibility is an important factor but since it has been mostly resolved the focus is on the other moderators.

Evidence does not support Hypothesis 3B – Generation does not appear to control the effect of product responsibility-related CSR on employees’ prosocial motivation in the workplace and has no noticeable difference in the prosocial motivation of younger generations. Evidence showed no statistical significance in the correlation as well as the multiple regression model results. The results were inconsistent with our literature because the literature showed that the age diversity within a workplace would positively affect younger employees’ product responsibility-related CSR along with increasing their prosocial motivation. (Eger et al., 2021; Markiewicz, 2020; Jancourt, 2020). But consistent with our findings, we discovered literature that presented the opposite view as Bordonaba-Juste et al. (2020) indicated that baby boomers were the most concerned about data loss protection, making their generation more positively correlated. We discovered that product responsibility CSR had little correlation to prosocial motivation in the workplace regardless of generation. We also discovered that the literature supports this as multiple correlations can be found during literature research.

### **Impacts of Community Engagement on Prosocial Motivation**

Evidence supported Hypothesis 4A – Community Engagement Related CSR is positively related to the prosocial motivation of employees. Evidence showed statistical significance ( $p < 0.05$ ) in the correlation as well as the multiple regression model results. The results showed that community engagement was significantly related to prosocial motivation ( $p < 0.01$ ). Our literature was consistent with these findings that community engagement-related CSR was positively related to the prosocial motivation of employees. Corporate cultures and organizations that encourage community engagement had a positive effect on the company’s prosocial motivations (Piatak, 2016). While community engagement has a positive effect on prosocial motivation within a company, it was also found that the reverse is true; a company with high prosocial motivation is more engaged in the community (Esteve et al., 2015; Santana, 2015). We discovered from our results that community engagement-related CSR has a strong correlation to prosocial motivation.

Hypothesis 4B states that generation controls the effect of community engagement-related CSR on employees’ prosocial motivation in the workplace, as well as community engagement-related CSR, is more positively related to the prosocial motivation of younger generations. While Gen Y showed statistical significance ( $p < 0.01$ ), Gen Z and Gen X showed no significance. Thus, the impact of community engagement on Gen Y was more than on the older generation, Gen X. Born in the younger generation, Gen Z was not. Therefore, the evidence shows the hypothesis is inconclusive. Our literature was inconsistent with our data. The literature found that younger generations were more inclined toward community engagement by prosocial motivations, while older generations have become more attached to communities over time and become more involved as they age (English & Olson 2009; Mahmoud et al., 2015). They found that there was a positive correlation between the younger generations and community engagement prosocial motivators, but that was not what we found in our results. We discovered, from our results, that they did not correspond to the findings of the studies in articles that were found prior. This could be because these studies were done in different years, as well as how times have changed since they were done. One big impact that would cause a difference in results is COVID-19 and how it has impacted every workplace in the world. While each generation has handled it differently, this is one reason why our results do not match.

### **Impacts of Corporate Governance on Prosocial Motivation**

The results are inconclusive regarding Hypothesis 5A – corporate governance-related CSR is positively correlated to employee prosocial motivation. The results showed the correlation between corporate governance-related CSR was statistically significant ( $p < .01$ ). However, the regression model shows it was not statistically significant ( $p = .899$ ). The findings are inconsistent with our literature (Zeitoun & Pamini, 2015; Kong & Volkema, 2015; Nawawi & Salin 2019). The prior studies claim corporate governance-related CSR is positively related to the prosocial motivation of employees. The difference between the results and the prior studies may be due to the difference in the questions that were asked. The questions asked in this questionnaire were associated with company financial information being public and the impact of marketing programs on society while some of the prior studies focused on reducing corruption and promoting whistle-blowers. Stopping corruption and encouraging whistle-blowers are topics that can be more easily interpreted by the person being asked the question and would therefore have a firmer opinion of whether the company is acting on them.

The results do not support Hypothesis 5A – generation controls the effect of Corporate Governance-related CSR on employees' prosocial motivation in the workplace, such that Corporate Governance-related CSR was more positively related to the prosocial motivation of younger generations. None of the regression models indicated a statistical significance ( $p < 0.05$ ) between corporate governance-related CSR and prosocial motivation in any of the age groups. The findings were inconsistent with our literature (Waelchli & Zeller, 2012; Cassematis & Wortley, 2013; Schullery, 2013). The prior studies claimed that corporate governance-related CSR is more positively related to the prosocial motivation of younger generations. The difference in the results and the prior studies may be a result of the effects of the Covid-19 pandemic. Actions taken by companies during the pandemic might have reduced the corporate governance-related CSR activities. Some companies were doing all they could to stay in business and so they might not have been too concerned with the marketing program's implications on society. Some companies might also not want to disclose their financial information to the public because of the negative repercussions it might have.

### **Managerial Implications**

Overall, the results of this study benefit future and current business owners in understanding the current labor force and the natural trend of the labor market. COVID-19 pandemic has been a major driving force in the drastic decrease of the labor force worldwide. Now on the other side of the pandemic, business managers and employers must understand the driving factors for employee retention, productivity, and performance as it relates to their business model while also adapting this to the transitioning of generations in the labor force. The five CSR topics (environment, human rights & labor, corporate governance, community engagement, and product responsibility) are all important aspects for any business to consider for long-term success and growth. Our study focuses on how the prosocial motivation of employees is affected by these five CSRs and compares high prosocial motivation vs low prosocial motivation of employees. We conclude that high prosocial motivation in employees equates to better performance, higher employee retention, and ultimately greater profits for the firm. In addition, we determine that environment-related CSR practice is the most significant driving force behind high employee prosocial motivation.

Through our research, we discovered high prosocial motivation was a direct outcome of employees' working towards the benefit of others which in turn had a significant impact on an employee's contribution to the workplace and the community at large. Inversely, high prosocial motivation was achieved through the desire to exert efforts to benefit others found through research on community engagement CSR (Grant, 2008). The omission of prosocial motivation at the team level was problematic as motivation researchers have discovered that individuals can be motivated to work for different reasons. Many people engage in their work, not for self-advancement alone, but more importantly for the opportunity to have a positive impact on the lives of others (Grant, 2008).

Specific findings of our study during our research helped us to identify which CSR factors affected prosocial motivation in the workplace. Additionally, we discovered that there are many differences among three employee generations, in terms of the impacts of CSR on prosocial motivation. More specifically, our study shed light on (1) environment-related CSR and impacts on prosocial motivation, (2) human rights and labor-related CSR impacts on prosocial motivation, (3) product responsibility-related CSR impacts on prosocial motivation, (4) community engagement-related CSR impacts on prosocial motivation, and (5) corporate governance-related CSR impacts on prosocial motivation.

Our results have proven important managerial applications. Based on the findings of our study, it is the implication that the factors of environmental CSR, human rights and labor CSR, product responsibility CSR, community engagement CSR, and corporate governance CSR impact prosocial motivation.

In summary, our study suggests that CSR contributes to increased levels of prosocial motivation. Moreover, such increased prosocial motivation of employees will lead to maximized profits and create the highest level of products, customer satisfaction, employee effectiveness, and stakeholder satisfaction.

### **All Generations**

When reviewing the best-fit model for all generations, we found three independent variables; community engagement, environment, and human rights/labor relations had significant statistical significance ( $p < .001$ ). The best-fit model further explained that community engagement had the most impact followed by environment and human rights/labor relations. We found that our model explained 20.8% of the outcome. When making decisions for the entire company, management would find a focus on community engagement to be the most efficient way to increase prosocial motivation among the workforces.

### **GEN X Employees**

For Gen-X, according to the best-fit model, the results showed only two independent variables, community engagement and environment-related CSR, because it had the highest adjusted  $R^2$  (0.318). The best-fit regression model explained 33.3% of the variance in the employee's prosocial motivation outcome ( $R^2 = 0.333$ ). Results also showed prosocial motivation was significantly related to community engagement ( $p = 0.011$ ) and environment-related CSR ( $p = 0.006$ ), and there was no statistical significance with the other variables. Any company that has a large Gen-X employee population should focus on community engagement and environment-related CSR to increase prosocial motivation among employees.

### **GEN Y Employees**

According to the best fit model, the data shows environment-related CSR has the greatest impact on Gen-Y employees with a strong statistical significance ( $p < .001$ ), followed by community engagement-related CSR which was also statistically significant. Additionally, the beta values show that environment-related CSR will have a higher impact ( $B = .297$ ) than community engagement-related CSR ( $B = .227$ ). Companies with a large Gen-Y employee base should focus on environment-related CSR to increase the prosocial motivation in their workforce. If the company has enough resources, it should then focus on community engagement-related CSR.

### **GEN Z Employees**

According to the best fit model, human rights and labor-related CSR was the only factor that impacted the Gen-Z employees with a strong statistical significance ( $P < .001$ ). Companies with a large Gen-Z employee base should focus on community engagement-related CSR to increase prosocial motivation in their workforce. Additionally, human rights and labor-related CSR had the highest Beta value of .578 which means efforts made in human rights and labor-related CSR will have the greatest impact on prosocial motivation in Gen-Z employees.

**Table 5. Executive Recommendations**

Priority	All	Gen X	Gen Y	Gen Z
1	CE	ENV	ENV	HRL
2	ENV	CE	CE	---
3	HRL	---	---	---

## **6. CONCLUSION**

This research fills the gap in management literature by providing empirical evidence on how CSR affects employees' prosocial motivation and how it varies by generation. The evidence suggests companies can most effectively increase employee prosocial motivation by implementing community engagement, environment, and human rights and labor-related CSR. By increasing prosocial motivation, companies can expect increased employee productivity and performance.

Due to monetary and time constraints, we were not able to thoroughly investigate the effects of the five CSR variables on the prosocial motivation of employees of all generations. In the future, studies can increase the overall sample size to increase the depth of the research. Also, the sampling could have more sample data for the younger generations, Gen X & Gen Z, to even out the sample sizes across the generations. The lack of inclusion of management style, organizational culture, and not profit vs. for-profit organizations can all have an added underlying effect on prosocial motivation and can be tested in another model. The turnover rate as it relates to different departments throughout an organization is an important calculation and relates to the overall prosocial motivation of the employees within the firm; future studies could further investigate that correlation to the prosocial motivations in the workplace. Future research can include the observed effects of the COVID-19 pandemic as it relates to the way workers of the different generations have adapted and are continuing to adapt to this new lifestyle and the way traditional jobs have "changed". New research could also explore the effects of other moderators such as education, gender, years employed, technology, etc., that are all directly related to the high or low prosocial motivation of employees. Lastly, we used the multiple regression model. Future studies could employ factor analysis, structural equation models, path analysis, etc.

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## **Innovative Approaches to Teaching Ethics**

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### **Abstract**

There is evidence that traditional courses in ethics (especially business ethics) have not been successful in making students ethical. The conventional methods used to teach ethics include case histories and studying the writings of great philosophers such as Kant. Using a text-based approach may not be ideal for reaching today's digitally-savvy students. The authors demonstrate numerous ways to instill values that include analyzing and studying cases, philosophy, history, literature, film, television, YouTube/TED talks, music, famous speeches, quotations, social justice humor, Scripture, Talmud/Midrash, Kabbalah, and Mussar.

### **Introduction**

In 1947, Martin Luther King, Jr. asserted that "We must remember that intelligence is not enough. Intelligence plus character—that is the goal of true education." He recognized that "If we are not careful, our colleges will produce a group of close-minded, unscientific, illogical propagandists, consumed with immoral acts" (King Institute, n.d., paras. 6-7). In 2004, an AACSB task force recommended that ethics be taught in business schools, and many schools fell into line with the accrediting agency suggestions, but it is not clear that these efforts are successful.

Scholars such as Milton Friedman and Peter Drucker feel that ethics cannot be taught in a classroom, and there is substantial evidence supporting this opinion (Altmyer, Yang, Schallenkamp, and DeBeaumont, 2011; Bowden & Smythe, 2008; Friedman, Fogel, and Friedman, 2005; Etzioni, 2002; MacDonald, 2007; Stape, 2002; Wang and Calvano, 2015). One study found that 56% of MBA students regularly cheated in college, more than students majoring in other areas (Holland, 2009). Many scholars believe that MBA programs have been complete failures in teaching ethics (Etzioni, 2002; Hühn, 2014).

Bazerman and Gino (2012) posit that the correct way to teach ethics is by using a behavioral ethics approach. Behavioral ethics takes a descriptive rather than a normative approach and attempts to assist professionals and students in understanding their behavior when facing an ethical dilemma. By making people aware of the contradictions between how they act and contrasting it with how they would ideally behave, they can develop their moral sensitivity. It may be challenging to teach individuals to be ethical, but it does appear possible to instill ethical awareness into students (Altmeyer et al., 2011; Bowden & Smythe, 2008; Koehn, 2005; Williams & Dewett, 2005).

In the Information Age, we should be using an assortment of tools – including internet-based ones – to teach values and ethics and not limit ourselves to one particular approach. A multi-modal approach may be the best way to get the message across to students that ethics and values matter and that greed is not good (Carnes, 2011; Ryan and Bisson, 2011). A significant number of scholars are urging educators to make use of Internet-based tools as a way of making education relevant and exciting to the students of today, who spend a great deal of time with social media and the Internet (Battalio, 2007; Brown, 2000; Carnes, 2011; Friedman & Friedman, 2011; Friedman, Lynch & Herskovitz, 2013; Gee, 2003).

### **Cases**

One popular approach to teaching courses in business ethics relies on case studies. Many professors feel that case studies enhance students' critical thinking skills because they can expose them to all kinds of issues that may arise in various organizational settings (Corey, 1998; Pomykalski, 2010). One obvious problem is that they are subject to selection bias. Moreover, an approach used by one company may not necessarily work for another firm, and it can be dangerous to generalize from one specific situation to all circumstances. Despite all the concerns about this method, it is helpful in teaching ethics in many different disciplines.

In using case studies, students take the ethical theories and arguments they have been studying in the classroom and apply them to a situation that either did happen or could plausibly happen. In doing so, the students are given opportunities to practice identifying relevant principles and problems and to apply various sorts of ethical analyses (Burns et al., 2012, p. 2).

### **Philosophers**

Another popular and traditional approach for teaching ethics relies on studying great philosophers such as Aristotle, Kant, and Mill. These courses focus on normative applied ethics employing the significant theories of philosophical ethics, such as Kantian deontology (duty-based), Millian utilitarianism (consequences-based), and virtue ethics (character-based). It appears, however, that these techniques are not doing the job, and other approaches to teaching ethics may be needed. Interestingly, one philosopher that is not usually studied is Adam Smith. He was an economist and moral philosopher and asserted in his *The Theory of Moral Sentiments* that economic growth depended on morality. Adam Smith, a believer in the "invisible hand" of free markets, did not believe in predatory, ruinous capitalism that only enriches the few at the top (Friedman and Adler, 2011).

We will examine one overlooked philosopher, Confucius, and much can be learned about ethics from him. Other major Eastern philosophers should be studied (e.g., Lao Tzu), and there is no reason to only focus on Western philosophers.

### **Confucius and Hillel**

Two great sages influenced billions of people: Hillel and Confucius. Hillel had a considerable impact on the Western world and Confucius on the Eastern world, especially China. Hillel and his descendants headed the Great Sanhedrin, one of the major academies of the ancient world. Confucius was born around 550 BCE and died c. 479 BCE. According to tradition, Hillel was born c. 110 BCE and died c. 10 CE. The *Analects* of Confucius was written by his disciples posthumously and has a great deal to say about humanism, moral leadership, learning, and humility. He believed that Jen (translated as goodness or humanity and benevolence) was necessary for society to function correctly and prevent war and evil. Jen is similar to the Hebrew word *chesed* (deeds of lovingkindness), a foundational value of the Judeo-Christian philosophy. Friedman and Friedman (2008) compare the philosophy of the two great thinkers. Both are famous for the negative formulations of the Golden Rule.

Zigong asked. Is there a single word that could guide one's entire life? The Master [Confucius] said, "Should it not be reciprocity? What you do not wish for yourself, do not do to others" (*Analects* XV:24).

A prospective convert asked Hillel to teach him the entire Torah while standing on one foot. Hillel replied, "What is hateful to you, do not do to your fellow-man, that is the whole Torah, the rest is commentary" (Hillel, *Babylonian Talmud*, Shabbos 31a).

Both were big believers in humanism

Love all people, but associate with the virtuous (Confucius, *Analects* I:6).

Be among the disciples of Aaron, loving peace and pursuing peace, loving people... (Hillel, *Babylonian Talmud*, Avot 1:12). (Aaron, brother of Moses, was known as a peacemaker in the Talmud and Midrash.)

And humility.

Don't worry if people do not recognize your merits; fear that you may not recognize theirs (Confucius, *Analects* I:16)

He who seeks renown destroys his reputation (Hillel, *Babylonian Talmud*, Avot 1:13).

Confucius stated the following about moral leadership:

He who rules by virtue is like the polestar, which remains unmoving in its mansion while all the other stars revolve respectfully around it (*Analects* II:1).

One of Hillel's most famous aphorisms:

If I am not for myself, who will be for me? But If I care only for myself, what am I? If not now, when? (Hillel, *Babylonian Talmud*, Avot 1:14).



## History

At first blush, one may not see the connection between ethics and history. Given the enormous amount of violence and wars, it may be valuable to demonstrate how the two are related (Edling, Sharp, Löfström, and Ammert, 2020; Hendrick, 2005). One question that might be addressed is whether sexism, racism, religious intolerance, and classism were morally wrong back when they were societal norms? By examining history, one learns to appreciate the consequences of unethical beliefs.

The number of deaths that can be attributed to the Mideast Slave Trade (7<sup>th</sup> to 19<sup>th</sup> Centuries) and the Atlantic Slave Trade (1452-1807) is greater than 34 million (White, 2012, p. 529). More than 27 million people starved to death in India during several famines (18<sup>th</sup>- 20<sup>th</sup> centuries). Adam Smith wrote in 1776 that famines occur when governments get involved and thus interfere with free-market capitalism and natural market forces. This view was eventually refuted by the economist Amartya Sen (pp. 309-310).

Lloyd (2017, para. 5) feels that moral certainty is dangerous. He posits, "History overflows with misery inflicted by well-intentioned people who were convinced that they had seen the only true moral values, and who sought to convert or destroy those who would not agree." His examples include the Inquisition, which was based on the moral certainty of the Roman Catholic Church, which was convinced that only its interpretation of Christian scriptures was correct. Similarly, Stalin's Russia, Mao's China, and Hitler's Germany were totalitarian societies built on the belief that they knew the truth and anyone who disagreed had to be exterminated. Mao Zedong's certainty about Communism and how to make it stronger resulted in the most severe famine in history. The "Great Leap Forward" killed 30 million people besides squandering natural resources and labor (White, 2012, pp. 433-434).

## Literature

Cases are used to teach ethics, but they rarely arouse the passion the way literature can. Cases and history are limited to facts; literature can use fiction, parables, fables, and all kinds of tools to teach values. Many scholars advocate using fiction to teach business ethics (Brawer, 1998; Clemens and Mayer, 1999; Kennedy & Lawton, 1992; Singer & Singer, 2005; Williams, 1997). Aesop's fables date back to the sixth century BCE and teach ethics and values. Upton Sinclair's 1906 novel, *The Jungle*, describing the corruption in the meat-packing industry, changed the way business was conducted in the United States. It was as crucial as *Uncle Tom's Cabin* described the horrors of slavery and was described as "the *Uncle Tom's Cabin* of wage slavery."

## Film

Films today may have the same ability to motivate and inspire as literature and music in ancient times. The advantage of films is that they relate complex themes using visual images that can be unforgettable. Movies also can "show how actions are interconnected and how people and institutions are interdependent, helping students understand that a small or isolated ethical act may affect a larger whole and that business and non-business are not distinct realities" (Bay and Felton, 2012, p. 161). The 1983 television film *The Day After*, dealing with the aftermath of a nuclear war, caused President Ronald Reagan to work hard to ensure that there would never be this kind of war. Films such as *Dr. Strangelove or How I Learned to Stop Worrying and Love the Bomb* and *The China Syndrome* also helped shape the public's attitude towards nuclear war and nuclear power. The people involved in the film *Don't Look Up* are hoping that this satire will help change attitudes towards the problem of climate change (Buckley, 2022).

One of the most memorable lines dealing with business ethics is from the film *Wall Street*. Gordon Gecko, a fictitious corporate raider, says, "The point is, ladies and gentlemen, that greed, for lack of a better word, is good. Greed is right. Greed works. Greed clarifies, cuts through, and captures the essence of the evolutionary spirit." There are websites dealing with the most ethical films of all time, e.g., Carnegie Council's list at <http://www.carnegiecouncil.org/education/002/film/index.html>. Stillman (2006) discusses various movies helpful in teaching ethical leadership.

### **Television**

Television is very similar to film and may also teach business ethics. One can find clips from several television shows to teach ethics. Several episodes of *American Greed* and *60 Minutes* may be of value as real-world cases of unethical behavior. Television has played a significant role in changing attitudes concerning various controversial issues. Then Vice-President Joe Biden attributed changing attitudes to gay marriage to the television series *Will & Grace* (Buckley, 2022).

### **YouTube/TED Talks**

YouTube provides a vast amount of visual material that can be used for instruction. The Department of Business, Government & Society at the University of Texas produced a handy website for teaching ethics that uses YouTube at <http://ethicsunwrapped.utexas.edu/>. Several of Michael Sandel's lectures on justice, ethics, democracy, and markets are available on YouTube. For example, Sandel's "Moral Limits of Markets" is available at <https://www.youtube.com/watch?v=UbBv2ZGC2VI>

### **Music**

One way of delivering inspirational messages to students is through music. Most students listen to music, so this can be a different way to teach them values. There are several examples of songs that helped change the world. Lynskey (2011) wrote a classic work describing the history of some of the great protest songs, and many were part of the music of the American labor movement. It was then fairly dangerous to go on strike, and many workers were killed by militias working for employers. The anti-war songs were also powerful and had an impact on society. The song "Strange Fruit," written by Abel Meeropol and recorded by Billie Holiday in 1939, is available on YouTube. It made everyone aware of the viciousness of racism, particularly the lynching of black Americans in the South. The "strange fruit" suspended from trees was an eerie symbolism for young black men who were hanged from the limbs of trees.

The "Let my people go!" proclamation from Exodus (5:1) became a famous African American spiritual and a mantra of the civil rights movement. It was also used as the battle cry of Soviet Jewish dissidents and refuseniks. Jews all over the world and many gentiles rallied to that passionate appeal. Muravchik (2010) believes that this chant helped make the world aware of the horrors of Communism. A country that has to imprison its citizens behind an iron curtain cannot be a workers' paradise. It reminded the world of the virtues of living in free countries where anyone had the right to emigrate. Some other famous hymns are "We shall overcome" associated with the civil rights movement and "By the Rivers of Babylon" (see Psalm 137), used by Frederick Douglass to denounce slavery, which includes the verse "How shall we sing the Lord's song in a strange land?" Pete Seeger's "Where have all the flowers gone" is a memorable song describing the futility of war.

## Speeches

Speeches are somewhat similar to songs and can also influence people. Students can learn so much about values and morality (as well as some history) from orations. Some of the most powerful statements in history were part of speeches. Patrick Henry's "Give me liberty or give me death!" was part of a speech he made. Fortunately, one can find the "Top 100 Speeches" of the 20<sup>th</sup> century compiled by Lucas and Medhurst (2021) on the American Rhetoric website. According to Lucas and Medhurst, the best speech of all time is Martin Luther King, Jr.'s "I Have a Dream Speech." The last passage in the address is from Isaiah (40:4-5). Reverend King often quoted from biblical sources to impact his listeners emotionally and psychologically. This was an ingenious way to demonstrate to believers that his messages of equality and justice for all were based on core biblical values.

Lincoln's Gettysburg address is considered among the classic speeches of all time. Howard Schultz, CEO of Starbucks, said that Lincoln "taught us that whether you are a business leader, an entrepreneur or a government official, one's foremost responsibility is to serve all of the people, and not just one's self-interest." (Koehn, 2013, para. 37).

## Quotes

Several websites provide ethics quotes that make people think (e.g., Kidadl, 2021). The following are interesting quotations dealing with ethics; most are from the Kidadl website.

"A man without ethics is a wild beast loosed upon this world." — Albert Camus

"Education without values, as useful as it is, seems rather to make man a more clever devil." — C.S. Lewis

"Relativity applies to physics, not ethics." — Albert Einstein.

"In civilized life, law floats in a sea of ethics." — Earl Warren.

"Never let your sense of morals get in the way of doing what's right." — Isaac Asimov.

"On three things the world stands: On justice, on truth, and on peace."  
— Rabban Shimon ben Gamliel

"Let your friends wealth be as precious to you as your own." — Rabbi Yossi

"This is my simple religion. There is no need for temples; no need for complicated philosophy. Our own brain, our own heart is our temple; the philosophy is kindness." — Dalai Lama XIV.

"Live one day at a time emphasizing ethics rather than rules." — Wayne Dyer.

"It is curious - curious that physical courage should be so common in the world, and moral courage so rare." — Mark Twain



"In law, a man is guilty when he violates the rights of another. In ethics he is guilty if he only thinks of doing so." — Immanuel Kant.

"Before I can live with other folks, I've got to live with myself. The one thing that doesn't abide by majority rule is a person's conscience." — Harper Lee, *To Kill A Mockingbird*.

"Ethics must begin at the top of an organization. It is a leadership issue and the chief executive must set the example." — Edward Hennessy.

"In looking for people to hire, you look for three qualities: integrity, intelligence, and energy. And if they don't have the first, the other two will kill you." — Warren Buffet.

"Real integrity is doing the right thing, knowing that nobody's going to know whether you did it or not." — Oprah Winfrey.

"There may be times when we are powerless to prevent injustice, but there must never be a time when we fail to protest." — Elie Wiesel

### **Social Justice Humor**

Some researchers have been examining the use of comedy to get people to pay closer attention to social justice issues (Chattoo, 2019; Feldman & Chattoo, 2019; Friedman & Friedman, 2020). It appears that comedy is more likely to engage and persuade people than simple facts. Fosco (2018) asserts that humor is changing, moving away from being self-deprecating and focusing instead on "using comedy specials and stand-up routines to vocalize marginalization and injustice they've faced — while making the audience laugh." The goal of the humor is to mock the oppressors and those in power and demonstrate how absurdly they behave. Bigots and sexists have no reason to feel superior.

Zekavat (2019) posits that "satire [and humor] can be used as a strategy to raise ethical and political consciousness and persuade people to change their attitudes in certain regards." He demonstrates that satire can be used to make people environmentally conscious. Kramer (2015, p. 61) shows how subversive humor can be a powerful tool to fight racism and oppression. He remarks, "I am concerned most with the cultural stereotypes engaged in racial and gender categorizations that sustain psychological oppression." Subversive humor can be considerably more effective than lecturing people about the evils of stereotyping.

The following is an example of how humor may be used to make people aware of racial inequality in the U.S.:

Here's the amazing part. For South Africa to achieve that kind of black-white wealth gap, we had to construct an entire apartheid state denying blacks the right to vote or own property. But you, you did it without even trying. We trained for decades, and you just waltzed in and won the gold medal (Trevor Noah, BBC News, 2015).

The aforementioned film, "Don't Look Up," chose to approach our blindness to climate change elliptically and satirically, describing a globe-destroying comet hurtling to Earth and the politicians and journalists who dismiss the threat, advising citizens just not to look up. The use of

metaphor and humor were more effective tools to convey a message that may not have been heard had the director chosen to preach instead earnestly.

### **Scripture**

The Hebrew Bible is replete with precepts dealing with business ethics. These include laws dealing with caring for the poor, treating employees fairly, paying wages and rents on time, providing fringe benefits for employees, maintaining fair and stable prices, not wasting natural resources, providing an honest day's work, and not discriminating against the stranger. The regulation demanding that one act transparently and not arouse anyone's suspicions also has its roots in the Torah (Friedman, 2000). The Torah demands that individuals and society do everything possible to "raise the needy from the dust" by providing training, jobs, and loans (Mizrachi and Friedman, 2021). It further insists that "Do not deprive the alien or the fatherless of justice, or take the cloak of the widow as a pledge" (Deuteronomy 24:17). The commandments dealing with affection are loving God (Deuteronomy 6:5), loving your fellow as yourself (Leviticus 19: 18), and loving the stranger (Leviticus 19:34; Deuteronomy 10:19). Precepts involving not mistreating or oppressing the stranger are mentioned an incredible 36 times in the Torah. The idea of imitatio Dei (imitating God) has its basis in the Torah (Leviticus 19:2): "You shall be holy, for I am holy" (see also Leviticus 11:44 and 20:26).

Nehemiah dealt with a serious situation: the exploitation of poor Jews by the wealthy in the Jewish community he was desperately trying to rebuild. Note that debtors had to bring their children "into bondage" to pay off their debts.

And there was a great cry of the people and of their wives against their brothers the Jews. For there were those that said: "We, our sons, and our daughters, are many: therefore, we must buy grain for them, that we may eat, and live." And there were those that said: "We have mortgaged our fields, vineyards, and houses, that we might buy grain, because of the famine." And there were those that said: "We have borrowed money for the king's taxes, and that on our fields and vineyards." Now, our flesh is as worthy as the flesh of our brothers, our children as worthy as their children: yet, see, we bring into bondage our sons and our daughters to be servants! Some of our daughters are brought to servitude already: neither is it in our power to redeem them; for other men have our fields and vineyards (Nehemiah 5: 1-5).

Nehemiah understood that without social justice, the Jews would have no future. He succeeded in convincing the nobility to remit the debts and restore the forfeited fields of the poor. This type of financial and agrarian reform was unheard of in its time and is one of the earliest examples of progressive land reform.

Few have described the ideal vision for humankind better than Isaiah.

He shall judge between the nations, and shall decide disputes for many peoples; and they shall beat their swords into plowshares and their spears into pruning hooks; nation shall not lift up sword against nation, neither shall they learn war anymore (Isaiah 2:4).

The wolf will live with the lamb, the leopard will lie down with the goat; the calf, the lion cub, and the fatling [will feed] together, and a small child will lead them. A cow and bear will graze together and their young will lie down together. The lion will eat straw like the cattle. An infant will play over a viper's hole, and a newly weaned child will stretch forth his hand over an adder's den. They will do no harm or damage anywhere in all of My holy mountain; for the earth will be filled with knowledge of God, as water covers the sea (Isaiah 11:6-9).

The *Book of Psalms* (*Sefer Tehillim* in Hebrew) consists of 150 inspiring and rousing hymns. The Hebrew word *Tehillim* means praises, and it is a book of praises of God. But it is much more than thanksgiving and praise. Many human emotions, faith, joy, trust, lament, grief, confession, thanksgiving, awe, remorse, anger, and happiness – are revealed in *Psalms*. The ancient psalms were songs accompanied by musical instruments, and these songs had powerful messages. Many did deal with the oppression of the poor and helpless. Three major religions – Judaism, Christianity, and Islam – consider its words holy

The idea of helping the weak is repeated numerous times in Scripture. The orphan, widow, and stranger are paradigms for those who can effortlessly be taken advantage of. In modern times, one might add the disabled. Psalm 146 demonstrates what God does for the oppressed, the poor, and the helpless.

He secures justice for the oppressed; He gives bread to the hungry.  
The Lord releases the imprisoned. The Lord gives sight to the blind;  
The Lord straightens those bowed down; the Lord loves the righteous. The Lord protects the stranger; orphan and widow He enables to stand firm; but the way of the wicked He thwarts (Psalm 146:7-9).

Psalm 15 and Psalm 25 describe what it takes to be a righteous person. For example, only those who "walketh uprightly, and worketh righteousness, and speaketh truth in his heart" are entitled to dwell in the house of the Lord (Psalm 15:2). The writer goes on to beg God for "integrity and uprightness" (Psalm 25:21) as desirable attributes worthy of God's attention.

### **Talmud and Midrash**

The Talmud, Judaism's Oral Law, primarily contains rabbinical discussions and commentaries on the Torah's written text. The Talmud, mainly concerned with *halachah* (Jewish law), also provides a detailed record of Jewish people's beliefs, philosophy, traditions, culture, and folklore, *i.e.*, the *aggadah* (homiletics), is replete with legal, ethical, and moral questions. The Midrash, a separate scripture, records the views of the Talmudic sages and is mainly devoted to the exposition of Biblical verses. The Babylonian Talmud, a product of the academies in Babylon, was completed in 500 CE; the Jerusalem Talmud, a creation of the academies in Israel, was finished in 350 CE.

The Talmud has much to say about the proper way to live an ethical, rewarding life (Friedman, 2012). Friedman and Fischer (2014) demonstrate how the ethical and moral principles of *Avot* (Ethics of the Fathers), one of the 63 tractates of the Talmud, can influence people's behavior to improve the world. According to Socken (2009), the Talmud is as relevant today as

when compiled about 1,500 years ago. Solomon (2009: xi) agrees: "The Talmud, frequently censored and occasionally banned and burned by the Catholic Church, is one of the most influential, though seldom acknowledged or properly understood, writings of Late Antiquity."

The sages of the Talmud were not historians; they told stories—fascinating ones. These stories are an ideal way of communicating essential truths ranging from ethics to theology. Rubenstein makes the point that:

The storytellers were not attempting to document "what actually happened" out of a dispassionate interest in the objective historical record, or to transmit biographical facts in order to provide pure data for posterity. This type of detached, impartial writing of a biography is a distinctly modern approach. Nowadays we distinguish biography from fiction...In pre-modern cultures, however, the distinction between biography and fiction was blurred. Ancient authors saw themselves as teachers, and they were more concerned with the didactic point than historical accuracy (Rubenstein, 2002, p.12).

Rubenstein (2002, p. 14) stresses that the correct question to ask about a Talmudic story is "What lesson did he [the storyteller] wish to impart to his audience?" and "What does the story teach us about rabbinic beliefs, virtues, and ethics?" Those are more important questions than whether the story is entirely accurate, partially true, or a metaphor.

The Talmud sees obeying the strict letter of the law as insufficient; therefore, one must go beyond the requirements of the law — *lifnim mishurat hadin* (literally, inside the line of the law). Indeed, the Babylonian Talmud (Bava Metzia 30b) declares that Jerusalem was destroyed for following the strict letter of Torah law and not doing more than the law required. The following story is a classic going beyond the letter of the law case. What is remarkable about this narrative is that it suggests that one who only follows the basic rules is a "barbarian."

Shimon ben Shetach was struggling in the flax business. His students said: Rabbi, abandon this business and let us buy you a donkey, and you will not have to work so hard. They went and bought a donkey from an Ishmaelite, which had a jewel hanging on its neck. They returned to him happily, saying, thanks to this good luck, you'll never have to work again! When he learned about the jewel, he asked his students whether the donkey's owner knew of it at the time of the sale. When they said no, he ordered them to return the jewel. [The voice of the Talmud's editor intervenes and asks:] But why should this be so?! For later, in Rabbi Yehuda HaNassi's time it was ruled that although stealing from pagans is forbidden, one may keep an item that a pagan has lost. [So why did Shimon ben Shetach not permit himself to benefit from the pagan's mistake?]

Rabbi Shimon answered them: Do you think Shimon ben Shetach is a barbarian?! Shimon ben Shetach would prefer to hear the words "Blessed be the God of the Jews" than all the money in the world (Jerusalem Talmud, Bava Metzia 2:5; translation by Halberstadt, 2019 and Amital, 2016).

The following is another example of a Talmudic story. Shmuel was an expert in astronomy/astrology (back then, the two were not separate disciplines). It was essential to teach

people about free choice and not believe that the stars controlled their fate. This story emphasizes the importance of charity.

Shmuel and Avleit [Avleit was an astrologer] were once sitting together watching people go to the swamp to cut reeds. Avleit said to Shmuel, "That man over there is going to go to the swamp, but he won't return because a snake is going to bite him and he will die." Shmuel said: "If he is a Jew, he will return." While they were sitting, the man returned. Avleit stood up and threw off the man's pack of reeds. He found among the reeds a snake that had been cut in two pieces. Shmuel said to the man: "What did you do to be saved from death like that?" The man replied: "Every day, all of us pool all our bread together and then share it. Today, one man had nothing to contribute, and he was ashamed. I, therefore, told everyone: "Today, I am going to collect the bread." When I got to him, I pretended to take something from him so that he would not be ashamed." Shmuel said to him: "You have done a good deed." Shmuel went out and lectured: "Charity saves one from death" (Proverbs 10:2), and not just from an unnatural death, but even from death itself (Babylonian Talmud, Shabbos 156b; ).

The following narrative teaches one how to argue constructively. There were numerous debates between the Schools of Hillel and Shammai. The Talmud (Babylonian Talmud, Eruvin 13b) explains why the law is determined according to the School of Hillel and not Shammai.

For three years, the School of Shammai and the School of Hillel debated each other. These said the *halacha* [Jewish law] agrees with our view, and these said the *halacha* is in accord with our opinion. Then, a heavenly voice (*bath kol*) went forth and announced: both opinions are the words of the living God, but the *halacha* is in agreement with the School of Hillel... What did the School of Hillel do to merit that the *halacha* is according to their view? Because they were kindly and modest, and they studied their own opinion and those of the School of Shammai. And not only that, but they would mention the view of the School of Shammai before their own (Babylonian Talmud, Eruvin 13b; based on translations by Soncino and ArtScroll).

The Talmud concludes that the School of Hillel had humility, and whoever searches for greatness, it flees from him. One who humbles himself, the Lord elevates. The way to debate is to respect the opinions of one's opponent. By listening to the other side's view and respecting it, one learns from it. That is the secret of Talmudic debate: respecting the opinion of others.

When we teach students about business ethics, we sometimes forget that business ethics is a two-way street: Employers must behave ethically, but employees must also act appropriately. Almost all the sages of the Talmud had jobs—Abba Chilkiyah was a field laborer.

Abba Chilkiyah was a grandson of Choni the Circle Maker, and whenever the world required rain, the Rabbis sent a message to him, and he prayed, and rain fell. Once there was an urgent need for rain, the Rabbis sent him a couple of scholars to ask him to pray for rain. They came to his house, but they did not find him there. They then proceeded to the fields, and they found him there hoeing. They greeted him, but he took no notice of them.

Towards evening he gathered some wood and placed the wood and the rake on one shoulder and his cloak on the other shoulder. He walked barefoot throughout the journey, but when he reached a stream, he put his shoes on to cross it. When he came to an area of thorns and thistles, he lifted up his garments, thus exposing his legs to the thorns.

When he reached the town, his wife adorned with jewelry came out to meet him. When he arrived home, his wife entered the house first, then he, and then the scholars. He sat down to eat, but he did not say to the scholars, 'Join me'. He then shared the meal among his children, giving the older son one portion and the younger child two portions. He said to his wife: "I know the scholars have come on account of rain, let us go up to the roof and pray, perhaps the Holy One, Blessed be He, will have mercy and rain will fall; and we will not have to take credit for ourselves for making it rain."

They went up to the roof. Abba stood in one corner and she in another. At first, the clouds appeared over the corner where his wife stood. When he came down from the roof, he said to the scholars: "Why have you come here?" They replied: "The Rabbis have sent us to you, Sir, to ask you to pray for rain." Thereupon he exclaimed: "Blessed be God, who has made you no longer dependent on Abba Chilkiyah." They replied: "We know that the rain has come on your account, but tell us, master, the meaning of these mysterious acts of yours, which are puzzling to us? Why did you not take notice of us when we greeted you?" He answered: "I was hired as a dayworker, and I said to myself I must not interrupt my work even for a moment to greet you." They then asked: "And why did you, master, carry the wood on one shoulder and the cloak on the other shoulder?" He replied: "It was a borrowed cloak; I borrowed it to wear, and not for any other purpose [to carry wood on it]."

They then asked him: "Why did you, master, go barefoot throughout the whole journey, but when you came to a stream, you put your shoes on?" He replied: "What was on the road I could see but not what was in the water" [he was afraid of stepping on something dangerous]. They asked: "Why did you, master, raise your garments when you came to a place of thorns and thistles?" He replied: This [the leg] heals itself, but the other [the garment] does not." They asked: "Why did your wife come out adorned in jewelry to meet you, master, when you entered the city?" He replied: "So that I should have no desire to glance at any other woman." They asked: "Why, master, did she enter the house first, and you after her, and then we?" He replied: "Because I did not know your character" [Abba did not feel it was right to leave his wife outside with two strangers]. They asked: "Why, master, did you not ask us to join you in the meal? He replied: "Because there was not sufficient food for all, and you would have declined my invitation. I, therefore, said that it would not be right to cause the rabbis to give me credit



for nothing" [Inviting people to a meal knowing they will refuse is a form of dishonesty.]

They asked: "Why did you give one portion to the older son and two portions to the younger?" He replied: "Because the one stays at home [and has access to food] and the other is away in the synagogue studying the whole day." They asked: "Why, master, did the clouds appear first in the corner where your wife stood and then in your corner?" He replied: "Because a wife stays at home and gives bread to the poor which they can immediately enjoy, and I provide them with money which they cannot benefit from immediately. Or perhaps it may have to do with certain robbers in our neighborhood. I prayed that they might die, but she prayed that they might repent; and they did repent (Babylonian Talmud, Taanis 23a-23b; based on translations by Soncino and ArtScroll).

There are many lessons in this story. The importance of being an honest laborer is one of them. Abba Chilkiyah did not waste time since he was paid for the day. We expect employers to be ethical when paying wages, but employees must also be righteous and be productive. Nowadays, with smartphones and the internet, it is so easy for employees to waste time that technically belongs to the employer. Abba Chilkiyah's ethics extended to a borrowed garment, and he would not use it for another purpose. He was cautious with the property belonging to others.

The relationship between Abba Chilkiyah and his wife is interesting. Women often dress up to go out when being seen by others; for their husbands, an old bathrobe may be adequate. Abba's wife dressed up for her husband when he returned from work. Abba's great humility is also evident: he did not want to receive credit for making it rain. He also had no issue admitting that his wife was more compassionate than he was: she successfully prayed that the robbers repent.

The following story uses Heaven and Elijah to support the argument that laughter is, in actuality, essential, both for this world and the next. In addition, this narrative aims to answer the question: What does it take to get into Heaven?

Rabbi Beroka Hozaah asked Elijah the Prophet: "Is there any person in this market who is destined for Paradise?" He replied, no. ... While they were conversing, two people passed by. Elijah said: "These two are destined for the world to come." Rabbi Beroka approached them and asked them what they did. They replied: "We are jesters, and we cheer up people who are depressed. Also, when we see two people who are quarreling, we work hard to make peace between them" (Babylonian Talmud, Taanis 22a; based on translations by Soncino and ArtScroll).

Helfgot (1998) advocates the use of Midrash as a tool to enhance the teaching of values. The following Midrash may be used to teach all kinds of ideals. This story about Moses when he was Jethro's shepherd teaches us valuable lessons about leadership:

Moses was shepherding his father-in-law's sheep one day when one of them bolted. Moses followed the runaway animal until it reached a body of water, where it stopped for a drink. Moses compassionately said to the sheep, 'If only I had known that you thirsted for water. You must be exhausted from running ...' Saying this, he scooped up the animal, placed it on his

shoulders, and headed back to his flock. Said God: 'If this is how he cares for the sheep of man, he is definitely fit to shepherd Mine ...' (Midrash Shemot Rabbah 2:2; translated by Zarchi (2013, para. 4).

This story demonstrates that a leader must have compassion. There is a great deal of evidence that compassionate leadership is critical in the knowledge economy.

It is the nature of leaders to surround themselves with "yes men" and cater to the constituency that supports them. In Moses we find the opposite. His greatness was that he loved and cared for every member of the flock entrusted to him, never reconciling himself to the fact that some people are just not worth losing sleep over. He put his life on the line for the Jews who violated Judaism's most sacred tenet just days after they were given the commandment not to worship idols. He never gave up trying to make peace with his nemeses Datan and Aviram, who wanted to have him killed for the crime of saving a fellow Jew from an Egyptian taskmaster. And even Korach, who led a mutiny against him, was the recipient of never-ending overtures for reconciliation. God himself pleads with Moses numerous times to distance himself from these troublemakers and let them suffer the consequences, but Moses, faithful shepherd of Israel, is concerned with the fate of every individual (Zarchi, 2013).

Zarchi (2013) finds another valuable lesson in this Midrash

But there is another layer to this Midrash. What Moses understood from his years of shepherding was that when a single sheep leaves the group and goes off on its own, it isn't an act of rebellion. It's just thirsty, and its leaders have not been able to quench its thirst. So, too, every Jew is precious; no one is expendable. When Jews wander off from their community or even reject the Judaism they grew up with, it is a cry for help rather than insubordination. They are looking for inspiration, searching for meaning. Rather than criticizing, Moses lifts them up and says: I'm sorry, I didn't realize your spiritual needs weren't being met (Zarchi, 2013).

### **Kabbalah**

The concept of making the world a better place is the old idea of *tikkun olam* (in Hebrew, *tikkun* means to repair, and *olam* means world). It is the belief that one is obligated to repair and perfect the world by using the legal system to enact laws that help society. The sages of the Talmud used the principle of *tikkun olam* to enact various laws to help humanity (e.g., Babylonian Talmud, Gittin 32a, 34b, 40b, 41b, 45a, b); it is also an essential part of the kabbalah of Rabbi Isaac Luria (1534-1572).

The Kabbalah of Forgiveness is a commentary on a heroic and pioneering work on the mechanics of forgiveness. Rabbi Moshe ben Yaakov Cordovero of Safed, Israel, wrote the *Date Palm of Devorah (Tomer Devorah)* during the sixteenth century. The first chapter describes 13 distinct levels of mercy that God confers upon the world (Abramson, 2014). Rabbi Cordovero's discussion of the nature of forgiveness inherent in the 13 levels of compassion should be emulated by individuals in their routine relationships with others.



The *Zohar* (Splendor) is one of the foundational works in Kabbalah (Jewish mysticism) and is often attributed to Rabbi Shimon ben Yochai, a Second-century Tannaitic sage (many modern scholars believe that it was written by Moses de Leon (c. 1240-1305)).

Rabbi Abba was sitting at the gate of the city of Lod. He saw a man coming and sitting on a protrusion that bulged at the side of the mountain. The man was weary from the road, and he sat and slept there. Meanwhile, Rabbi Abba saw a snake approaching him, and a lizard came out and killed the snake. When the man woke, he saw the snake dead in front of him. The man rose, and the protrusion he had been sitting on was torn off the mountain and fell to the valley below it. But the man was saved. [Had he slept on the protrusion for even a few more minutes, he would have plunged to the valley along with the overhang and would have been killed.]

Rabbi Abba came to him and told him: "Tell me, what have you done so that God performed for you these two miracles." He told him. "Throughout my whole life, never has anyone done me an evil that I did not make peace with him and forgave him.

Moreover, if I could not make peace with him, I did not go to my bed before I forgave him and to all those who afflicted me. Thus, I did not hold any grudge for that evil that had been done to me. And I do not suffice for that, but even more, from that day forth, I have tried to do a kindness for them."

Rabbi Abba wept and said: "The deeds of this one are greater than Joseph's, for with Joseph, the wrongdoers were his brothers, and he certainly should have pitied them because of the brotherhood. But what this one did is greater than Joseph's deeds. He is worthy to have God perform for him one miracle after another miracle (*Zohar*, 201a, Parshat Miketz; based on translations by Laitman (2011, pp. 378-379; Drizin, 2018).

## **Mussar**

Mussar (original meaning was "instruction" — see Proverbs 1:2 —but now means ethics) is a traditional Jewish ethical and spiritual movement that became a widespread movement in 19<sup>th</sup> century Lithuania under the guidance of Rabbi Yisroel Salanter (1810-1883). One of his central beliefs was that Talmudic study should not be an end in itself and what truly mattered was virtue-based ethics; the spirit of the law was more essential than the letter of the law. Furthermore, people must work on character and ethical development, enhance their moral conduct, and improve. Self-awareness is an essential part of the Mussar process. One of the earliest Mussar books was *Duties of the Heart* by Rabbi Bahya ibn Paquda written in eleventh-century Spain. Dr. Alan Morinis, the founder of The Mussar Institute, is a prominent teacher in the modern-day revival of the Musar movement. It is currently being practiced by individuals worldwide from all religious denominations. Morinis (2007) has written several books that promote the study of Mussar, including *Everyday Holiness*.

Mussar and Kabbalah are included in Jewish spirituality, but the latter focuses mainly on the mystical and efforts to experience and understand God. Mussar is much more practical and grounded in the real world and concentrates on living an ethical life and behaving righteously. There is overlap between the two, and some great works of Mussar were written by Kabbalists.

The following is a selection from *Messilat Yesharim (Path of the Just)*, a significant work on Mussar written by the famous Kabbalist Rabbi Moshe Chaim Luzzatto (1707–1746). The author also stresses how crucial it is for employees to provide an honest day's labor.

CLEANLINESS FROM THEFT: We can observe that even though most people are not blatant thieves, literally taking with their hands the possession of their fellow and putting it in their own possessions, nevertheless, most people experience a taste of theft in their business dealings by rationalizing permission to profit through their fellow's loss. They may tell themselves: "Business is different" ...

They likewise exempted hired workers from reciting the (Hamotzi) blessing over bread and from the last blessing of the grace after meals (*Birkat Hamazon*). And even in the case of reciting the Shema, they required them to pause from their work only for the first chapter (Babylonian Talmud, Berachoth 16b). How much more so for things that are optional. And if he transgresses this, he is considered a thief.

Abba Chilkiya did not even return the greetings of Torah scholars in order to not be idle from the work he was doing for another (Babylonian Talmud, Taanit 23b). Yaakov, our forefather, peace be unto him, states explicitly, "in the day heat consumed me, and the frost by night, and my sleep departed from my eyes" (Genesis 31:40).

The summary of the matter: one who is hired out to his fellow for any kind of work, behold, all of his hours are sold to his employer for the workday as the Sages stated: "to hire oneself out is to sell oneself for the day" (Bava Metzia 56b). Whatever time he takes for his own pleasure, whatever it may be, is completely guilty of stealing. And if his employer does not forgive him, he is not forgiven. For the Sages already stated: "sins between man and his fellow are not atoned for on Yom Kippur until he has pacified his fellow"(Yoma 85b) (*Mesillat Yesharim*, Chapter 11)

Interestingly, there is a crime recognized under American federal law known as "honest services fraud" (18 U.S.C. §1346) that can be asserted against both political figures and private sector employees. Although this law has been criticized for vagueness and has been limited by United Supreme Court decisions to situations where there are "fraudulent schemes to deprive another of honest services through bribes or kickbacks" (see *Skilling v. United States*, 561 U.S. 538 (2010)), in its simplest interpretation it could theoretically encompass any employee who does not provide full value for the work he has been hired to do.

In the classic medieval ethics (Mussar) work, *Orchos Tzadikim* (Chapter 14: Jealousy), the author notes that jealousy comes from observing what friends own. We become envious of a friend's garment, food, house, and/or wealth, and envy leads to coveting. Thus, individuals who purposely flaunt wealth to arouse their fellows' envy are guilty of the transgression of causing others to sin (*lifnei iver*). The *Orchos Tzadikim* recommends a life of moderation and simplicity so as not to arouse the envy of others.

## Conclusion

This paper demonstrates many methods to teach values ethics, and educators should not limit themselves solely to cases and philosophers. Even if it is not possible to teach people to behave ethically in a classroom setting, academics need to use all available tools to teach ethical sensitivity. Undoubtedly, there are other approaches to teaching ethics. Future research should compare the various techniques and attempt to determine which, if any, do an exceptional job of teaching students to behave ethically. Until this is resolved, educators should not solely examine Western philosophers and case studies.

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# **Operations Management / Operations Research**



**POISSON-BINOMIAL DISTRIBUTION FOR CONFORMING UNITS IN A  
CONTINUOUS-REVIEW (s, Q) MODEL WITH BACKORDERS AND REWORKS**

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**ABSTRACT**

The seminal continuous review (s, Q) model with backorders is formulated based on a series of suppositions among which are probabilistic demand and impeccable quality of all replenishment units. Various modifications of this model have appeared in the literature for a wide range of operational settings. These variations encompass a group of models that relax the perfect quality assumption of replenishment items by treating the number of conforming units in a lot as a binomial random variable. Such representation is suitable for stable processes in which the production yield is not perfect but is a known constant, and process quality, therefore, may be monitored by a proportion control chart. A second group of models extend the basic framework of these stable paradigms by allowing the production yield to be a random variable. Included in this second group is a recent continuous review (s, Q) model in which the production yield is assumed to be a beta random variable. Under this assumption, the number of conforming units in a lot of size Q follows a beta-binomial distribution. In this paper, we consider another interesting case where the number of conforming items in a lot of size Q follows a Poisson-binomial distribution which arises in a collection of Q independent conforming/non-conforming (success/failure) experiments with different state-of-process-dependent conforming (success) probabilities. Assuming that conforming probabilities, immediately after the production of each specific unit in the lot, decline according to a simple logistic function of power form, we present a continuous review (s, Q) model with backorders and imperfect quality, which includes, besides the customary setup, holding, and shortage costs, additional inspection and rework costs for identifying and correcting nonconforming (defective) items. We also present closed-form expressions for the optimal values of policy variables for the special case of exponential lead time demand.

Keywords: Continuous Review Models; Poisson-binomial Distribution.



## 1. INTRODUCTION

In his ground-breaking book about the Just-in-Time (JIT) inventory systems, in which goods are received from the vendors only as they are needed, Schonberger [1982] highlighted that substantial cost reductions, in the form of plunge in scrap and waste; attenuation of rework; enhanced worker morale; shortened cycle inventories; and reduced buffer stocks, result when the production system produces small lots of high quality. The same collection of viewpoints is underpinned in Hall [1983] in the framework of zero inventory or stockless production where a notion of continuous process improvement is promoted. Motivated by the success stories of firms that have embraced these operational principles, in the past several decades, academics, consultants, and practitioners, engaged in the line of work associated with the continuous-review  $(s, Q)$  inventory systems, have committed considerable amounts of time and effort to study the possible relationships between quality, reorder point, and lot size of these systems and their potential effect on the firm's overall operation and performance. In the early years, Moinzadeh and Lee [1987] investigated the impact of non-conforming items on the order quantity and reorder point of a continuous-review inventory model with Poisson demand and constant lead time. Nasri, Paknejad, and Affisco [1991] assumed that each lot contains a random number of non-conforming (defective) items and derived explicit results for a  $(s, Q)$  inventory system based on the assumption that demand during the lead time follows a geometric distribution. Paknejad, Nasri, and Affisco [1995] developed similar results for the cases of exponential and uniform lead time demand distributions. They also studied the economic trade-offs associated with investment in reduced setup costs and their impact on total inventory related costs as well as the policy variables of the model. Pakenjad, Nasri, and Affisco [1999] studied the effect of investing to improve quality on lot size and reorder point in a continuous review  $(s, Q)$  inventory system with exponential lead time demand in which an order of size  $Q$ , containing a random number of defective (non-conforming) items, is placed each time the inventory position, on-hand plus on-order minus backorders, reaches the reorder point,  $s$ . Assuming that the investment function is logarithmic, the authors also presented explicit results for the optimal values of the policy variables and the resulting optimal total cost per year. Paknejad, Nasri, and Affisco [2000] developed the same set of results for the case of power investment cost function.

A major component of the vast majority of models discussed above is the assumption that the manufacturing process is an independent process with the obvious implication that the number of conforming units in each lot is a binomial random variable with parameters  $Q$  and  $(1-\theta)$ , where  $(1-\theta)$  is the probability of success (conforming) or yield rate, which is assumed to be constant for all items in a lot of size  $Q$ , and  $\theta$  is the proportion of defective items in a lot. Nasri, Paknejad, and Affisco [2006] considered another unique distribution for conforming items, also studied by Porteus [1986], which may arise from dependent processes. The authors presented an approximately optimal quality-adjusted  $(s, Q)$  model for this special case.

The binomial assumption used in previous research is appropriate for stable processes in which the proportion of acceptable items in a replenishment lot, referred to as production yield or yield rate, is not perfect but it is a known constant, and process quality, therefore, may be monitored by a proportion control chart. In a recent paper, Paknejad, Nasri, and Affisco [2020] extended the main framework of a stable continuous-review  $(s, Q)$  system with constant production yield rate by allowing production yield rate, defined as proportion of conforming units in a lot, to be a random variable. Specifically, they assumed that production yield follows a beta distribution leading to a beta-binomial distribution for the number of conforming units in a replenishment lot. The authors then presented explicit results for a special case where demand is Poisson and lead time is exponential so that the asymptote of demand during the lead time is an exponential distribution. In this paper, we consider another interesting case in which the number of conforming (acceptable or non-defective) items in a lot is viewed as the sum of  $Q$  independent Bernoulli trials (conforming/non-conforming) that are not necessarily identically distributed. Under this scenario, the number of conforming items in each lot follows a Poisson-binomial distribution representing the number of successes (conforming units) in a collection of  $Q$  independent success/failure (conforming/non-conforming) experiments with different state-of-process-dependent success (conforming) probabilities  $p_i$  for  $i = 1, 2, 3, \dots, Q$ , for each item in the lot. Please note that if all the success (conforming) probabilities are the same (regardless of the state of the production process), that is  $p_i = p$  for  $i = 1, 2, 3, \dots, Q$ , where  $p$  is a constant between 0 and 1, then the number of conforming items in a lot of size  $Q$  follows the ordinary binomial distribution, which is a special case of Poisson-binomial distribution discussed in this paper. Similarly, if

$p_i = p$  for  $i = 1, 2, 3, \dots, Q$ , but  $p$  is viewed as a random variable following beta distribution, then the number of acceptable items in each lot follows a beta-binomial distribution studied in Paknejad, Nasri, and Affisco [2020].

In section 2, we briefly review the underlying continuous review  $(s, Q)$  model with backorder under the implicit assumption that all items in each lot are of perfect quality. In this same section, we also review a few of the imperfect quality models appeared in the literature in which there are relationships between lot size, reorder point and quality. However, the nature of those relationships are such that the number of conforming units in a lot can be described by either binomial or beta-binomial distributions.

This paper models the relationships between lot size, reorder point, and quality in another simple way. Specifically, as alluded to before, we consider the number of conforming units in each lot as the sum of  $Q$  independent Bernoulli trials (conforming/non-conforming) that are not necessarily identically distributed. In this case, the number of conforming (non-defective) units in a lot follows a Poisson-binomial distribution with conforming probabilities  $p_1, p_2, p_3, \dots, p_Q$  for each of the  $Q$  trials, which are not necessarily all the same. We further assume that the conforming probabilities  $(p_1, p_2, p_3, \dots, p_Q)$  follow a simple logistic function of power form, defined by the formula

$$p_i = p \left( \frac{1}{1 + e^{-c}} \right)^{i-1} \text{ for } i = 1, 2, 3, \dots, Q, \text{ where } 0 < p \leq 1, -\infty < C < +\infty, \text{ and the return values for}$$

all the conforming probabilities,  $p_i$  for  $i = 1, 2, 3, \dots, Q$ , being in the range 0 to 1. In this portrayal, the conforming probability of the first item ( $i = 1$ ) in the lot, produced at the beginning of the production cycle, is  $p_1 = p$ . However, success or conforming probabilities for all the subsequent items,  $p_i$  for  $i = 2, 3, \dots, Q$ , decline by a factor of  $r = \left( \frac{1}{1 + e^{-c}} \right)$ , while transitioning from the production of item  $i = 1, 2, 3, 4, \dots, Q - 1$  to the production of item  $(i + 1) = 2, 3, 4, \dots, Q$ . In what follows we refer to  $p$  and  $r$  as conforming probability coefficient and common ratio, ratio of any conforming probability with the previous one (that is  $r = \frac{p_{i+1}}{p_i}$  for  $i = 1, 2, 3, \dots, Q - 1$ ),

respectively. Of course, the value of the common ratio  $r$ ,  $0 < r < 1$ , as well as the corresponding value of the rate of decline in consecutive conforming probabilities,  $\frac{p_i - p_{i+1}}{p_i} = 1 - r$  for  $i = 1, 2, 3, \dots, Q - 1$ , both depend upon the value of  $C$ , where  $-\infty < C < +\infty$ . For example, if  $-5 < C < +5$ , then  $.0067 < r < 0.9933$ . It should be noted that as  $|C| \rightarrow \infty$ ,  $r \rightarrow 1$  when  $C$  is in the positive direction, and  $r \rightarrow 0$  when  $C$  is in the negative direction. Obviously, the higher the common ratio  $r$  (the closer it is to 1), the lower the rate of decline,  $(1-r)$ , in conforming probabilities for one item to the next (from  $p_i$  to  $p_{i+1}$ ). By the same token, the lower the common ratio  $r$  (the closer it is to 0), the higher the rate of decline from  $p_i$  to  $p_{i+1}$ . In addition to these model specifications, we also assume that the system incurs an extra cost for inspection of each lot and an extra cost for rework and related operations associated with each nonconforming (defective) unit. Hence, for the model proposed here, there is an incentive for production or procurement of smaller lots, because of the smaller expected number of nonconforming units requiring less rework costs. For the scenario described above, in section 3 we develop a quality-adjusted continuous-review  $(s, Q)$  model with backorders in which an order of size  $Q$  is placed each time the inventory position (on-hand plus on-order minus backorders) drops to or below the reorder point,  $s$ . In this same section, we also present closed form expressions for the optimal values of policy variable,  $s^*$ , and  $Q^*$ , when lead time demand follows an exponential distribution. Finally, a brief summary and conclusion is presented in section 4.

## 2. REVIEW OF THE FOUNDATIONAL MODELS AND ASSUMPTIONS

The pivotal model in this paper is the fixed reorder quantity system, known as continuous review  $(s, Q)$  model, presented in many textbooks and studied by numerous researchers, including Hadley and Whitin [1963], Johnson and Montgomery [1974], Wagner [1975], Hillier and Lieberman [1990], Paknejad, Nasri, and Affisco [2020], and Carlson [1982]. In this last article, the author views the demand per unit time,  $d$ , as a Poisson random variable with  $E(d) = \Delta$ . He also considers the lead time,  $w$ , as an exponential random variable with  $E(w) = \lambda$ . The author then shows that demand during the lead time,  $D(w)$  or  $X$ , is a geometric random variable with its asymptote approaching an exponential distribution with  $E(X) = \lambda\Delta$  and  $\text{Var}(X) = \lambda^2\Delta^2$  as  $\lambda\Delta$  increases. Under these contexts, the author develops closed-form expressions for the optimal pair of policy variables, lot

size,  $Q$ , and reorder point,  $s$ , for two separate cases of shortage cost: (1) Based on the average number of shortages irrespective of magnitude, and (2) based on the expected number of shortages during the year.

Paknejad, Nasri, and Affisco [1999] consider the first type of shortage cost and extend Carlson's model under the following assumptions: Each lot contains a random number of defective items. Upon arrival, the purchaser inspects the entire lot using a 100% inspection policy. Defective (nonconforming) units are immediately returned to the supplier at no extra charge. The system, however, incurs an additional cost for inspection of each lot. The following notation, which is similar to those in Carlson [1982], are used.

$A$  = expected demand per year,

$Q$  = lot size,

$s$  = reorder point,

$d$  = demand per unit of time, a Poisson random variable with  $E(d) = \Delta$ ,

$w$  = lead time, an exponential random variable with  $E(w) = \lambda$ ,

$D(w)$  = lead time demand, an exponential random variable,

$\lambda\Delta = E[D(w)]$ ,

$\lambda^2\Delta^2 = \text{Var}[D(w)]$ ,

$(1-\theta)$  = proportion of conforming items in a lot, yield rate,

$\theta$  = proportion of non-conforming items in a lot, defect rate,

$c_1$  = holding cost per unit per unit of time,

$c_2$  = shortage cost regardless of the magnitude,

$c_3$  = ordering cost per order,

$c_4$  = inspection cost per lot,

$Y$  = number of conforming items in a lot of size  $Q$ , a random variable.

The authors showed that the total cost per year is a function of the mean and variance of  $Y$  given order size  $Q$ . When demand is Poisson distribution and lead time follows an exponential distribution, the asymptote of demand during the lead time is exponential, as shown in Carlson [1982]. Considering this case and assuming that  $Y$ , the number of conforming units in a lot of size

$Q$ , is a binomial random variable with parameters  $Q$  and  $(1-\theta)$ , the authors presented closed form expressions for the optimal order quantity,  $Q^*$ , reorder point,  $s^*$ , and the resulting expected total cost per unit of time. Nasri, Paknejad, and Affisco [2006] discussed another interesting case where the number of conforming (acceptable), items is not binomial. Specifically, they relax the assumption that the manufacturing process is an independent process and develop an approximately optimal  $(s, Q)$  model for a unique state dependent case, initially presented by Porteus [1986] in the context of the classical undiscounted Economic Order Quantity Model. In this case the authors assumed, as in Porteus [1986] and Paknejad, Nasri and Affisco [2005], that while producing a particular lot, the production process may become “out of control” with a constant probability,  $q$ , each time a unit is being produced. Once in “out of control” state, the production process continues to produce defective items until the entire lot is produced. Assuming that  $q$  is fixed and close to 1, the authors provided closed form expressions for approximately optimal pair of policy variables,  $s^*$  and  $Q^*$ , and the corresponding expected annual cost. The results in Paknejad, Nasri, and Affisco [1999] and those in Nasri, Paknejad, and Affisco [2006] are based on the assumptions that the defect rate,  $\theta$ , or probability of process moving “out of control”,  $q$ , are known and constant. These assumptions are appropriate for stable processes that are in a state of statistical control. For unstable production processes, these parameters are not constant and should be viewed as random variables.

Paknejad, Nasri, and Affisco [2020] studied the relationship between lot size, reorder point, and quality in continuous-review inventory systems with backorders for processes that have not yet achieved the state of statistical control by allowing the production yield,  $1-\theta$ , to be a continuous random variable with known probability density function. Using this assumption, they developed a modified continuous review  $(s, Q)$  model with exponential lead time demand. The authors also presented explicit results for the optimal pair of policy variables for a special case where production yield rate follows a beta probability density function and, therefore, the number of acceptable items in a replenishment lot is characterized by a beta-binomial distribution. In the following section, we develop another quality-adjusted continuous review  $(s, Q)$  model with backorders in which the number of conforming (non-defective) units in a lot,  $Y$ , is regarded as the sum of  $Q$  independent Bernoulli experiments (conforming/non-conforming or success/failure) with different, but related, success (conforming) probabilities,  $p_i$  for  $i = 1, 2, 3, \dots, Q$ , while

producing a specific item in the lot. Specifically,  $Y$  follow a Poisson-binomial distribution with conforming probabilities given by  $p_i = p \left( \frac{1}{1+e^{-c}} \right)^{i-1} = pr^{i-1}$  for  $i = 1, 2, 3, \dots, Q$ , where  $p$  and  $r$  represent the parameters of the conforming probabilities, that we call coefficient and common ratio, respectively.

### 3. CASE OF POISSON-BINOMIAL DISTRIBUTION FOR NUMBER OF CONFORMING UNITS IN A LOT

Let us now consider the relationship between lot size, reorder point, and quality in continuous-review  $(s, Q)$  inventory systems with backorders for processes in which the random variable  $Y$ , the number of acceptable items in a replenishment lot of size  $Q$ , is characterized by a unique discrete probability distribution. Specifically, we deem the experiment of producing a lot as the sum of  $Q$  independent Bernoulli trials with outcomes of 1 (conforming) or 0 (non-conforming) that are not necessarily identically distributed. In other words, the number of conforming units in a lot,  $Y$ , is viewed as a discrete random variable with support  $\{0, 1, 2, 3, \dots, Q\}$  following a Poisson-binomial distribution, which arises in a collection of  $Q$  independent conforming/non-conforming experiments with conforming probabilities,  $p_i$  for item  $i = 1, 2, 3, \dots, Q$ , in a lot. To facilitate the formulation of the model under this scenario, we assume  $p_i = pr^{i-1}$  for  $i = 1, 2, 3, \dots, Q$ , where  $p, 0 < p \leq 1$ , and  $r, 0 < r < 1$ , are the coefficient and common ratio parameters, respectively. Since  $r$  follows the logistic function, i.e.,  $r = \left( \frac{1}{1+e^{-c}} \right)$  for  $-\infty < C < +\infty$ , the conforming probabilities form the first  $Q$  terms of a geometric sequence as follows:

$$p_1 = p \left( \frac{1}{1+e^{-c}} \right)^0 = p, p_2 = p \left( \frac{1}{1+e^{-c}} \right)^1 = pr, p_3 = p \left( \frac{1}{1+e^{-c}} \right)^2 = pr^2, \dots, p_Q = p \left( \frac{1}{1+e^{-c}} \right)^{Q-1} = pr^{Q-1}.$$

Beyond this, we use the following supplementary notations, definitions, and relationships:

$$X_i = \begin{cases} 1 & \text{if the } i^{\text{th}} \text{ item in a lot is conforming} & \text{for } i = 1, 2, 3, \dots, Q \\ 0 & \text{if the } i^{\text{th}} \text{ item in a lot is nonconforming} & \text{for } i = 1, 2, 3, \dots, Q \end{cases},$$

$$P(X_i = 1) = p_i = p \left( \frac{1}{1 - e^{-c}} \right)^{i-1} = pr^{i-1} \text{ for } i = 1, 2, 3, \dots, Q,$$

$$Y = \sum_{i=1}^Q X_i = \text{number of conforming items in a lot of size } Q \text{ with support } y \in \{0, 1, 2, 3, \dots, Q\},$$

Note:  $Y$  is a Poisson-binomial random variable with success probabilities,

$$p_i = p \left( \frac{1}{1 + e^{-c}} \right)^{i-1} = pr^{i-1} \text{ for trial } i = 1, 2, 3, \dots, Q$$

$$E(Y) = \mu = \sum_{i=1}^Q p_i = \sum_{i=1}^Q p \left( \frac{1}{1 + e^{-c}} \right)^{i-1} = p + pr + pr^2 + pr^3 + \dots + pr^{Q-1} = \text{expected number of conforming (non-defective) units in a lot of size } Q,$$

Note:  $\mu$  is the sum of the first  $Q$  terms of a geometric series, up to and including the  $pr^{Q-1}$  term, with common ratio of any term with the previous one,  $r$ , and the coefficient,  $p$ , representing the first term of the geometric series in expanded form. Therefore, upon using the closed-form formula for the sum of the first  $Q$  terms, we find

$$E(Y) = \mu = \sum_{k=0}^{Q-1} pr^k = p \left( \frac{1 - r^Q}{1 - r} \right).$$

$$Q - \mu = Q - p \left( \frac{1 - r^Q}{1 - r} \right) = \text{expected number of nonconforming (defective) units in a lot of size } Q,$$

$Q$ ,

$c_5$  = rework cost per nonconforming (defective) unit,

$c(s, Q)$  = expected total cost per cycle,

$$T = \frac{Q}{A} = \text{expected cycle time, time between two successive placement of orders,}$$

It is interesting to note that the expression obtained above for  $Q - \mu$ , the expected number of defective units in a lot of size  $Q$ , reduces to the corresponding expression for the model presented by Porteus [1986] and used in Nasri, Paknejad, and Affisco [2006], when  $r = p = 1 - q$ . In this connection  $q$ , as defined in Porteus [1986], represents the probability that the machine moves “out of control” while producing a single unit of the lot and starts producing nonconforming units. Furthermore, Porteus [1986] assumed that once the machine moves “out of control” it stays in “out



of control” state until the rest of the lot has been produced. Based on this scenario, the author found an expression for the expected number of defective items in a lot of size  $Q$  which is a special case of our model with  $r = p = 1 - q$ . Hence, the results obtained here are more general in a sense that  $r$  and  $p$  need not be necessarily the same.

Now let us return to our continuous review  $(s, Q)$  model with backorders and imperfect quality and denote the lead time demand,  $D(w)$ , by  $X$ . Using an approach similar to Johnson and Montgomery [1974] or Hillier and Lieberman [1990], the expected total cost per cycle, including the customary setup, holding, and shortage costs, plus the additional rework and inspection costs, is

$$c(s, Q) = c_5 \left[ Q - p \left( \frac{1 - r^Q}{1 - r} \right) \right] + c_4 + c_3 + c_2 \bar{b}(s) + c_1 \frac{Q}{A} \left( s - \lambda \Delta + \frac{Q}{2} \right) \tag{1}$$

where

$$\bar{b}(s) = \int_s^\infty (x - s) f(x) dx \tag{2}$$

Referring to the underlying characteristics of the random variable  $Y$  (the number of conforming units in a lot of size  $Q$ ), which follows a Poisson-binomial probability distribution with

$$E(Y) = \mu = \sum_{i=1}^Q p_i = p \left( \frac{1 - r^Q}{1 - r} \right),$$

it is reasonable to assume that the rate of decline  $(1-r)$  in conforming probabilities from one item to the next (from  $p_i$  to  $p_{i+1}$ ) is low. Hence, the common ratio,  $r$ , is close to one. Under this condition, we can use a second order Taylor series expansion of  $r^Q$ , similar to the one used by Porteus [1986], to obtain

$$r^Q = e^{(\ln r)Q} \cong 1 + (\ln r)Q + \frac{[(\ln r)Q]^2}{2} \tag{3}$$

Upon using  $\ln r \cong -\left(\frac{1-r}{r}\right)$  in (3), substituting the result into (1), and simplifying, we find the following approximate expression for the expected total cost per cycle:

$$c(s, Q) = c_5 Q \left[ \left( \frac{r-p}{r} \right) + p \left( \frac{1-r}{r^2} \right) \left( \frac{Q}{2} \right) \right] + c_4 + c_3 + c_2 \bar{b}(s) + c_1 \frac{Q}{A} \left( s - \lambda \Delta + \frac{Q}{2} \right) \quad (4)$$

In what follows, we refer to equation (4) and all the subsequent results without mentioning them as approximations. Multiplying (4) by the expected number of cycles per unit of time ( $\frac{A}{Q}$ ), we drive the expected average annual cost, EA(C), as follows

$$EA(C) = c_1 (s - \lambda \Delta) + c_1 \left( \frac{Q}{2} \right) + A c_5 \left[ \left( \frac{r-p}{r} \right) + p \left( \frac{1-r}{r^2} \right) \left( \frac{Q}{2} \right) \right] + A [c_4 + c_3 + c_2 \bar{b}(s)] \left( \frac{1}{Q} \right) \quad (5)$$

Assuming that lead time demand,  $D(w)$  or  $X$ , is an exponential random variable with  $E(X) = \lambda \Delta$ , we have

$$\bar{b}(s) = \int_s^\infty (x-s) f(x) dx = \lambda \Delta e^{-\frac{s}{\lambda \Delta}} \quad (6)$$

Using (6) in (5), the expected total cost per unit of time is

$$EA(C)_{\text{exp.ltd, pois-bin.confdist}}(s, Q) = c_1 (s - \lambda \Delta) + A c_5 \left( \frac{r-p}{r} \right) + \left[ c_1 + A c_5 p \left( \frac{1-r}{r^2} \right) \right] \left( \frac{Q}{2} \right) + A \left( c_4 + c_3 + c_2 \lambda \Delta e^{-\frac{s}{\lambda \Delta}} \right) \left( \frac{1}{Q} \right) \quad (7)$$

To minimize (7), we set

$$\frac{\partial EA(C)_{\text{exp.ltd, pois-bin.confdist}}(s, Q)}{\partial Q} = \left( \frac{1}{2} \right) \left[ c_1 + A c_5 p \left( \frac{1-r}{r^2} \right) \right] - A \left( c_4 + c_3 + c_2 \lambda \Delta e^{-\frac{s}{\lambda \Delta}} \right) \left( \frac{1}{Q^2} \right) = 0 \quad (8)$$

$$\frac{\partial EA(C)_{\text{exp.ltd, pois-bin.confdist}}(s, Q)}{\partial s} = c_1 - A c_2 e^{-\frac{s}{\lambda \Delta}} \left( \frac{1}{Q} \right) = 0 \quad (9)$$

Solving (8) and (9) simultaneously, produces

$$Q_{\text{exp.ltd, pois-bin.confdist}}^* = \left( \frac{1}{c_1 + A c_5 p \left( \frac{1-r}{r^2} \right)} \right) \left( c_1 \lambda \Delta + \sqrt{(c_1 \lambda \Delta)^2 + 2A(c_4 + c_3) \left[ c_1 + A c_5 p \left( \frac{1-r}{r^2} \right) \right]} \right) \quad (10)$$

$$s_{\text{exp.ltd, pois-bin.confdist}}^* = -\lambda \Delta \ln \left( \frac{c_1}{AC_2} Q_{\text{exp.ltd, pois-bin.confdist}}^* \right) \quad (11)$$

As alluded to before, if all the conforming probabilities are the same, that is  $p_i = p$  for  $i = 1, 2, 3, \dots, Q$ , where  $p$  is a constant between 0 and 1, then the number of conforming items in a lot of size  $Q$ ,  $Y$ , follows the ordinary binomial distribution with support  $y \in \{0, 1, 2, 3, \dots, Q\}$ , which is a special case of Poisson-binomial distribution. Similarly, if  $p_i = p$  for  $i = 1, 2, 3, \dots, Q$ , but  $p$  is viewed as a random variable following beta distribution, then  $Y$ , the number of acceptable items in each lot, follows a beta-binomial distribution studied by Paknejad, Nasri, and Affisco [2020] with support  $y \in \{0, 1, 2, 3, \dots, Q\}$ . Finally, when  $r = p = 1 - q$  and  $q$  represents the probability that the production process moves “out of control”, while producing a single unit of the lot, then the expression for the expected number of conforming units in a lot of size  $Q$ ,  $E(Y) = \mu$ , given in this paper reduces to its corresponding result obtained by Porteus [1986].

#### 4. CONCLUSION

This paper presents another extension of the commonly used continuous review  $(s, Q)$  model with backorders to account for imperfect quality of items in a replenishment lot. Specifically, the paper views the experiment of producing a lot of size  $Q$  as the sum of  $Q$  independent Bernoulli trials with outcomes of 1 (if item is conforming) and 0 (if item is non-conforming) that are not necessarily identically distributed. In other words, the number of conforming units in a lot is treated as a discrete random variable following a Poisson-binomial distribution with different, but related, success (conforming) probabilities, denoted by  $p_i$ . Assuming that  $p_i = pr^{i-1}$  for  $i = 1, 2, 3, \dots, Q$ , where  $p$  is the coefficient and  $r$  is the common ratio of a geometric series, the paper presented an approximate expression for the expected average annual cost for a continuous-review  $(s, Q)$  model with backorders and imperfect quality. Explicit results for the optimal order quantity and reorder point were also given based on the assumption that lead time demand follows an exponential distribution.

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# **Sustainability Management**

# Plastic Crisis: A Business Data-Driven Study on the Evolution and Comparison of its Practice and Research

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## Abstract

Plastic management-related research is becoming essential and critical to address the burgeoning issues of plastic consumption and waste, nationally and internationally. In this study, we seek to explore and investigate the research trends and the related areas to Plastic Management from business, technological, and environmental perspectives within the time window between 2016 and 2021. Based on our holistic review, we highlight the current research gaps and propose future research directions. Moreover, we shed light on the plastic crisis status encountered by the United States. One of the main contributions of this study is the data-driven interpretation, discussions, and implications gleaned from the data analysis on a large-scale dataset shared by the U.S. Department of State. In addition, we analyze thousands of abstracts using text mining techniques from various perspectives (Business Models, Circular Economy, Closed Loop, Value Chain, and Consumers, etc.); to stimulate new research ideas in plastic management and supply chain management to provide a framework for academia to respond to the needs of practitioners and regulators to tackle the detrimental plastic crisis.

*Keywords:* plastic, sustainability, circular economy, closed-loop, business model, text mining, single-use plastic.

## 1. Introduction

The linear consumption of resources is becoming an intriguing issue due to its detrimental impact pertaining to resource scarcity. Recently, plastics have been classified as the latest supply chain disruption (Vakil, 2021). There is an estimated \$12 Trillion in new business opportunities by developing solutions or models to implement the United Nations Sustainable development goals

(Business Sustainable Development Commission, 2017). To tap the opportunities, for example, in the United States (U.S.), a bill of \$1.3 Billion has been rolled out to support the Act #breakfree from plastic, which will be used to cover education orientation, incentives (consumers level), evaluating the incineration practices on health, protecting water municipals from downstream, tackling toxic chemicals and marine debris (Congress, 2020). The reports and activities by Greenpeace, #breakfree from plastic, and Plastic Pollution Coalition significantly impacted the bill's passing before congress in the year 2020 to tackle the plastic crisis. Table 1 lists the main acronyms used throughout the study.

**Table 1 List of acronyms used in the Study**

Term	Abbreviation	Term	Abbreviation
Artificial Intelligence	AI	Operations Management	OM
Blockchain Technology	BCT	Small and Medium-sized Enterprises	SMEs
Circular Economy	CE	Supply Chain Management	SCM
Internet of Things	IoT	Sustainable Plastic Management	SPM

## 1.1 History of Plastic

Plastic was first introduced in 1862 by Alexander Parks as a replacement for Ivory at London International Exhibition. Later, plastic was introduced to the consumer market in the 1950s. In the 1960s, para-aramid synthetic fiber was used in the racing industry to replace steel in the tires. While bio-based and bio-degradable plastics were widely used in the 1970s. Over the past 50 years and until today, there has been an increase in plastic consumption. It is a core material in almost all industries, including and not limited to construction, packaging, medical, and end-user products. (Plastic-Industry-Association, 2017). According to the Science and History Institute, plastic refers to “pliable and easily shaped ”. Plastics are polymers, and the polymer's chemical structure determines the shape and flexibility of the plastic (Lucas, 2018). Polymers exist in nature, but



plastics are manufactured from synthetic polymers. Synthetic polymers are based on using carbon atoms from petroleum and fossil fuel. The atoms' chain length and the pattern determine the strength, weight, and flexibility (Science-History-Institute, 2016).

### 1.2 Problem Statement

Plastic pollution is a critical crisis threatening the whole planet disastrously. Global plastic production increased by 26% from the year 2010 to the year 2016 (Geyer et al., 2017). The total plastic waste items collected from marine debris in the U.S. is around 2.4 million items. The cumulative global plastic production since the year 1950 is 8.3 billion metric tons; out of those, the amount of waste is 6.3 billion metric tons (until the year 2015), and the cumulative waste is expected to be steadily grow up to 12 billion tons by the year 2050; cf. Statistica (2017). Hypothetically, if the current consumption of plastic goes at the same rate, by the year 2050, the CO2 emissions due to plastic will reach 56 gigatonnes (Heinrich Boll Foundation, 2020).

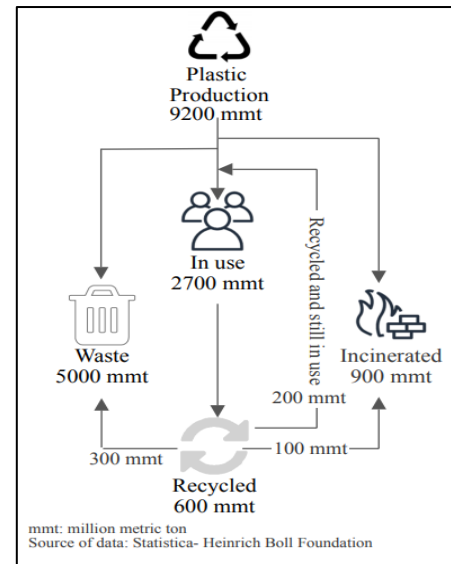


Figure 1. Schematic flow of plastic (1950-2017)

## 2 Research Questions, Objectives, and Contributions of the Study

### 2.1 Research Questions

One of the challenges in the research area related to *plastic management* is the lack of business-related literature, especially in the regime of business data science. Although searching by specific keywords returns numerous results, most of these publications are non-business related. Therefore, to bridge the gap, we aim to address several questions, including but not limited to:

- (1) What is the current status of research concerning plastic management from a business and data science perspective?
- (2) Where is the gap between scholarly research and industrial practice? What are the open (unsolved) questions or challenges in literature?
- (3) What are the disruptive technologies involved in plastic crisis management and the degree of inclusion?
- (4) What are those main business models developed in the literature to address SPM?
- (5) Operations Management (e.g., SCM, Value chain) role in addressing the growing sustainable plastic management?
- (6) What are the primary roles of different stakeholders in addressing the plastic crisis?

These questions are critical to address as the solutions will help tackle the global plastic crisis, especially after the U.S. was reported as the leading country exporting plastic (World Bank, 2018). The urgency become more overwhelming recently, as the U.S. is ranked first in terms of the average plastic waste per year per capita, which is estimated to be around 231 lbs. (Vetter, 2020).

## **2.2 Objective and Contribution of the Study**

The objective of the study is to develop a framework for both practitioners and academic researchers, respectively from two aspects: (1) from the practicing perspective, we analyze the data shared by the U.S. State department over the past 5 years; (2) from the academia perspective, we perform a holistic and deep review of the literature status over the same time frame to identify the gaps, and future areas of research related to that field from business, technological, and environmental perspectives. This study is featured with data-driven results interpretation, discussions, and implications provided based on the analysis done on a large-scale dataset that we collected from the U.S. Department of State (approximately 1.04 Million records) from the year

2016 to 2020. In addition, thousands of abstracts and keywords of publications were analyzed using text mining techniques.

The remainder of this study is structured as follows. Section 2 covers a background of the areas under study. Then, Section 3 describes the methodology for our analysis, and Section 4 presents the analysis and results. Section 5 reports our main findings and discussion, and Section 6 provides concluding remarks and implications (Academic, Managerial, and Policy). Finally, future work is discussed in Section 7.

## **2. Background**

This section reviews the literature on the following themes: business models, value chain, technologies, circular economy/closed loop, and consumers.

### **2.3 Business Models**

The business models reflect the strategy and the business process to create value. A sustainable business model extends after adding the social and environmental responsibility dimension (Dijkstra et al., 2020). One of the comprehensive definitions for sustainable business models incorporates pro-active multi-stakeholder management while creating value for a broad range of stakeholders with a long-term perspective (Geissdoerfer et al., 2018). While sustainable plastic is defined as "plastic that fit for purpose, consumes, resources, generate minimal waste, and involve minimal risk to social and environmental systems." (Landon-Lane 2018). SPM refers to using techniques across the waste hierarchy to minimize the environmental damage (Dijkstra et al., 2020). The authors reviewed and classified forty-four management business models into eight archetypes: Maximize material and energy efficiency; Create value from waste; Substitute with renewables and natural processes; Deliver functionality rather than ownership (i.e., product-as-a

service); Adopt a stewardship role; Encourage sufficiency; Re-purpose the business for society/environment; Develop scale-up solutions (Bocken et al., 2014). According to a study by MIT Sloan Management Review, out of 3057 participants from various global organizations, 60% reported that their firm has a sustainability strategy, but only 25% reported they have business cases (Unruh et al., 2016). To address the issue, five business models are proposed after studying more than 100 circular business model typologies, which are design-based start-ups, waste-based start-ups, platform-based start-ups, service-based start-ups, and nature-based start-ups (Henry et al., 2020). Circular business models are essential for the implementation of a CE (Geissdoerfer et al., 2020). Stakeholder enablers and enabling environment are the two halves that enclose a sustainable model (Pankaj, 2015). Recently, Dijkstra et al., (2021) evaluate comprehensively the status of 105 start-ups and SMEs active in the plastic management field and provide an overview of the innovations and solutions for managing the plastic problem for marine. Ellen MacArthur's foundation proposes four models underneath it: refill at home, return from home, refill on the go, and return on the go (Ellen MacArthur Foundation, 2019a). One of the effective industry practices is the "*Performance with Purpose*" model (PWP) developed by PepsiCo, which is based on four pillars: deliver a superior financial return, transform product portfolio, limit environmental impact, and talent sustainability (Nooyi et al., 2020). Investors avoid stocks for organizations with poor sustainability (Unruh et al., 2016).

## **2.4 Value Chain**

Designing the correct value chain is vital for supporting innovations to help enhance economic development (Lee, 2021). In 1985, Michael Porter developed the competitive advantage model and how sustainability impacts superior performance. In 2006, the value chain components were mapped to corporate social responsibility (Porter et al., 2006). Lee et al., (2017) evaluate the

literature between 1980 and 2015 and suggests a direction related to responsible social and environmental value chain concerning three dimensions; *Context, Objectives, and Stakeholders*. Organizations embracing socially and environmentally responsible value chains will face operational issues. Those issues/challenges create opportunities for OM researchers to explore; cf. Lee et al., (2017) and Zhang et al., (2020).

## **2.5 Technologies**

Technological development and adoption (e.g., IoT, AI, BCT, 3D printing, and many other technologies) force research toward information and financial flow; cf. Zhang et al., (2020). Among those aforementioned technologies, BCT, IoT, and AI are the top three technologies cited across various literature and technical reports as promising technologies for battling the plastic crisis (e.g., Walden 2020, Chidepatil et al. 2020, Ellen MacArthur Foundation 2019b). BCT is more valuable with credence good followed by experienced goods (Chang et al., 2018). REMADE road map in the year 2019 evaluated the technology situation and gap in the industry and what solutions are needed to tackle waste, energy consumption, and CO<sub>2</sub> emissions (REMADE, 2019). Modeling the long-term effect of an intervention (i.e., technology) is an important research direction (Lee et al., 2017). Disruptive technologies mandate full participation from all the stakeholders across the supply chain (Erhun et al., 2020). Technologies for processing, recovering, and separating plastic packaging are costly and not affordable for many organizations (REMADE, 2019).

## **2.6 Circular economy and closed loop**

The essence of CE is the standardization of components starting from the design/re-design of (Products), for improved materials flow and practical disassembly, in addition to promoting technology licensing and having access to products rather than owning them (Ellen MacArthur

Foundation, 2019b, Ellen MacArthur Foundation 2013). Geissdoerfer et al., (2020) revisited 114 definitions for *Circular Economy* (CE) and proposed a modified definition:

*“Circular economy is an economic system in which resource input and waste, emission, and energy leakages are minimized by cycling, extending, intensifying, and dematerializing material and energy loops. This can be achieved through digitalization, sterilization, sharing solutions, durable product design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.”*

Unruh et al., (2018) propose a framework for having a CE based upon 3D printing technology. This technology is not more environmentally friendly than existing techniques, but the author points out the similarity in how 3D printing and nature operate, where the latter grow cell by cell. Additionally, 3D printing fulfills the principle of materials parsimony, where one material can be used for various products. Reusable packaging is an option that has a promising impact on minimizing the plastic problem (Ellen MacArthur Foundation 2017). Between 40-48% of the annually produced plastic is non-recyclable. Most non-recycling plastic might be converted to energy, but it ends up being dumped in the landfill or the ocean (Chidepatil et al., 2020).

## **2.7 Consumers**

Involving the various stakeholders (consumers, shareholders, government, non-governmental agencies, producers, and suppliers) is essential and links research to global economy areas; otherwise, the study's relevance and value will be questioned (Lee et al., 2017). Governments are among the top leading stakeholders by setting policies and regulations to expand the waste collection, build facilities for safe waste disposal, and reduce plastic waste exports to countries with low waste collection and high leakage rates (PEW Charitable Trusts, 2020). However, governments alone are not enough to support a CE. The transition to a CE requires an ecosystem of various partners (Ellen MacArthur Foundation, 2019b). Unruh et al., (2016) suggest that investors may play a role in enforcing organizations to sustainability goals. There are four core

groups to tackle the plastic crisis pollution: multinational corporations, developed country governments, developing country governments, and citizens who may put public pressure to save the environment. Each has roles and responsibilities toward the plastic crisis (Williams et al., 2019). Some of the top issues to address sustainability are the lack of consumer demand for sustainable products, short-term thinking of businesses, and quantifying the impact and effect of sustainability (Unruh et al., 2016).

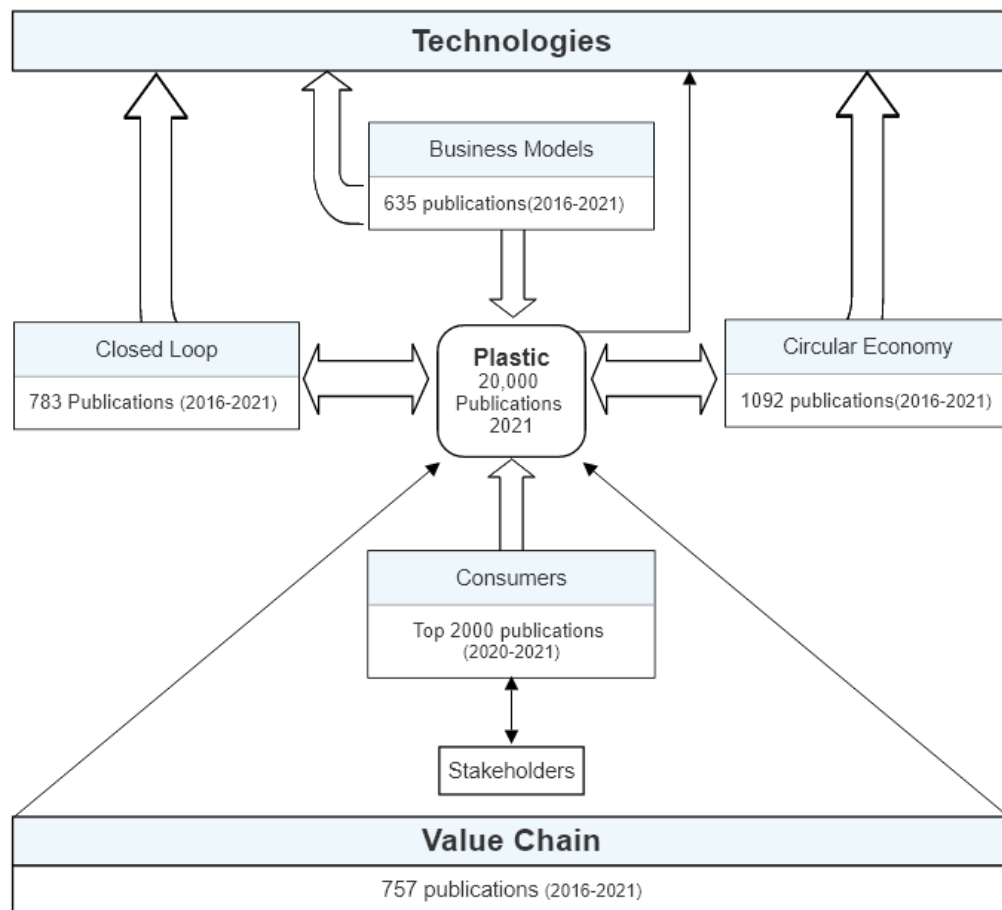
### **3 Methodology**

To explore the status of research concerning the plastic crisis, we perform a two-step analysis as follows. First, more than 500 abstracts of publications were reviewed for a preliminary exploratory evaluation to extract the themes related to plastic management. The sources reviewed are Harvard Business Review (HBR), MIT Sloan, Google Scholar, and Science Direct. The abstracts reviewed from google scholar are based on the rank order. Table 2 reports the number of publications by keyword from which the 500 abstracts were evaluated. Papers were selected from this sample that has strong relevance from a business perspective, in addition to reports by non-for-profit organizations to extract themes related to plastic management. Second, the themes below were extracted from the sources above for another iteration of exploration through the Scopus database. The themes are **‘Plastic Business Models,’ ‘Plastic and Circular Economy,’ ‘Plastic and Consumers,’ ‘Plastic and Closed Loop,’ ‘Plastic and Value Chain,’ ‘Plastic and Technology.’** Figure 2 shows the frequency of publications by theme and year from the Scopus database. ‘Technology and Plastic’ keywords did not return accurate literature. Accordingly, the technical aspect is studied based on the technologies included in the other themes. In addition to the publications retrieved by theme, the top 20,000 publications in 2021 were retrieved in accordance with the Plastic keyword.

Next, the 20,000 publications are screened manually to exclude the non-business-related publications. Finally, this subset was merged with the publications under the themes in Figure 2 to remove the duplicates and the publications not available in full text.

**Table 2 Keywords and Publications by Source (Mid-April 2021)**

Keywords	Source	Time Range	Frequency
Plastic Management	Google Scholar	2015-2021	610 k
Plastic Management	ScienceDirect	2015-2021	84 K
Sustainable Plastic	Google Scholar	2015-2021	224 K
Plastic	Harvard Business Review	Before 2021	149
Plastic	MIT Sloan	2019-2021	13



**Figure 2. Publications Frequency by Theme Scopus Database**



The publications in each theme are extracted in a separate data set with details about authors, year, journal, volume, issue, citation, affiliation, abstract, keywords, references, publisher, corresponding author address, document type, publication stage, for cluster, text, and bibliometric analysis.

## 4 Analysis and Results

### 4.1 Network Visualization

Figures 5 and 6 (as well as Figures 10-14 in Appendix) show the network visualization between the keywords that appear more than the theme's threshold set (10 occurrences). The colors reflect the cluster of keywords that co-occur together. The size of the 'node' depends on the total occurrences, while the 'links' reflect the number of terms it is tied to. Total link strength is a score provided to a term based on its appearance in various publications. The Network diagram shows the connection between the top terms included in Table 3. VOS viewer clustering method is based on an optimization algorithm to determine the number of clusters in each run. Thus, small clusters are merged with larger ones.

### 4.2 Research Trends and Gaps

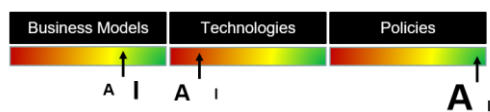


Figure 3. Research Status (Saturation, Contribution, Sector) [Based on literature reviewed]

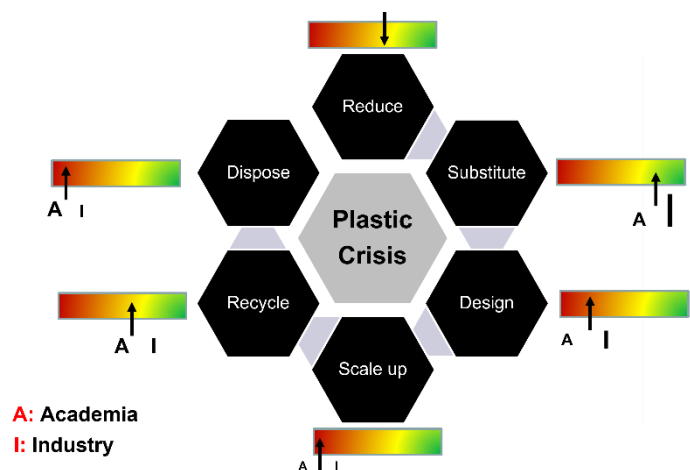


Figure 4. Research Status by Sub-categories (Saturation, Contribution, Sector) [Based on literature reviewed]

Figure 3 is developed based on our opinion after reviewing the abstracts reviewed across three categories 'Business Models', 'Technologies,' and 'Policies.' The bar's color from 'Red' to 'Green' reflects the saturation level of publications based on the amount found, where 'Red' means there is a shortage of publications and 'Green' means there is an abundance of related papers. The pointer reflects the location on the saturation bar for academia and industry combined. The letters on the map reflect academia and industry, while the size of the letter reflects the amount of contribution based on the sample reviewed. In Figure 4, Scale-up is the most sub-category that has little literature.

On the other hand, many publications share ideas and descriptive statistics about plastic reduction. It was unclear which sector contributed more; accordingly, we left that label blank for further studies. The industry is superior in practices and uses cases to find substitution and design ideas to minimize the amount of plastic and standardize the components. At the same time, academia is superior in recycling and disposal techniques.

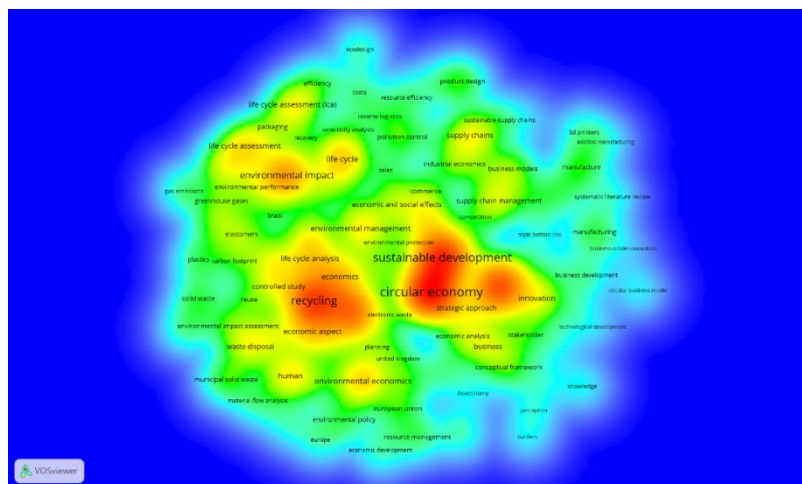
## **4.3 Text Analysis**

### **4.3.1 Text Analysis Algorithm**

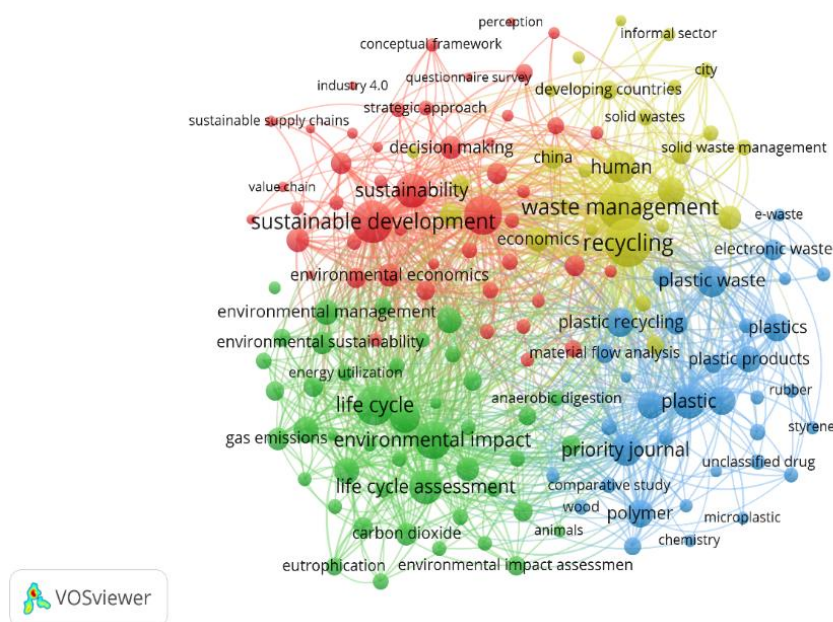
Any copyright statements in the abstract are removed, then a sentence detection algorithm is used to split the abstract into sentences. Afterward, a 'part-of-speech' tagging algorithm is applied to break down the sentence by the verb, adjective, preposition, noun, etc., convert plural to singular terms and remove the stop words. The algorithms are based upon the Apache OpenNLP library. The total keywords in Table 3 are based on the final set of words, excluding the stop words.

**Table 3 Themes Breakdown by Documents and Terms**

Theme	Documents	Total Keywords abstract	Keywords fulfilling threshold	Keywords included Network Diagram	Clusters
Consumers	2000	18213	846	802	5
Circular Economy	1092	9530	403	376	5
Closed Loop	783	6937	182	165	5
Value Chain	757	6781	166	155	4
Business Models	635	4794	118	107	5



**Figure 5. Density Map for the Business Model Theme**

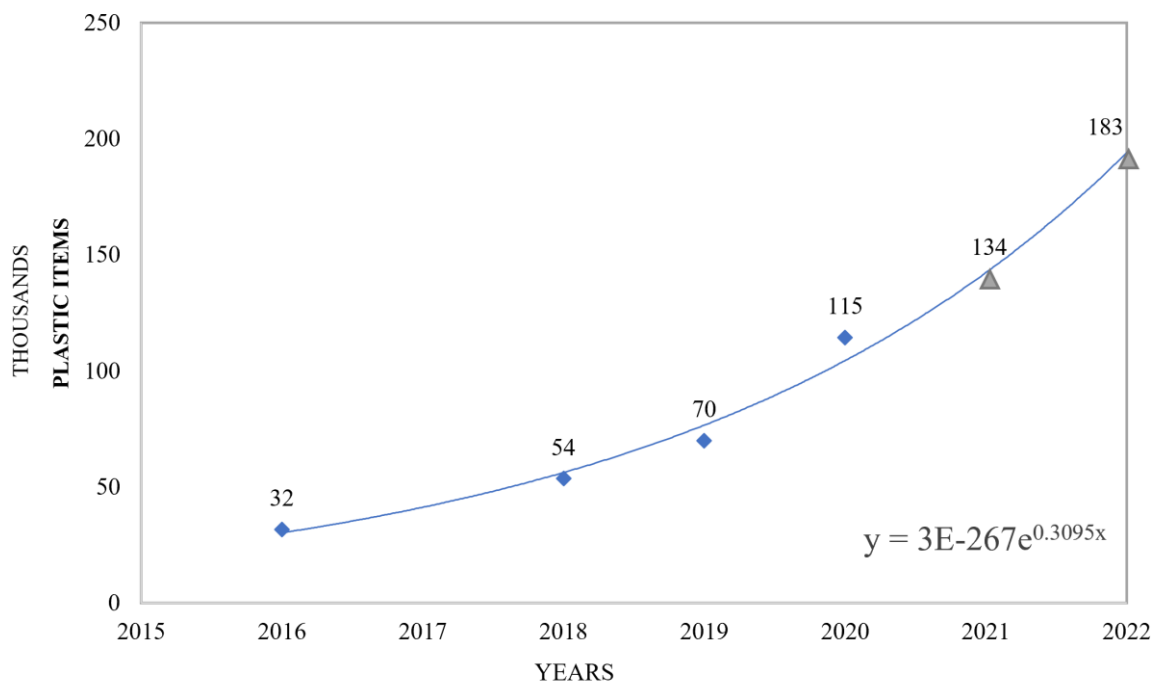


**Figure 6. Co-occurrence and Clusters under the Value Chain Theme**

## 5 Findings and Discussion

### 5.1 Marine debris in the U.S.

Based on the data retrieved from the U.S. Department of State, the top three single use-plastic items collected in the U.S. are (1) cigarette butts, (2) bottles, and (3) caps or lids. While the top States from which the plastic waste was collected were Florida, California, Illinois, Hawaii, and Texas. The items of marine debris follow an exponential distribution. Following the same pattern, the forecasted marine debris is expected to reach 183K by the end of the year 2022 as shown in Figure 7.



**Figure 7. Plastic Items Grow Exponentially in the U.S.**

### 5.2 Text Mining

*Business Model theme:* As depicted in Figure 5, the top three terms are ‘Circular Economy’ that occurred 234 times, ‘sustainable development’ that occurred 163 times, and ‘recycling’ that occurred 109 times. ‘Plastics’ has no ties (links) with ‘sustainable development, more research is

needed to examine ‘SPM’ models. There is a complete absence for two of the five ‘R’ (Reduce and Re-purpose). Figure 8 shows the 5 ‘R’ mapping across the theme studied. The shaded bars represent the existence of a research-related. ‘Reuse’ has a minor occurrence under the business model theme.

*Consumer theme:* in Figure 14 (Appendix), some of the top terms are ‘human’ that occurred 367 times, 763 links with a total link strength of 7739, ‘recycling’ that occurred 308 times, 630 links with a total link strength of 4382, ‘polymer’ that occurred 190 times, 652 links with a total link strength of 3795. Two areas were found under the consumer theme covered from various aspects, ‘Environment’ and ‘Food.’ Check Figures 15 and 16 (cf. Appendix) for the top terms tied with the ‘Environment’ and ‘Food.’ Although ‘Environmental monitoring’ appeared 16 times in the documents related to the CE theme. However, it appeared more frequently under the Consumer theme, around 147 times with 613 links and a total link strength of 3622. Packaging is the second top area investigated by researchers under the consumers' theme. There are four significant clusters in the consumers' dataset (See Figure 14).

*Closed loop theme:* in Figure 12 (Appendix), the top three terms are ‘recycling’ that occurred 271 times, 163 links with a total link strength of 2101, ‘circular economy’ that occurred 166 times, 148 links with a total link strength of 992, ‘sustainable development’ that occurred 149 times, 156 links with a total link strength of 1024. Closed Loop is more than waste management or recycling. There is a cluster (‘Green’) in this data set, with SCM and environmental protection terms. Moreover, a cluster has terms related to single-use plastic (specifically bottles) from life cycle analysis and its connection with consumers' behavior.

*Circular Economy theme:* in Figure 13 (Appendix), the top three terms are ‘recycling’ that occurred 473 times, 401 links with a total link strength of 7046, ‘circular economy’ that occurred 401 times, 399 links with a total link strength of 4506, ‘waste management’ that occurred 377 times, 399 links with a total link strength of 5926. In addition, ‘Analysis’ is tied to ‘Waste management,’ ‘Waste disposal,’ and ‘procedures.’

*Value Chain theme:* in view of Figure 6, some of the top terms are ‘Sustainable development that occurred 145 times, 145 links with a total link strength of 972, ‘recycling’ that occurred 138 times, 151 links with a total link strength of 1257, ‘waste management’ that occurred 132 times, 152 links with a total link strength of 1145, ‘circular economy’ that occurred 126 times, 141 links with a total link strength of 866. This data set has four significant clusters, cluster 1 (Red) related to sustainable development, decision-making, and methodologies used in the related studies. At the same time, cluster 2 (Yellow) is related to countries' waste management and its connection with recycling. Cluster 3 (Blue) covers materials flow analysis and chemical components. In comparison, Cluster 4 (Green) is related to environmental management, protection, and sustainability.

**Table 4 Terms with a Shortage in Literature**

Term	Occurrences	Theme	Links	Total Link Strength	Cluster color
Industry 4.0	48	Circular Economy	48	75	Red
Textiles	36	Consumer	276	478	Blue
Industry 4.0	25	Business Model	59	96	Red
Textile Industry	20	Consumer	192	289	Blue
Environmental Technology	19	Value Chain	77	177	Green
Bioeconomy	22	Value Chain	78	144	Green
Environmental monitoring	16	Circular Economy	164	286	Green

Bioeconomy	15	Circular Economy	90	146	Yellow
Bioeconomy	10	Business Model	32	48	Red
Green Supply Chain	15	Closed Loop	42	67	Green
Game Theory	15	Closed Loop	40	71	Green
Social Media	14	Consumer	35	41	Red
Industry ecology	14	Closed Loop	66	113	Blue
Textiles	13	Circular Economy	123	208	Green
Technology	13	Consumer	165	237	Red
Environmental monitoring	13	Value Chain	75	150	Blue
Single- use	12	Consumer	127	195	Red
Bioplastic	11	Circular Economy	81	130	Yellow
Industrial Research	12	Value Chain	30	56	Red
Industrial Research	11	Closed Loop	34	60	Blue
Circular Business Model	11	Business Model	34	64	Red
Consumer Behavior	10	Closed Loop	38	51	Blue
Industry 4.0	10	Value Chain	29	48	Red
Technology	10	Value Chain	69	103	Yellow

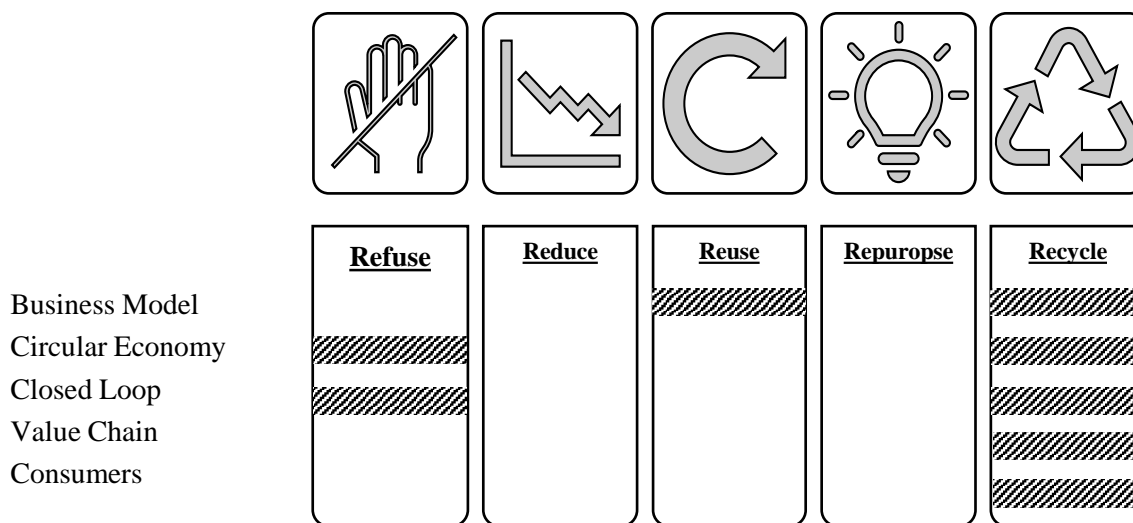


Figure 8. The 5 'R' across the Themes Reviewed

## **6 Concluding Remarks and Implications**

Through our holistic review, the most innovative and disruptive technology has not been discussed with enough attention from the literature. For example, AI, BCT, Machine Learning, Robotics, and Sentiment, did not appear in any of the themes, so either it means it appears less than ten times or it did not appear at all. That opens an area of research for business data science and analytics related to plastic management. Although Industry 4.0 covers most of the technologies not mentioned in the literature, the term Industry 4.0 is still used in a very generic way. The term was either absent or existed with a small node size on the outer layer of the different network diagrams across the themes studied. Leveraging Industry 4.0 technologies may enable organizations to be more efficient, resilient, and sustainable. Some keywords/terms appeared more frequently and in almost every theme, some of which are 3D printing, innovation, behavior change, and carbon emission. But there is no clear evidence or connection yet between ‘Innovation’ and ‘Re-purpose.’ Some nodes are related to ‘Product development, or ‘re-design,’ but that is insufficient to foster ‘Re-purpose’ initiative, especially on the research level. Raising the awareness on the consumer level may guarantee quick fixes, but consumers alone are not enough. Collaboration among the various stakeholders, specifically policymakers, regulators, researchers, and practitioners, is vital to impact the state and national levels.

### **6.1 Theoretical / Academic Implications**

There is a gap between scholarly research and industrial practice. Industrial practices explore technologies and novel business models to tackle the plastic management problem. For business models, there are many publications, but most of the business models were developed by commercial companies rather than academic scholars. Dijkstra et al. (2021) conclude that SPM is used inconsistently in the literature and urge researchers to describe their business model based on



four components (infrastructure, value proposition, financial structure, and customer interface). So, new business models are needed to be developed to deal with the inconsistencies in the literature. Recycling has been covered thoroughly across the themes studied. More research studies are needed to explore the other four 'R': Reuse, Refuse, Re-purpose, and Reduce (see Figure 8).

## **6.2 Managerial/Business Implications**

Accessing green markets and maintaining a competitive advantage are the two drivers mentioned in the literature reviewed. Unfortunately, there is a significant shortage of technology-related publications. Most of the publications do not go beyond introducing or illustrating the technology broadly. Only a few papers go in-depth; Clear actions are needed at the organizational/business level to minimize the average plastic waste. Investors may be enablers for a sustainable supply chain, especially investors who avoid investing in organizations that do not have sustainability-related actions or strategies.

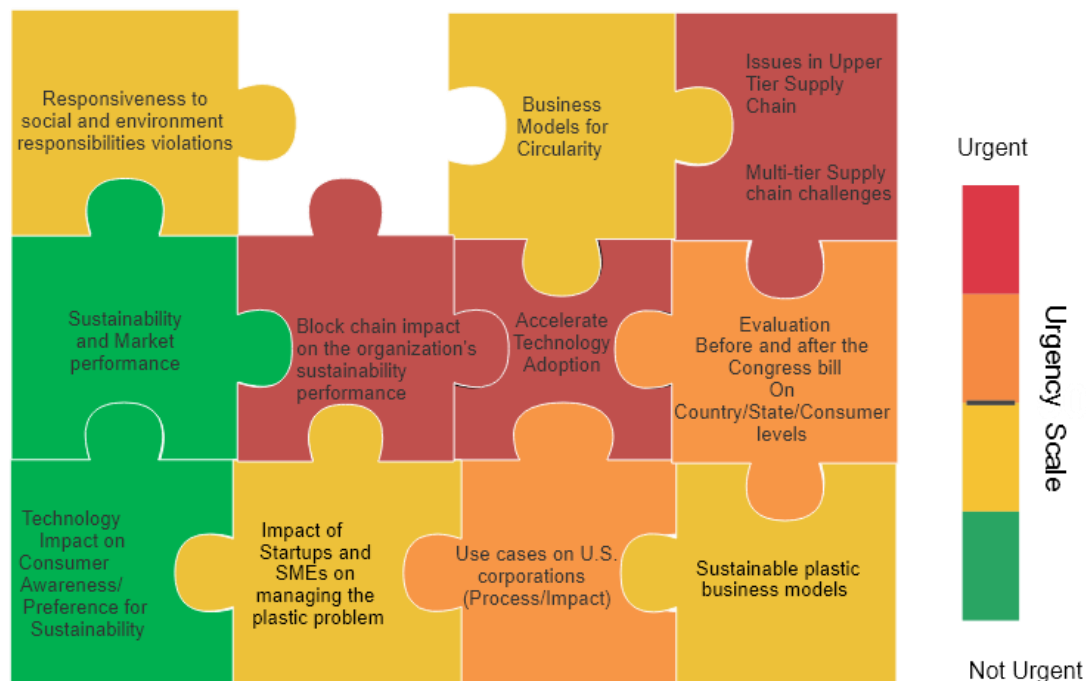
## **6.3 Policy Implications**

Weak sustainability is essential to monitor, manage, control, and prevent environmental pollution. Collaboration is needed across multiple stakeholders to take actions on the policy level to foster and encourage organizations toward a circular economy and environmental responsibility. Policies and regulations are fully saturated from a research perspective; many papers and reports cover the plastic crisis and implications from this dimension. But there is a shortage of mechanisms and practical measurement tools to manage the plastic crisis concisely and ensure the effectiveness of the policies and regulations set. Furthermore, 'Social Media' is one of the terms that have shortage in literature (cf. Table 4). With the increase in social media platform usage among the public, social media may be used to set force on organizations to re-think their SPM strategies. That method was adopted and implemented by the Chinese government and showed its effectiveness

and the power of the crowing in facing the suppliers that have environment-related violations (IPE, 2022).

## 7 Future work

As illustrated in our study, there exists a gap in research studying strong sustainability factors, specifically reframing production patterns. Figure 9 reflects the different pieces of the open areas of research and investigation based on our point of view upon the literature reviewed. The ‘missing piece’ refers to a space of opportunities that is not determined yet. When the congress bill goes effective, or the technologies roadmap initiative starts the implementation phase, the framework structure may change. The colors reflect the urgency of an area where ‘Green’ is not urgent and ‘Red’ is urgent. ‘Red’ zones are technology-based, as there is a gap between industry and research on that level.



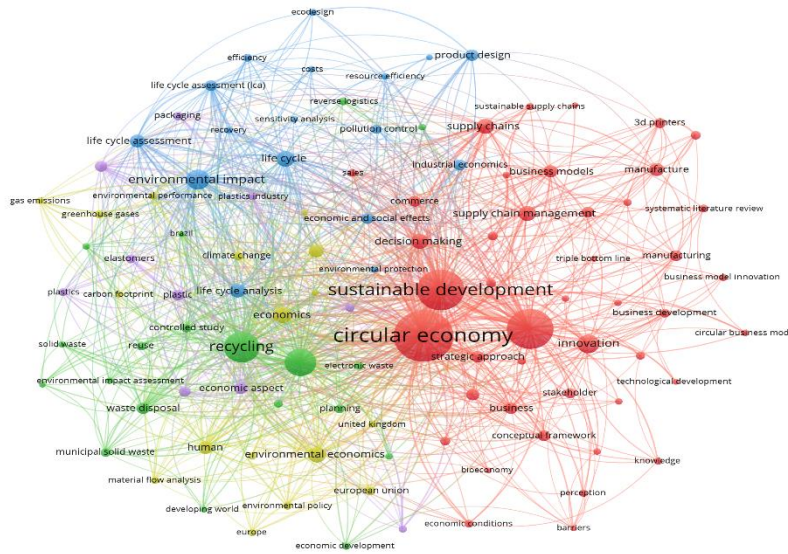
**Figure 9. Open/Future research areas [Based on the Literature Reviewed]**

## Appendix

**Table 5 Methods/ techniques/Technologies in the Literature by Cluster**

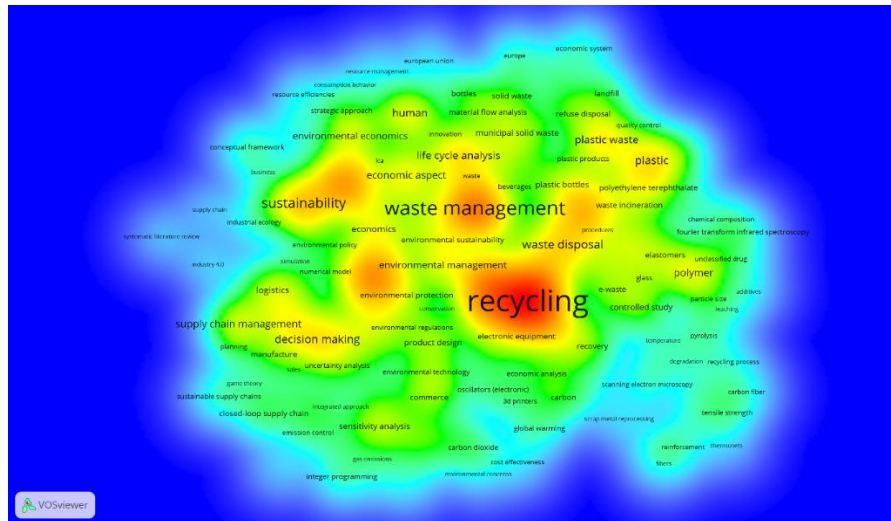
Term	Occurrences	Theme	Links	Total Link Strength	Cluster Color
Questionnaire/Survey	82	Consumer	673	1444	Red
Materials flow analysis	78	Circular Economy	279	1166	Yellow
Fourier transform infrared	61	Consumer	410	1244	Blue
Questionnaire/Survey	71	Circular Economy	353	773	Red
Comparative study	54	Consumer	468	1061	Purple
3D printing/printers	48	Business Model	97	252	Red
Sensitivity analysis	46	Circular Economy	230	709	Blue
Experimental study	40	Consumer	361	738	Blue
3D printing/printers	37	Consumer	247	422	Blue
Sensitivity analysis	31	Consumer	278	534	Red
Correlation	30	Consumer	471	695	Green
Optimization	30	Closed Loop	101	238	Green
Optimization	28	Circular Economy	206	407	Red
Materials flow analysis	26	Consumer	169	396	Red
Surveys/Questionnaire	25	Value chain	94	141	Red
Comparative study	23	Circular Economy	168	390	Blue
Sensitivity analysis	23	Value chain	23	100	Green
Regression Analysis	23	Consumer	196	372	Green
Optimization	22	Consumer	174	240	Red
Integer Programming	22	Closed Loop	65	148	Green
Materials flow analysis	21	Value Chain	93	212	Blue
Fourier Transform infrared spectroscopy	18	Circular Economy	111	258	Green
Fourier Transform infrared spectroscopy	18	Closed Loop	57	143	Red
Surveys	17	Business Model	55	91	Red
Simulation	16	Circular Economy	145	260	Green
Simulation	15	Consumer	219	307	Blue
Materials flow analysis	13	Business Model	54	105	Green
3D printing/printers	13	Closed Loop	56	94	Red
Regression Analysis	12	Circular Economy	95	145	Red
Optimization	12	Value Chain	52	75	Green
Comparative Study	10	Closed Loop	56	79	Red

Comparative study	10	Value chain	82	141	Blue
Process optimization	11	Circular Economy	130	210	Green



VOSviewer

Figure 10. Co-occurrence and clusters under the Business Model Theme



VOSviewer

Figure 11. Density Map: The Closed Loop Theme

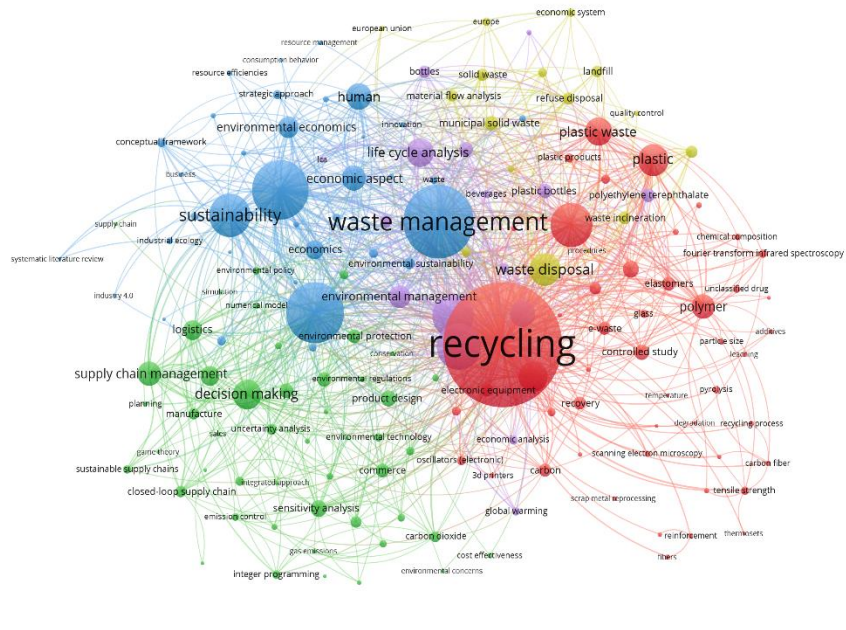


Figure 12. Co-occurrence and Clusters under the Closed Loop Theme

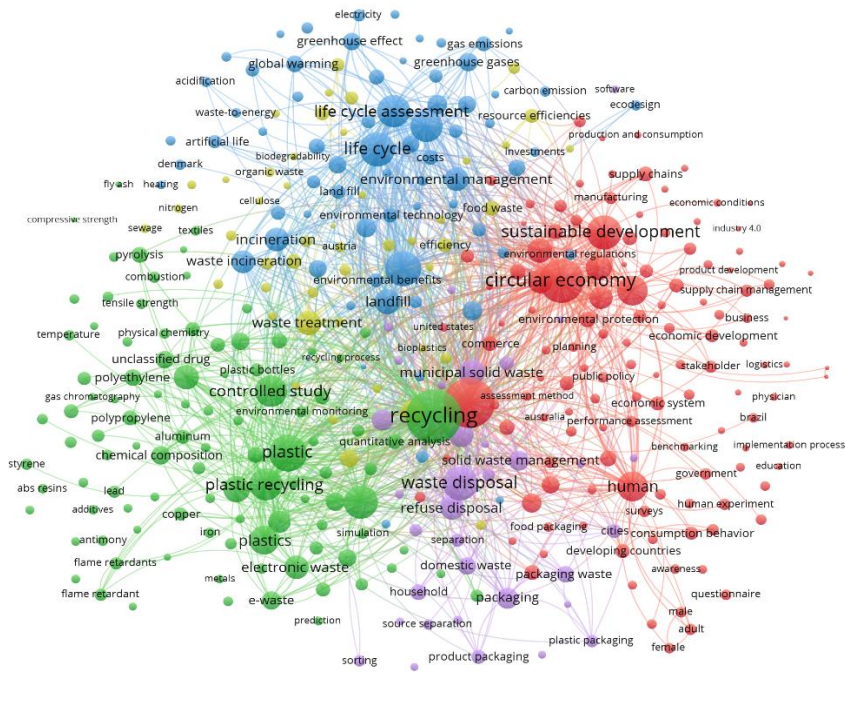


Figure 13. Co-occurrence and Clusters under the Circular Economy Theme



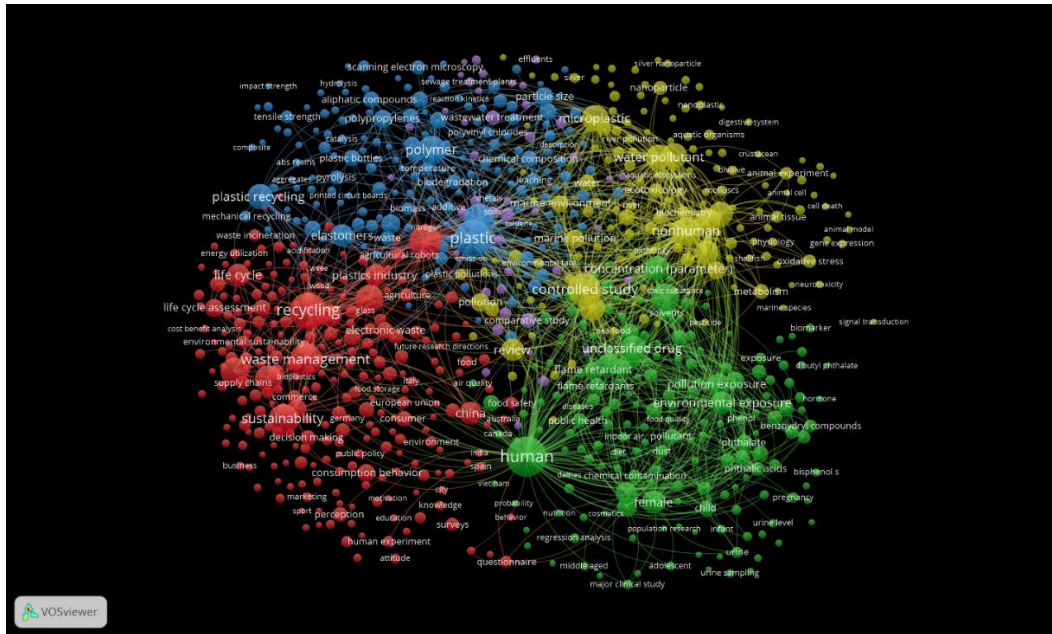


Figure 14. Co-occurrence and Clusters under the Consumer Theme

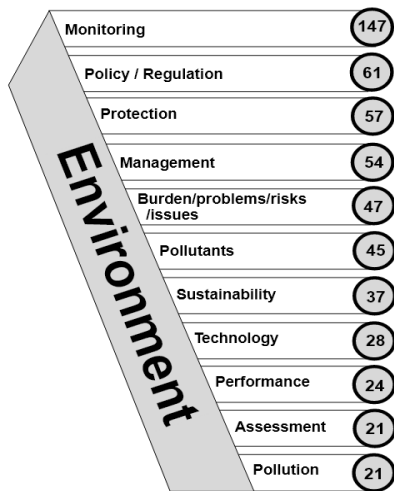


Figure 15. Terms tied with the Environment by Frequency (Consumers Theme)

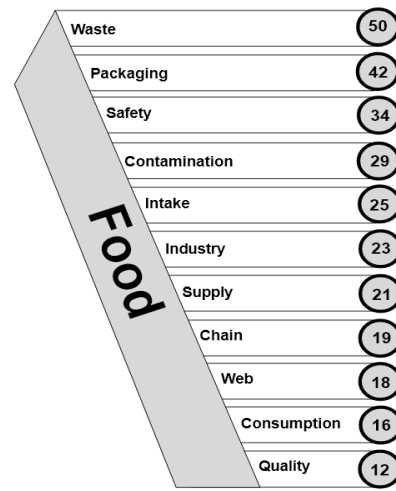


Figure 16. Terms tied with Food by Frequency (Consumers Theme)

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# **Strategy and Organizational Behavior**

## **"Fighting the Last War": The Importance of Organizational Resilience and Leadership Agility in the Digital Age**

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### Abstract

The economy today is ruthless, and organizations that are not nimble and resist change do not survive. We live in a VUCA world: an environment that is volatile, uncertain, complex, and ambiguous. The coronavirus pandemic illuminates what happens to a firm or industry that lacks organizational resilience and responds slowly to threats. Even before COVID-19, due to globalization, the internet, and exponential technological growth, no business was immune from early obsolescence. Organizations need new leaders, those with vision who can see where technology is going, hire adaptable employees, and quickly change direction when necessary. This paper provides several examples of firms that were too slow to implement change and redefine their business.

**Keywords:** age of disruption, pandemic, VUCA, organizational agility, learning organization, business blunders, Xerox, I.B.M., Apple, military strategy, competency trap.

## Introduction

The amount of information is increasing exponentially, mainly due to globalization and the prevalent use of the internet. Whereas it took 1,800 years for the amount of knowledge in the world to double from 100 BCE to 1700 ACE, information is currently doubling every 12 months. Online information doubles every six months; technical knowledge doubles every 18 months (Lewis, 2016). Destin (2012, para. 1), using the mathematical connotation of the word *chaos*, states: "We have entered an age of chaos (in the mathematical sense), marked by accelerated change and unpredictability." This may partially explain why we live in a VUCA world with an environment that is volatile, uncertain, complex, and ambiguous. The term VUCA was coined by the U.S. Military and is now a popular buzzword in the corporate world (Cotton, 2019).

In this kind of turbulent business world, the biggest threat to an organization is not necessarily a familiar competitor. Threats can come from anywhere, and every business is vulnerable to obsolescence that might come from evolving technology and/or globalization. Schwab (2016) maintains that the Fourth Industrial Revolution has begun. It is based on cyber-physical systems and is characterized by exceedingly fast breakthroughs due to technology. The world has never seen so many rapid advances in diverse fields, and society is evolving at an extraordinary pace. Leadership styles that might have worked during the industrial age will be disastrous during the Fourth Industrial Revolution.

According to Wolfe (2016, pp. 18-19): "Leadership agility and the ability to improvise on the fly are now fundamental skills if organizations are to succeed in this VUCA world... Leadership selection and development must be focused on identifying talent with critical

thinking skills, the ability to innovate, a passion for continuing learning, resourcefulness, and adaptability." No one would have imagined that a phone would be used as a computer, entertainment device, and camera. When was the last time a person driving in a car used a map? Note how Uber and Lyft have wreaked havoc with the taxi industry. Video streaming has done the same in the entertainment industry. It is hard to imagine that Amazon started in 1995 as a small online bookstore. One doubts that Sears, Toys "R" Us, and other major retailers saw Amazon as a concrete threat back then. Sears, a company that made billions of dollars with its mail-order catalogs, lacked the vision and agility to do what Amazon did. The world is changing at a breathtaking pace.

Denning (2012, para 23) points out that "most big firms still have a factory mindset oriented to economies of scale... They are not organized for continuous innovation." This is why they have difficulty competing in an economy that demands creativity. Digitization is altering the rules of competition, making it very easy for rival firms to come from anywhere. Hirt and Wilmott (2014, para. 1) believe that "digitization often lowers entry barriers, causing long-established boundaries between sectors to tumble."

More than 60 years ago, Theodore Levitt (1960), in one of the more persistently cited articles written, described the great danger of "marketing myopia" – a tendency to define a firm's business in terms of a product rather than a need or a benefit. Levitt posited that organizations that lose sight of their customers' needs and focus instead on their product are guilty of myopic and short-term thinking, resulting in early obsolescence. Thus, Levitt claimed that the railroads, at the turn of the century, were guilty of marketing myopia because customers wanted efficient and comfortable transportation and were not committed to travel by rail. Railroad executives,

however, made the mistake of believing that they were in the business of transporting people and goods by rail and ignored other developing modes of transportation such as air and truck.

Because we are in an age of technological convergence, Raphan and Friedman (2014) aver that the rules have changed, and firms that want to thrive must do more than not suffer from "marketing myopia."

In recent years, there has been a rapid convergence of and cross-fertilization between industries, which has created market situations that challenge traditional assumptions underlying marketing theory. Thus, even those organizations that are able to avoid Levitt's myopia, and define themselves in terms of meeting a consumer need, may find that this is insufficient. Firms today must be far more adaptable, looking for opportunities and threats that can come from businesses that are outside the scope of traditional myopia, but which, in today's environment, can rapidly and unexpectedly impinge upon a firm's business (Raphan and Friedman, 2014, p. 2).

In 2009, *The Economist* surveyed 349 executives from all over the world. Ninety percent of them identified *organizational agility* as a "core differentiator in today's rapidly changing business environment" (Economist Intelligent Unit, 2009). Researchers at McKinsey & Company have studied organizational health and found that firms have to be flexible and move quickly to take advantage of opportunities or to deal with threats because of the rapidly changing business environment (Bazigos, Smet & Gagnon, 2015).

Agile leaders have the skill to encourage innovation and experimentation and create a culture of creativity; they know when something is not functioning effectively and can move on to something else (Forbes Coaches Council, 2018). The coronavirus pandemic sheds light on what happens to a firm or industry that lacks organizational agility and responds slowly to threats. Industries that have been devastated by COVID-19 include retail, gambling, hotel, airline, movie theater, live sports, cruise, film production, automaking, theme parks, gyms, construction, and transportation (Suneson, 2020). Firms that survive will be resilient, agile, and

innovative and need leaders who have the courage and ability to change course quickly and make fast decisions (Forbes Coaches Council, 2018; Friedman & Kass-Shraibman, 2016; Friedman & Lewis, 2014; Porter-O'Grady, 1992; Raphan & Friedman, 2014; Schwab, 2016).

Chase (2021) attributes the longevity of the Chinese Communist Party — it is now 100-years old — to ideological agility (as well as brutality). As soon as Mao died in 1976, his successor, Deng Xiaoping, eliminated "people's communes" and allowed some degree of capitalism. Many state-owned firms were closed, and private property rights were begun. Under the current leadership of Xi Jinping, China is changing again, and society and business are being tightly controlled by the government, almost as severely as when Mao was alive. Corruption is not tolerated. Ideological rigidity can destroy a country as quickly as it can devastate an organization.

The first principle a leader must embrace is that nothing is forever. Organizations should not fall into the competency trap, which means that an "organization becomes so good at one thing, it can't learn to do anything new" (Lohr & Tejada, 2018, A1). Robson suggests the following as a way to avoid this problem.

Leaders should make a special effort to listen to junior employees and new starters who might have a fresh viewpoint on the organisation procedures at the company, and to encourage all staff to question the underlying assumptions behind a company's decision making. "What is crucial is to have ways to challenge the status quo, to inject variation in the corporate D.N.A.," says Heracleous [Professor at the Warwick School of Business in the U.K.] (Robson, 2020, para. 25)

Complacency is a disaster for any organization. Brosseau et al. (2019) emphasize how difficult it is to move to an agile operation model, but it is a necessity for survival. A silo mentality is the adversary of organizational agility, as is too much bureaucracy. A silo mentality occurs when groups or different departments in an organization refuse to share knowledge.

Capable corporate leaders are engaging in silo-busting because silos breed tribalism (Tett, 2015). Indeed, organizations that get too large often find themselves with rigid silos and are consumed with turf battles. To succeed in today's economy, people from different departments must collaborate and share information rather than existing in silos.

Some organizations that want to be innovative, inventive, and nimble are becoming learning organizations (Argyris and Schoen 1996; Senge 1990). Peter M. Senge popularized the "learning organization" in his influential 1990 book *The Fifth Discipline* (Senge 1990). Friedman *et al.* (2005) summarize what one should expect to see in a learning organization. First and foremost is the belief in continuous and collective learning, collaboration, and knowledge sharing; moreover, there must be a commitment to lifelong learning. The organization must be nimble and develop the ability to adapt to changing conditions, *i.e.*, an ability to regenerate, renew, and revitalize itself. It cannot allow stagnation. Also, there has to be a concern for people and respect (and empowerment) for employees. The individuals that make up the organization have to learn from experience and mistakes — experience is the best teacher — and learn from the experiences of others in the organization. There must be a willingness to experiment and take chances; this means that there has to be a tolerance for failure. Diversity is beneficial as it allows for new ideas.

Organizations that want to create resilience and agility must move away from the hierarchical structure. Instead, they should attempt to flatten the organizational hierarchy and reduce layers of bureaucracy to promote open communications, make organizations more nimble and effective, and enhance employee involvement.

A flat organizational structure is characterized by short chains of command and a wide span of control, which refers to the number of subordinates controlled by the supervisor. A tall or

hierarchical organizational structure is marked by long chains of command and narrow spans of control. Each additional layer of bureaucracy slows down decision-making, increases costs, and hurts creativity. In the knowledge economy, no efficient business can afford a complicated organizational hierarchy. Too many layers of bureaucracy lead to corporate sluggishness and the inability to change quickly. Morgan (2015) notes the following about hierarchical organizational structure:

There are many challenges with this model but to name a few. Communication typically flows from the top to the bottom which means innovation stagnates, engagement suffers, and collaboration is virtually non-existent. This type of environment is riddled with bureaucracy and is extremely sluggish. This is why the hierarchy is perhaps the biggest vulnerability for any organization still employing it. It opens up the doors for competitors and new incumbents to quickly take over...those still stuck with the hierarchy are going to have one heck of a time trying to attract and retain top talent.

The hierarchy has permeated virtually every company around the world regardless of size, industry, or location. The greatest strength of the hierarchy used to be that it was so reliable at maintaining the status quo, which was exactly what companies wanted decades ago...The hierarchy is a very resilient management structure that has been so embedded in how we work that most organizations around the world are having a tedious time getting rid of it (Morgan, 2015, paras. 5-6).

Firms today cannot expect to be around forever. One only needs to examine the list of Fortune 500 companies from 1955 and then look at it from 2019. In those 64 years, only 52 companies appear on both lists. About 90% of the Fortune 500 companies from 1955 have gone bankrupt, merged, or shrunk. The average tenure on the Fortune 500 list was 33 years in 1965, 20 years in 1990, and it will likely shrink to 14 years by 2026 (Perry, 2019). Every Fortune 500 CEO should know that there is a 50% chance that their firm might disappear from the list during the next ten years. Therefore, an organization must have a flexible, futuristic leader who understands the importance of agility and speed and knows when to change course.



This paper will examine cases of colossal errors that demonstrate what happens when organizations lack agility.

### **Military Using Old Models of Warfare**

In the military, the expression "fighting the last war" has become shorthand to describe the stupidity of using old strategies when fighting current battles. The Industrial Revolution changed the way wars are fought. Tactics such as Napoleonic charges attacking entrenched soldiers with rifles no longer worked. Rifles were mass-produced and could be quickly loaded, unlike muskets. Thus, at Waterloo, only one bullet out of 459 wounded or killed someone. In the Crimean War (1854-56), the first major war after the Industrial Revolution, with improved rifles, the ratio of hits was one out of 16 (White, 2012, p. 295). The Mahdists were successful fighters, but the British defeated them in one of the most uneven battles in history (30,000 Mahdist vs. 48 British casualties) because they used machine guns rather than cavalry charges (White, 2012, p. 324).

Warfare tactics again changed during World War II, and the blitzkrieg (lightning war) was developed, which involved using tanks and aircraft to break through enemy lines. Trench warfare that was a crucial part of World War I was not significant (except for the Maginot Line, which the Germans rapidly overcame) during World War II. The Vietnam War (1959-1975) established that the tactics used to fight another army would not work when fighting guerrillas who could blend into the countryside. No country has yet come up with a winning formula when the enemy can simply disappear into the civilian population. The wars of the future will involve cyberwarfare, drones, and possibly robots.

The corporate world can learn about the importance of adaptability from the military. The military has been talking about the significance of training adaptive leaders. Adaptive leaders are agile, possess "a flexibility of mind, a tendency to anticipate or adapt to uncertain or changing situations." They must also be able to "break from habitual thought patterns, to improvise when faced with conceptual impasses, and quickly apply multiple perspectives to consider new approaches or solutions ... Agile leaders stay ahead of changing environments and incomplete planning to preempt problems" (Field Manual, 2006, 6-3, 6-4).

### **Blockbuster Misses Opportunity to Buy Netflix Because it did not Recognize the Potential of Streaming**

In 2000, Blockbuster was very successful and had thousands of video stores. Back then, consumers went to Blockbuster to rent videos. Netflix approached Blockbuster with a deal in which Blockbuster would take care of the in-store part of the business (this would eliminate the need to mail DVDs to customers; Netflix was mainly a DVD mailing service back then), and they would take care of the online (streaming) part of the business. Blockbuster declined the deal. . Reed Hastings was ready to sell Netflix, the company he started, to former Blockbuster C.E.O. John Antioco for \$50 million. Antioco saw Netflix as a "very small niche business." Several years later, however, Blockbuster went bankrupt, and Netflix flourished (Roesler, 2015; Chong, 2015).

### **I.B.M. allows Microsoft to Retain Copyright for D.O.S. Platform Because it Saw Itself as a Hardware Company**

In 1980, I.B.M. approached Bill Gates to develop an operating system for its personal computers. Microsoft was a small firm with 40 employees and annual revenues of \$7.5 million while I.B.M. had more than 340,000 employees. Gates took the job and provided I.B.M. with the

system known as PC-DOS in exchange for \$80,000. There was a stipulation that the copyright for the operating system would remain with Microsoft. This allowed Microsoft to sell its operating system to other personal computer manufacturers as MS-DOS. I.B.M. did not realize that the real money to be made was not in the hardware but the software (Business Insurance Staff, 2011). Today, Microsoft is worth more than IBM. and has significantly greater revenues.

### **Xerox Develops Innovative Computer Technology and Does not Recognize its Value**

In the early 1970s, Xerox developed the graphical user interface (G.U.I.) that uses icons and a mouse at its PARC research and development lab. This G.U.I. allowed users to work with icons on a computer rather than text. Today, this G.U.I. is used by almost every personal computer. Unfortunately, Xerox was so focused on profits from copying machines that it did not recognize the value of its innovation. Xerox even developed a personal computer -- which they never marketed -- called the Xerox Alto that used the interface. Xerox executives were used to productivity measures like "pages copied" and did not understand how important the G.U.I. desktop would become. Against their own design team's advice, they allowed Steve Jobs and several Apple employees to visit the PARC facilities in exchange for some Apple stock. That visit enabled Apple to become a trillion-dollar company. Xerox later tried suing Apple for using the G.U.I. technology in the Apple Macintosh personal computer, but the case was dismissed (Lindner, 2008; Nazar, 2013). Jobs remarked: "If Xerox had known what it had and had taken advantage of its real opportunities, it could have been as big as I.B.M. plus Microsoft plus Xerox combined—and the largest high-technology company in the world" (Gladwell, 2011, para. 6). Xerox, the once-powerful technology company, is the "poster child for monopoly technology businesses that cannot make the transition to a new generation of technology." Researchers say

this is because it fell into a "competency trap" which means that an "organization becomes so good at one thing, it can't learn to do anything new" (Lohr & Tejada, 2018, A1).

Xerox also made a similar mistake with innovative publishing software that was sold to some employees for \$2000. The employees used the software to build an immensely successful software company called Adobe. Xerox also failed to develop inexpensive personal copiers because the only business model they were familiar with involved renting out expensive copying machines and making additional money from paper, ink, and maintenance. It is no surprise that Xerox has become the textbook case of a company that used to be innovative and agile and morphed into an inflexible firm frozen into one way of conducting business (Robson, 2020). Xerox fell into the competency trap discussed above.

### **Kodak Invents Digital Camera in 1977 and Does Not Take Advantage of it**

Kodak may also have fallen into the competency trap. It was previously a world brand recognized everywhere and made an enormous profit from film. The company invented the digital camera in 1977, but was reluctant to switch to better technology because of the significant returns from its film business. By the time the company switched to digital technology, it was too late: other firms had taken over the digital market (Roesler, 2015).

### **ExxonMobil Refusing to Move Away from Fossil Fuels**

In 2013, ExxonMobil was the largest public company in the world. In 2020, the company reported a net loss of \$22.4 billion (Hiller, 2021). ExxonMobil was also known as a firm that used tactics reminiscent of Big-Tobacco and played a crucial role in climate change denial and attempting to destabilize the science in this area (Friedman, 2021). This may all change now due

to a shareholder revolt started by a small hedge fund called Engine No. 1. They have been pushing for a dissident slate consisting of believers in transforming ExxonMobil into a diversified energy company and gradually moving away from oil and gas. As stated by the old adage: the Stone Age did not end because people ran out of stones; it ended because bronze tools were superior to those made from stones. Oil and gas will be replaced with better and cheaper forms of energy (e.g., solar and wind) even when there will be vast quantities of fossil fuels in the ground (Friedman, 2021). Time will tell whether ExxonMobil will become a corporate fossil or a dynamic energy company.

### **Higher Education Focused on Degrees Instead of Skills**

Higher education is not progressing, perhaps due to academics mocking what they consider "vocational" courses and majors. The author was once told by a provost that "our college cringes at the thought of more accounting students." One rarely hears a college administrator discuss the importance of diversity of ideas and critical thinking. Courses should foster independent thought and not encourage students to conform to the instructor's opinions and beliefs. This may be why employers are disillusioned with higher education and are moving away from the so-called traditional metrics such as degrees and G.P.A.; they seek employees with skills. Many critical skills, including critical thinking and adaptability, are not taught in colleges and universities (Friedman and Friedman, 2020). People should now expect to change professions and jobs several times during their working lives; this is why students need to develop a passion for lifelong learning (Friedman, 2020). Scholars claim that the value of a college degree has little to do with the acquisition of skills. Instead, the value comes from market

signaling, and there are questions as to whether college degrees from second-tier schools are worth the steep tuition fees (Feroohar, 2020). This may be why the proportion of employees at Google, IBM., Ernst & Young, and Apple without any college degree keeps increasing, even for positions that require exceptional skills. Employers look at applicants with skills-based certifications rather than traditional four-year college degrees (Smith, 2020).

Ravi Kumar, president of Infosys, opines:

We have started hiring many people with no degrees. If you know stuff and can demonstrate that you know stuff and have been upskilling yourself with online training to do the task that we need, you're hired. We think this structural shift —from degrees to skills— could bridge the digital divide as the cost of undergraduate education has increased by 150% over the last 20 years (cited in Friedman,2020, para. 19).

It should not be astonishing that students learn few valuable skills in academe, given that academic research is almost irrelevant in today's world. Lattier (2017, para. 1) makes a compelling point about academic scholarship: "Most Western academics today are using their intellectual capital to answer questions that nobody's asking on pages that nobody's reading." If that is not bad enough, the average journal article is read by at most ten people (Biswas & Kirchherr, 2015; Lattier, 2017). Biswas and Kirchherr (2015, paras. 1-2) observe: "Many of the world's most talented thinkers may be university professors, but sadly most of them are not shaping today's public debates or influencing policies. Indeed, scholars often frown upon publishing in the popular media." They note that only four individuals in the entire country of India — a place where access to clean water is a severe issue — subscribe to the foremost journal in the field of water.

One of the scariest statistics about academic research is that most academic journal articles are rarely cited, though this percentage varies by discipline. In literature and literary

theory, this percentage is 75%, 77% in the visual and performance arts, 69% in architecture, and 75% in the professional health area of pharmacy (Baker, 2018). That so many papers never get cited hints at the actual "value" of much of academic research.

The future of higher education is not bright. Higher education revenues are expected to plunge, and one scholar predicts that half of the 4,000 colleges and universities in the United States will be bankrupt within the next few decades (Hess, 2017), and that was before the appearance of the coronavirus. Because of the coronavirus, Moody's, the rating agency, downgraded the higher education sector from stable to negative. Higher education revenues were expected to decline by \$23 billion in the following year. This is why 64% of university presidents stated that their biggest problem today is to ensure the long-term survival of their institutions. This may mean laying off staff, furloughs, and/or eliminating programs (Foroohar, 2020).

### **Greatest Corporate Comeback in Corporate History: Apple**

Apple could easily have made it to the list of business failures. People forget that Apple was almost bankrupt in 1997 and is now arguably the most successful company in the world's history with a market capitalization of more than \$1 trillion. Some see this as the "greatest corporate comeback of all time." The failure to innovate was what got the company into severe financial trouble. The economic situation was so dire that Michael S. Dell, C.E.O. of Dell Technologies, said that he would shut down Apple if it were up to him. Apple was saved from bankruptcy when Microsoft rescued it with a \$150 million investment. Steve Jobs returned to Apple and understood that the company had to be innovative, change the rules, and think outside the box to survive. Jobs was responsible for innovations that include iMacs, iPods, iPads, iTunes

Music Store, and iPhones (Shontell, 2011; Weinberger and Hartmans, 2020). The rejuvenation of Apple is evidence of how adaptability and innovation can save a firm.

### **Conclusion**

The economy today is ruthless, and organizations that are not nimble and resist change do not survive. Some companies had to reinvent themselves completely to survive (Friedman & Friedman, 2016; Roos, 2014). Some examples of firms that did so successfully include I.B.M., which was founded in 1896 and manufactured punch card equipment (as well as scales, clocks, and cheese slicers), Sony, which began as a radio repair shop back in 1945, Motorola which started out manufacturing car radios, and Nokia, which was founded as a firm with a wood pulp mill in Finland (Friedman & Friedman, 2016; Roos, 2014) : I.B.M., for example, had to change its business model several times in order to remain viable. In 1984, I.B.M. led the computer world with its iconic personal computer. Competition from clones changed everything; I.B.M. was too slow to adapt and could not compete in the personal computer market on price or quality. Also, the demand for mainframe computers, an essential product of I.B.M., was in decline. In 1993, I.B.M. announced an \$8 billion second-quarter loss. The number of employees at I.B.M. went from more than 400,000 in 1986 to about 300,000 in 1993. Ultimately, I.B.M. acquired more than 200 firms in the I.T. services sector and transformed itself into a firm that provided computer services and I.T. expertise to the corporate world (Roos, 2014; Paltrow & Weber, 1993). In October 2020, I.B.M. announced that it is changing course and redefining the company again. It will spin off its "legacy technology services" business and is shifting to cloud computing and artificial intelligence. The cloud market was pioneered by Amazon back in 2006, so I.B.M. is late in entering this business. Today, almost all new software is designed to be a cloud service (Lohr, 2020). Leaders in all areas – business, education, military – must transform



their organizations to become agile and respond quickly to threats and opportunities. Only then can they remain viable in the current economy.

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## **Analysis of Tactical Decision-Making of Undergraduate Course Coordinators of a Community Higher Education Institution in Brazil**

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### **Abstract**

The institutional context requires that managers make decisions with increasingly scarce deadlines and resources, in contrast to a greater complexity of the environmental variables that guide this process. Thus, the main objective of this study is: to analyze the tactical decision-making environment of undergraduate course coordinators from a Brazilian community university while contemplating the role of these decision-makers. We aim to determine through a case study, with data collected from documentary research and focus groups, and data analyzed using the content analysis technique. To support the findings, the theories of business strategy were observed, combined with decision-making and university management, in the light of Porter (2005), Taylor (1978), Simon (1979), Kahneman and Klein (2009), Orasanu and Connolly (1993), Cohen et al. (1972) and Lück (2010). The collected data were analyzed with NVivo software and under four categories: decision environment, values, university management and decision-making process. It is concluded that these decision-makers are exposed to a complex and heterogeneous tactical environment, and rely on quality information, knowledge, and repertoire to qualify their decision. The university is required to provide an information system based on organizational processes, aligned with strategic management. The university must compete with a strategy that contemplates its essence, supported by the Christian-Lasallian Tradition spanning three centuries, with the adoption of control mechanisms and permanent and systemic strategic adjustments.

*Keywords:* Tactical decisions. Business strategy. University management. Decision-making.

### **1 Introduction**

Every day we are compelled to make decisions, from the simplest to the most complex ones (Torres Júnior & Moura, 2011). The business context requires that managers make decisions with increasingly scarce deadlines and resources, in contrast to a greater complexity of the environmental variables that guide this process. Furthermore, such decisions consume much of the efforts of management professionals, and the more qualified they are, the more assertive and fast the result will be. The nature of the role of "managing" makes professionals in this context dedicate much of their time to the decision-making process (Mintzberg, 1973).

Most studies on the strategic decision-making process produced content, in a way, "focused" on a set of observations on this processor, a rich but "loose" description of the entire decision-making process (Fredrickson, 1986). In this context, it is relevant to observe the influences and dependencies from the unfolding of strategic decisions in tactical decisions (Kadoić et al., 2017), which are made by the company's senior management and aim to define the business path. At the same time, the implementation of this strategy in effective actions occurs at the

tactical and operational levels, but few empirical studies have discussed this topic (Falqueto et al., 2020).

In the empirical field, community higher education institutions (CHEI) are non-profit entities. Even without aiming for profit, it is emphasized that any entity needs positive results to ensure that its activities are continued. Therefore, many decisions can imply a conflict between the economic and financial health and the community vocation of those institutions. Thus, this research is important for the field of educational management, and, consequently, for Brazilian higher education, considering the following research problem: How can we describe the tactical decision-making environment of undergraduate course coordinators from a Brazilian community university while contemplating the role of these decision-makers? Thus, the general objective is to analyze the tactical decision-making environment of undergraduate course coordinators from a Brazilian community university while contemplating the role of these decision-makers.

The main contribution of the study is the understanding of the decision-making environment to which the tactical decision-maker is exposed. The decision-making environment is understood to be the set of variables that somehow interfere with the decision result (Simon, 1979). The way the decision-maker perceives the environment, summarizes the information, processes and implements the decisions are preponderant elements for the success of the decision-making process (Silva, 2017). In addition, it allows them to prioritize their goals and make the right decisions (Falqueto et al., 2020).

## **2 Theoretical Background**

Making decisions is inherent to the human being, as such decisions occur constantly, at any time or place, with different levels of complexity. Therefore, it is necessary to present the theories that underlie the decision-making process, as well as the theories that address the organizational strategy in order to evidence the tactical level within this context.

### **2.1 Information and Decision-Making Environment**

The quality of information is analyzed in the light of Satur et al. (2017), who argue that perfect information does not exist, but must be pursued. This search must occur to avoid three types of imperfect information: incomplete, asymmetrical and ambiguous. Rascão (2006), in the same line, argues that the decision-maker does not need perfect information to make a decision, but the minimum that satisfies their needs. Thus, it is understood that perfect information is the one that is complete, symmetrical, transparent and in adequate time and space. The pursuit of perfect information must occur to the limit of incremental benefit to the decision-making process.

The information useful for decision-making, when following the Resource-Based View (RBV) theory, can lead to an advantage over competitors. For Barney (1991) the organization having resources and the efficient and effective management of these resources enables a sustainable competitive advantage. Among the available resources, information stands out. The way the organization manages information can influence the assertiveness of decision making. Still based on RBV, Barney (1991) understands that the management of these resources is very particular and heterogeneous among firms, even in the same sector. Each organization makes its investments to claim a better position when compared to other firms. In the case of an information system, the organization can build one internally, a practice which is known by the RBV theory as an accumulation process, which is defended by Dierickx and Cool (1989) as an alternative way to build competitive advantage without the need to acquire the resource. This type of decision is justified when it addresses a specific need, which would make it impossible to buy a ready-made solution.



Some information is more useful than others, being for each decision-maker. Decision-making is personal, and thus each decision-maker uses different information. Bispo and Cazarini (1998) understand that the information can be more or less relevant depending on each decision-maker. Therefore, the excess of information can harm the decision-making process. Each decision-maker must build their informational matrix, linked to their needs. Silva (2017) argues for a multilevel and multidisciplinary approach, since the decision-making process does not belong to a single area of knowledge, that is, it is personal and occurs in all areas. Moreover, information asymmetry can compromise decision assertiveness. When the information is incomplete, it can result in the benefit of one party to the detriment of another, that is, this information does not provide security and credibility (Akerlof, 2002). Therefore, management must comprehend an information package, which can be in the shape of indicators, linked to an information system, capable of providing the decision-maker in a personalized and symmetrical way, to meet their specific decision-making needs for each situation.

Indicators are usually created and fed as a source of information capable of qualifying the decision-making process or measuring the performance of people and organizations. Lück (2009) argue for the use of performance indicators to guide the decision-making process in educational institutions. In a more global context, Parmenter (2007) describes that indicators should reflect the pulse of the institution, and that organizations need to measure their importance. Atkinson (1998) adds that the matrix of these indicators should focus on variables that are critical to the success of the organization or, in the context of this study, the most critical and relevant variables for the course coordinator. This was the origin of a management control methodology, whose differential was the use of a mix of financial and non-financial indicators: the Balanced ScoreCard (BSC) (Kaplan & Norton, 1997).

Two factors determine the complexity of the environment: the amount and oscillation of environmental variables. The more variables and the greater the fluctuation of their values, the more complex the decision-making environment will be. For Bataglia and Yu (2008), such dynamism contributes to uncertainty in the strategic decision-making process, making it difficult to establish an objective relationship between the action alternatives and their future developments. The volume of information obtained by the analysis of external environmental variables must be summarized to the point of contributing to assertiveness in decision making. External motivations are considered to influence decisions, however, they involve internal resources.

## **2.2 Decision-making process**

The decision-making process within organizations has evolved substantially in difficulty. Decision-makers operate in turbulent organizational contexts, with complex and ambiguous signals (Hahn et al., 2014). When making a decision, the objective is to change a state, as it is intended for a determination or a resolution, which is taken in relation to a certain element (Silva, 2017). For Nutt and Wilson (2010), the decision-making process is a complex research topic, because it is a multilevel phenomenon, permeated by individual dimensions, such as cognition and affection, organizational dimensions, such as structure and values, and even social dimensions, arising from the technical and institutional environment.

Hammond et al. (2004) complement the perception by listing some psychological traps that interfere with this process: need for confirmation of evidence, exaggerated self-confidence, guessing, and prudence. Thus, strategic business decisions often take place in complex and uncertain environments. For Ansoff (1991), such psychological and environmental issues increase the difficulty of achieving goals.

For this study, it is important to address decision types, but not necessarily with all theories. The main theories are as follows: Rational, Limited Rationality, Naturalistic and Garbage Can.



Briefly, Table 1 presents the central idea of each of these theories based on their seminal authors.

**Table 1**  
Theoretical synthesis on the field of decision-making

Approaches	Central Idea	References
Rational	The Rational theory advocated that the decision-maker always made the perfect, rational decision, motivated by economic interest.	Taylor (1978)
Limited Rationality	He relativized reason by linking the decision to the fallible man. The decision-maker is possibly imbued with the desire to make the best decision, however, human cognition is incapable of making the so-called optimal decision all the time.	Simon (1979) and Kahneman and Klein (2009)
Naturalistic Decision Making	The Naturalistic theory presents an unstructured decision model, which is not rational and intuitive and occurs under specific conditions while taking advantage of the experience and accumulation of the decision-maker's repertoire.	Orasanu and Connolly (1993)
<i>Garbage Can</i>	It is characterized by inverting the logic of the decision as a process, and by diagnosing elements of the theory of anarchy about business decision-making. For this theory, the solutions filed in the “trash can” must be matched with compatible problems.	Cohen et al. (1972)

Source: Created by the author (2022).

In order to understand the decision-making process, the first studies were proposed at the beginning of the last century. Also called classical theory, Taylor's theory provided a scientific foundation to the movement called Scientific Management, whose focus was on production, with the rational and efficient use of the workforce. However, it should be noted that this model received many criticisms, since it is restricted to a few physiological variables: times and movements, economic incentives and equipment capacity (Ribeiro, 2015). For Bispo and Cazarini (1998, p. 2) “[...] the decision-making criteria at the beginning of the century were centered on the main executive, in general the owner, who had the prerogatives to choose what was considered best for the company and the workers” (our translation), since only the latter would be able to make assertive and rational decisions. The fragility of the rational proposal, according to March and Simon (1975), is evidenced in the assumptions that the model requires a choice mechanism, in which all alternatives are listed and their consequences are known and classified according to their utility. Nonetheless, the possible social and organizational pressures of the environment are not considered (Motta & Vasconcelos, 2006).

In order to evolve from the rational theory, the Theory of Limited Rationality understands that the decision-maker is not able to make rational decisions most of the time. That is, the human ability to absorb information and make decisions is limited. In this context, Weick (1973, p. 9) states that “individuals have perceptual as well as information-processing limits, and even though they may intend to act rationally, they can do so only in a limited fashion.” Simon (1979) highlights that rationality requires complete and unobtainable knowledge of the exact consequences of each choice. In reality, human beings have only a fragmented knowledge of the conditions surrounding their actions, and a slight perception of the regularities of phenomena and laws that allow them to generate future consequences based on what they know about current circumstances. Such limitations provide the creation of cognitive biases in the decision-making process.

Kahneman and Klein (2009) consider that inconsistency is a major weakness of informal judgment, because when a case is presented with the same information on different occasions, human judges often reach different conclusions. In this sense, informal judgment is related to intuition, which in Simon's view (1979) can be defined as a trigger for a suggestion, originated by a certain situation. This trigger gives access to specialized information stored in memory, which provides an answer, and intuition is this recognition. As such, the author demystifies intuition as an almost magical aura of knowledge that is not acquired by a rational process.

The Naturalistic Decision Making (NDM) has also been termed by the creators as the theory of decision in the real world. Zsombok (1997, p. 4) explains that "[...] it's how people use their experience to make decisions in their field." It should be noted that NDM does not intend to understand and describe all human decisions. This model is restricted, according to Orasanu and Connolly (1993), to decisions in complex environments, characterized by limited time, uncertainty, unclear or conflicting objectives, and whose consequences of choices are associated with significant implications. Russo, Frederick and Nogueira (2008), (27) understand that the NDM "[...] It is based on a context [...] that is uncertain and dynamic, for the solution of poorly structured organizational problems, within unstable norms and objectives, and also based on multiple participants, mainly specialists in the context of the problem." (our translation) Still on the NDM, it should be noted that it aims to assess how shared decision-making takes place in dynamic and uncertain environments, with time constraints and in poorly defined problems (Zsombok, 1997).

The fourth theory of the decision-making presented in this study is the *Garbage Can*. For Ramos et al. (2015), the main argument of the theory based on the Garbage Can is that organizational decisions are often made under conditions very different from those described by previous theories and that, therefore, this model could include elements hitherto ignored. March and Olsen (1976) describe the model as organized anarchy in a highly uncertain environment. March and Olsen (1976) characterize organizations based on an ambiguity that can be perceived in three moments: Problematic preferences, fluid participation and non-evident technology.

Among the theories presented in this study, this represents a more disruptive thinking, when understanding the logic of the decision as a process. Another contribution of the Garbage Can theory is to diagnose elements of anarchy theory, linked to business decision-making in the educational context.

### **2.3 Strategic University Management**

Oliveira (2012, p. 4) highlights that, in the military sense of the time before Napoleon, strategy meant "[...] the art and science of leading military forces to defeat the enemy or mitigate the results of defeat." (our translation) This definition began to incorporate broader concepts, with political and economic perspectives over time. The strategy has a military origin, however, the interest of this study rests on the strategy in the organizational context. In this sense, it is possible to observe the convenience of the strategy, which is strong to protect itself from external threats, and at the same time, flexible to enable the organization to quickly adapt to the constant changes in the environment in terms of opportunities. The organizational culture and values are essential variables for the construction and adaptation of the strategy to the organization's competitive environment (Deal & Kennedy, 1983).

The organization should build a strategy consistent with the available resources, appropriate to the environment, and aligned with the culture and institutional values (Paim et al., 2009; Pradella, 2013). Thus, Oliveira (2012) understands it as an adjustment of the firm to adapt to the environment in which it is inserted. It should be noted that the firm usually ends up changing its own characteristics in order to adapt to the constant changes in the environment. Mintzberg et al. (2006) complement by addressing the importance of firms' flexibility to respond quickly

to competitive market changes and must constantly measure their performance to achieve their best practice. The relevance of the environment in the strategic context is evident.

However, Porter (2005) argues that this change should be gradual, as companies form an inter-related system. The field of education has a close relationship with other areas of the economy, being responsible for the qualification of people who work in organizations. Thus, if the education system is doing well, it will tend to generate positive implications for the entire market and society. Rocha et al. (2016) believe that the strategy requires a reflection on the systematic, critical and reflective attitude on the position of the firm today and which it wants to achieve in the future. Therefore, the analysis of resources, as well as the situation of the company placed in a given scenario, is fundamental to design the objectives linked to the designed hypotheses. In the community educational context, there is a similar reality, with the need to balance social vocation and economic-financial viability. However, it is important to note that the types of decisions, as well as their complexity, tend to vary within the hierarchy in terms of operational, tactical and strategic levels.

University strategic management can be understood as a specificity of educational management. Universities must make changes in terms of strategy in order to promote the attraction, retention and loyalty of their students, including in new market niches that were hitherto unexplored. Such niches must be identified, more and more, not only with the mission, vision and values of the higher education institution, as well as with the demands of the community, mainly those motivated by community extension policies and practices of entrepreneurship and innovation (Hoernig & Fossatti, 2019). However, the educational sector has shown a lack in the number and training of managers, mainly due to the growing number of new higher education institutions that have intensified competitiveness (Jung et al., 2019) and motivated behaviors based on strategic isomorphism in order to reduce uncertainty in decision making.

Strategic educational management is concerned with adapting the knowledge of the science of administration within the context of the educational industry (Morosini & Franco, 2006), which for Lück (2010), 25) and can be understood as the “[...] area of action responsible for establishing the direction and mobilization capable of sustaining and dynamizing the way education systems and schools are and act, to carry out joint, associated and articulated actions, aiming at the common objective of the quality of teaching and their results” (our translation). In the context of educational management, it is worth noting that universities are places where ideas and values are deeply integrated into physical structures, personal attributions, rules and culture (Romero & Henriquez, 2014). Accordingly, for Peregalli (2020), the strategy considers the phenomenon of power and the individuals involved in these processes, their interests, resources, values and representations. The focus is on people's contribution to the achievement of objectives and results. This interaction constitutes a power game emphasized by the need to direct the policy and, in turn, promote the participation of different actors.

### 3 Method

This study describes the tactical decision-making environment, from the perspective of the main actors involved in the higher education institution studied here. Research reliability is linked to the method as used. In this sense, this topic aims to explain the methodological procedures that promote the scientific significance of this study. For the purpose of classifying this study, Table 2 below summarized the method used:

**Table 2**  
Methodological Classification of the Study

Categories	Method Used in the Study
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From the point of view of its nature	Applied Research
From the point of view of the approach	Qualitative research
From the point of view of the objectives	Descriptive Research
From the point of view of technical procedures	Case study
From the point of view of data collection	Document Analysis and Focus Group
From the point of view of data analysis.	Content analysis

Source: Created by the authors based on the survey data (2022).

### 3.1 Empirical field and study participants

The laboratory for the present study is the La Salle University, a community higher education institution based in Brazil. Community Higher Education Institutions (CHEI) are non-profit institutions, following Law No. 12,881 (Brazil, 2013) and have prerogatives for the provision of public services. This law formalized the emergence of a third segment in the national higher education scenario, which was composed of state-owned public institutions and private institutions until then. Building a university required a great organizational effort, derived from a bold goal. This moment implied in a more complex decision-making environment, regarding the number of variables involved, the oscillation speed of these variables, as well as a shorter time for the decision. Therefore, the university was chosen for its distinctive character in an increasingly competitive educational market.

The participants of this research were the coordinators of the undergraduate course of the aforementioned institution. They are part of the tactical decision group, with relevance to the organizational and economic-financial performance of the university. Initially, a total of twenty-six coordinators was estimated. Therefore, the inclusion criterion was to be a coordinator of an undergraduate course at La Salle Canoas University, regardless of how long they have been working in that position or their research area. Coordinators play a tactical role, closer to the operation. However, their academic training does not necessarily include management practices, mainly those updated to new market needs. Thus, Lück (2000) describes that the educational institution and its leaders are approaching the need to develop new knowledge, skills and attitudes to adapt to a new paradigm on the relationship between education, institution and its management.

### 3.2 Data collection

Data collection took place in two different circumstances. Initially, on secondary data, document analysis was carried out to obtain public materials from the university, namely: a) Institutional Development Plan (IDP); b) Statute; and c) Regiment (Unilasalle, 2016, 2017, 2019). Next, on primary data, the course coordinators participated in focus group sessions, intending to identify the decision-making environment of these coordinators through guiding questions. The focus group session started with the following topic: What is the environment to which the La Salle University Course Coordination tactical decision-makers are exposed?

The sessions were scheduled in different shifts, disregarding the night shift, this is because most professors in Brazilian higher education institutions work in the night shift, whether in classes or academic events. Eleven course coordinators participated in two different focus group sessions. Each session had a mediator conducting the dynamics and an observer who wrote down all the information given, whether it was explicit (e.g., participants' statements) or implicit (e.g., bodily expressions). It is important to highlight that the use of face-to-face groups was considered. However, with the suspension of face-to-face activities due to the Covid-19

pandemic, it was necessary to adopt a remote version of a focus group while using *Google Meet*.

### **3.3 Procedures of Data Analysis**

The anonymity of the participants was guaranteed by placing a coding whenever they were quoted during the data analysis. The participant's number was assigned according to the order they started speaking, in sequence, the focus group session chosen. "FG1" refers to the first focus group session and "FG2" refers to the second focus group session. The collected data were analyzed according to the content analysis method (Bardin, 2016). The data analysis steps were: a) pre-analysis; b) material exploration; and c) analysis of the results: inference and interpretation. The material collected was explored using the NVivo software version 12.0 for qualitative content analysis. Data processing using software such as QSR NVivo is the most suitable step for mining large amounts of qualitative data (Kozinets, 2014), to the point of serving as relevant information for interpretation in the study.

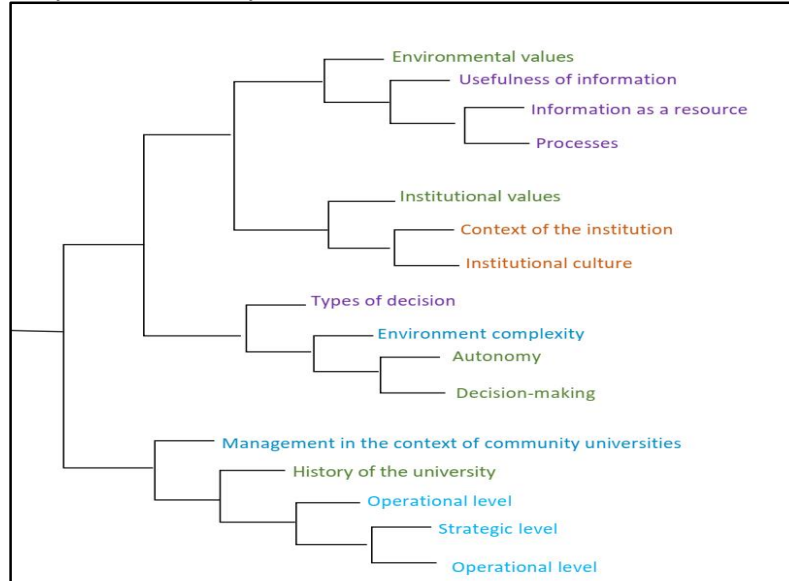
The data were grouped and, later, the analysis of cluster was applied with word similarity, following Jaccard's methodology, in which words are explored within a sample (Teuteberg, 2015). Jaccard compares the frequency of words present in similar groups, as well as the total number of groups involved. In addition, the total number of absences shared between groups, ranging between 0 and 1, is excluded. The closer to 1, the stronger the correlation is; consequently, the closer to 0, the weaker the correlation is. In this sense, two researchers were required to analyze the data separately and then to identify convergences and divergences in order to ensure the reliability of the method. Therefore, the categories were reclassified based on the intersection between the interviewees' statements and the category nodes.

The collected data were processed using the NVivo software, and the excerpts were linked to subcategories. Four files were used, one for each literal transcript of the focus group sessions, and two with the mediator's and assistant's notes. Four categories and 11 subcategories were identified, namely, in order of reference:

1. Decision-making environment
  - 1.1 information as a resource
  - 1.2 environmental variables
  - 1.3 usefulness of the information
  - 1.4 environment complexity
2. Values
  - 2.1 institutional values
  - 2.2 institution
  - 2.3 institutional culture
3. University management
  - 3.1 processes
  - 3.2 management in the context of community universities
4. Decision-making process
  - 4.1 Decision-making
  - 4.2 types of decision

To understand the behavior of the indexed data, Figure 1 shows the data cluster by word similarity.

**Figure 1**  
Cluster analysis by word similarity



Source: Created by the authors based on the survey data (2022).

The cluster analysis makes it possible to sort heterogeneous data into homogeneous clusters. The illustration of the cluster shows among the categories a grouping around four topics: The first alludes to the decision environment, showing similarity between environmental variables and information. It is also noteworthy, in this first link, the similarity with the processes. It is deduced that, for the participants, there may be a correlation between the information for decision making and the management of organizational processes. The second outcome correlates institutional culture and values to the institution's context. The third grouping of the *cluster* highlights the concerns of these decision-makers with the decision-making environment and their autonomy, in the face of decision-making. Finally, the fourth pattern of similarity associates strategy with university management.

#### 4 Discussion of the Results

The La Salle University is a private higher education institution of community, confessional and philanthropic nature, based in Brazil. The university has its origins in the mission of the Lasallian Brothers in Brazil. The work of Saint John Baptist de La Salle in Brazil began on March 19, 1907, with the foundation of the first Lasallian school in the country, in the city of Porto Alegre. La Salle University, then La Salle Educational Center for Higher Education, was opened in 1975. In 1998 the institution was promoted to La Salle University Center. The process that finally culminated in the transformation into a University was resolved in 2013 and lasted approximately 4 years. On May 5, 2017, the university was approved by the Ministry of Education.

The La Salle University of Brazil is part of a global education network, present in 77 countries on 4 continents. It has approximately 93,000 educators and 1 million students ranging from elementary school to doctorate programs. The La Salle University of Brazil has approximately 11,000 undergraduate and graduate students, both *lato and stricto sensu*. According to the



university's IDP, its mission is “[...] to promote the integral and continuous formation of the individual through teaching, research and extension of excellence, aiming at the sustainable development of society, based on the Christian-Lasallist tradition and principles” (Unilasalle, 2019, p. 22). To face the challenges of the next five years, La Salle University presents the following view: “[...] to be a University perceived by academic excellence, innovation, sustainability and internationalization [...]” (Unilasalle, 2019), 22, our translation).

Understanding the decision environment serves to identify the complexity of environmental variables to which these decision-makers are exposed. The coordinators' perception of which variables are most relevant in this environment, as well as their complexity, was explored. The categories and subcategories of analysis based on the Organizational Strategy were identified. The categories are the following: decision environment, values, university management and decision-making process.

#### **4.1 Decision-making environment**

The first subcategory, “Information as a resource,” was the most referenced in the focus group sessions. The management of organizational information can influence the assertiveness of the decision, as highlighted by the participant: “So, if we have the information, we can make more assertive decisions” (Part5 FG2). The aforementioned concern, expanding investments in technology, aiming to deliver greater agility to the decision-maker, is highlighted in the speech of Part3 FG1, where the institution makes an effort to reduce excess bureaucracy by investing in computer systems. However, even for the same participant, there is a concern about the concentration of information to some people: “For me to get the information, I get it from the key people” (Part4 FG2). It should be noted that this does not prevent obtaining information; however, it can generate greater difficulty. There is no ready-made solution for this that applies to all firms. Barney (1991) highlights that these key resources are not easily transferable to build a competitive advantage. It is noticeable for the coordinators the increase in the volume of investments to provide technological tools that enable greater access to information. On the other hand, it is worth highlighting the concern with the personalization of information in some key sectors.

These observations are similar to Barney's RBV theory (1991) when the author suggests that this resource is difficult to transfer and thus requires a solution that can meet the specific case of the organization. Regarding the personalization of information, the coordinators' report shows that, somehow, these decision-makers need more personal and personalized information, which could be made possible through an information system with customizable technologies or artificial intelligence. Therefore, this information system can be built internally by the firm, a practice which is known by the RBV theory as an accumulation process (Dierickx & Cool, 1989).

Still on access to information, in the collected data, it is largely up to the decision-maker to prospect information in the reference sectors, as reported by Part1 FG1: “This information is not always explicit, sometimes it depends on our knowledge in coordination. Sometimes it is information that we have to go after, that we have to look for, [...] we spend a lot of unnecessary time, having to look for some information”. Therefore, the coordinator needs to be proactive when obtaining the necessary information in order to make a decision. Part2 FG2 also adds: “The longer you've been working here, the more people you meet, the more you understand the university system, how things work, who has more information and, with that, you end up taking short-cuts, going straight to the source. Over time you create your own information network”. Therefore, the experience in the position of course coordinator contributes to making more assertive decisions. It provides a better familiarity with the internal processes and the means of obtaining information. In short, information is a resource capable of leading the organization to a sustainable competitive advantage (Barney, 1991; Porter, 2005).

In the Decision Environment category, the subcategory “Environmental Variables” is presented. In this item, the main variables mentioned by the coordinators in the focus group dynamics are explored. Part7 FG2 says that “[...] specifically at a tactical level, what would be important for decision making are course indicators [...]”, or even “[...] I think this information as indicators would be important for us [...]” (Part5 FG2). For Bispo and Cazarini (1998) information relevant to one decision-maker may not be relevant to another. Each decision-maker must have information that is useful to their needs. In short, it is convenient to provide each decision-maker with an informational matrix that considers what best suits their needs. In due course, these indicators could be based on the strategic macro-indicators derived from the BSC (Kaplan & Norton, 1997) being developed in more tactical and operational indicators.

The subcategory “Use of Information” aims to lead to an understanding of whether the information obtained is useful for an assertive decision. When chasing the perfect information, the decision may be jeopardized due to the amount of information available, as seen in this participant's statement: “[...] it would be important that it be segmented, because too much information gets in the way [...]” (Part6 FG2). Thus, a fine line is established between the search for complete information and the excess of information. The more complete the information, the better its influence on the assertiveness of the decision. On the other hand, the excess of information can impact negatively on decision-making (Bispo & Cazarini, 1998). Additionally, as Akerlof (2002) emphasizes, management should be concerned with the risk of information asymmetry harming the assertiveness of decision-making.

The last subcategory, “Environment Complexity”, of the decision environment category is interested in highlighting the coordinators' perception regarding the degree of complexity of the environment to which they are exposed. As a way of trying to quantify this environment, the actors with whom these coordinators must interact by assignment of the position were identified, according to art. 59 of the La Salle University Regiment (Unilasalle, 2017): NDE; Course Collegiate; Undergraduate Board; Distance Education Directorate; Teaching, innovation, research and extension bodies; Dissemination of the Course (Marketing and Relationship); Other HEIs; International HEIs; Events; Academic Registration Service; Professors; Tutors; Contributors; Students; and Candidates. However, it is possible to observe an interaction with other actors, such as the other courses of the institution.

#### **4.2 Values**

This category aims to identify the values that guide the decision-making process of the coordinators of undergraduate courses at La Salle University. The subcategory “Institutional Values” guides the decisions of the coordinators, such as attention to the student, welcoming, listening and empathy. The concern with putting the student at the center of the process was described by Part3 FG1: “[...] when it comes to the values that guided my decisions, I always put the student first. And I know that all of our decisions will affect our student” (Part3 FG1). Part4 FG1 complemented that statement: “Understanding the student's decision-making process is a value. This process of putting oneself in the student's shoes. This positioning is in line with the institutional mission: “[...] promote the integral and continuous formation of the individual [...]” (Unilasalle, 2019), 22). Likewise, one of the institutional values is: “Valuing people” (Unilasalle, 2019), 23) also helps coordinators understand the importance of the student in the decision-making process. The mission and values are included in the University's IDP and served as inspiration for the university's strategic plan, in which, in the second strategic objective, this influence can be evidenced: “Ensure strategies for attracting, retaining and fidelizing students” (Unilasalle, 2019, p. 26, our translation).

Taking it to the context of business management, in which the student can be considered the customer, some authors defend this view of placing the customer at the center of the process. Porter (2005) understands the company's relationship with its customer as a key factor for its



positioning in the market. For this author, buyers compete with the business, pushing the price down or bargaining for quality. However, understanding the customer needs enables the organization to gain a competitive advantage, thus creating customer value that cannot be copied by competitors (Barney, 1991).

Thus, to put the student at the center of the decision-making process, it is necessary to try to understand their motivations and needs. In the educational context, it is not only about meeting the explicit needs of the student as clients, but also providing a quality education, even if there is some conflict between student and university. Often, the student does not have their demands met while the university, through its managers and professors, promotes a dialogue capable of temporizing the friction. This can be observed by the coordinators, when Part1 FG2 refers to the commitment to the quality of education of these students: “[...] you have a responsibility towards the students, mainly, who are buying this service and, even more than that, are accessing education. So, the commitment is with the quality of education for these people” (Part1 FG2). For Hoernig and Fossatti (2019), at the center of this conflict and acting as a key to its mediation, is the educator who must be able to understand the student as a whole, systematically and integrally. Thus, it is possible to perceive the vocation of the Lasallian educator to promote the integral formation of the academic student, and of the course coordinator as a manager capable of enabling this professor-student relationship. However, course coordinators do not work alone, as they are helped by colleagues, as mentioned by this coordinator: “[...] the decisions and considerations take place in a group, both at the area level (as the NDE) and within the collegiate” (Part4 FG2). For Lück (2010), democratic management provides the collective and conscious participation of actors in decision-making.

In this sense, another dimension considered in the decision-making process is the institution. During the meeting, the coordinators often mentioned considering what is best for the course and the university in the decision-making process. As shown below: “[...] I believe that it is also relevant to understand the stability of the university as a business [...]” (Part4 FG2). Part3 FG2 contributed to understanding the institution's profile: “We have a control institution; management means a control management, this is the profile. I'm not questioning whether it's good or bad, I'm just saying it's an institutional profile, the control”. Even being a non-profit institution, it is not possible to conceive that an institution can survive without positive economic results. The sustainability of the university, as a business, is defended in institutional documents, such as the IDP, which deals with the university's view for 2025: “[...] to be a University perceived by academic excellence, innovation, sustainability and internationalization [...]” (Unilasalle, 2019), 22, our translation). Due to this view, the management of the university highlighted among the challenges, the sustainable development of the institution, as follows: “Sustainable development reflects the challenge of guaranteeing the autonomy of the University, with the critical exercise of rights and duties and the sustainability of its undertakings” (Unilasalle, 2019), 24). Within this context, the university considers it relevant that the financial result is maximized through a balanced portfolio, with sustainable products and services (Unilasalle, 2019).

Community universities have their social function linked to the community of which they are part. Therefore, when thinking about the sustainability of the university, it is closely linked to the local social context. It is a complex decision and, according to the participants' statements, this dimension is present in their values for their decisions. Part3 FG1 was straightforward when reported that “University is not made in isolation, the University is made together with the community [...]” and added, while emphasizing the importance of the community for management actions: “[...] we are not here alone on a pedestal; the University is made with the community and for the community [...]” (Part3 FG1). Therefore, positive economic and financial results must be accompanied by gains for all parties involved, including the community (Jung et al., 2019).

Within this category, the following subcategory was also identified: "Institutional Culture". This finding serves to emphasize quotes during the focus group to deduce some details of the organization's culture, which in some way, can influence the decision making. Some decisions must consider the specific moment the course is facing, as described by Part1 FG2: "[...] I had to do it while thinking about the recognition of the course [...]", or even "[...] If I could I wouldn't fire [that person]. But as I had to do it, I chose the one who contributed less to the course [...]" (Part3 FG2). The sense of urgency or the perception of lack of time, together with the excess of tasks, can be observed in some lines, as in Part3 FG1: "We are working urgently, not only now, because of the pandemic, but since always [...]". At the same time, the feeling of having too many tasks for a short time, "Because the coordination routine is like this, every week we have a new demand. This is the life of being a coordinator [...]" (Part3 FG1). This acuity can be linked to shorter deadlines for decision-making, as seen in the previous analysis category.

### **4.3 University Management**

The coordinators were identified as giving rise to theories that deal with management in the educational context, aiming to understand the processes in this type of firm. There is a perception on the part of the participants that the formal process does not exist, as explained by Part2 FG2 "[...] because we do not have the processes described or established [...]", When analyzed the statements of other participants, it is evidenced the difficulty in obtaining information about the processes. According to Part4 FG2, "[...] Since when I joined La Salle, I have had to look for key people to try and understand many processes.". Based on how the coordinators position themselves, it can be seen that they link the difficulty in obtaining information to the lack, or perception of lack, of processes. Information is more reliable and is likely to be obtained more naturally and fluidly, if it is generated by a structured process. When attempting to establish a basis for the organizational process management practices, Pradella (2013) and Paim et al. (2009) guide that there is no study capable of detailing this step by step, since authors and organizations differ on the subject.

According to Pradella (2013), it is up to the management to establish processes that can align the organization's strategy and capabilities, that is, they must contribute to creating measurable goals and collaborating to achieve strategic objectives. The need to manage processes and link to the strategic plan was pointed out by Part7 FG2: "[...] the information is handed fragmented, doesn't match with others. Then something is needed that connects with the strategic [sector], with the BSC and with the operational [sector], but there is no connection".

Still, within the category, University Management, the Subcategory Management in the Context of Community Universities is presented. Community universities have a charisma inherent to institutions with a philanthropic purpose. The case of La Salle University adds to the tradition of Lasallian education spanning more than three centuries. This charisma is confirmed by the coordinators, when they recognize the university's connection with the community and consider this in their decision-making process. This bond contributes to the sense of belonging, as seen in the description of another coordinator: "[...] I am not a person who will do something to harm the institution, who will make the name La Salle look bad, I will never do that. So, I carry this La Salle thing, I have it very strongly with me, and it influences my decision-making a lot [...]" (Part1 FG1). In this sense, Part3 FG1 reinforces: "I have a very strong identification with Lasallian ideas and values, I always say, [...] When I got to know Lasallian values, I believe that I was always a Lasallian and didn't know, I just didn't know how to name it." According to these coordinators, it is seen the identification with the Lasallian philosophy and with the university's vocation to integrate with the community.

Understanding this context is essential to analyze the management of community universities. As any other organization, they must obtain positive economic results for their sustainability.

On the other hand, this result is not distributed to a specific shareholder, but is reinvested in the business or, in a language more appropriate to the segment, the positive result returns to the Lasallian Institution. Another factor that must be considered in this context is the higher education segment, which currently includes three types of higher institutions, namely: public institutions, private for-profit institutions and community institutions (Jung et al., 2019). The competition in the higher education market has evolved substantially, especially when foreign entrants began to operate in Brazil. This market movement, among other factors, drives major transformations in the way these institutions organize themselves in terms of management. Thus, Morosini and Franco (2006) emphasize that community universities should focus their efforts on providing a quality education that can be perceived by the student and differentiate them from the international players. It is up to the university to adapt to changes without losing its essence. The Lasallian philosophy influences the university's values and culture and can be seen in the coordinators. In this sense, these values must guide this adaptation to constantly changing scenarios, and permanent monitoring of the results is essential in order to measure the effectiveness of the adaptations.

#### **4.4 Decision-Making Process**

This category, which embraces the decision-making process, aims to understand how coordinators of undergraduate courses at the aforementioned CHEI interact with the decision-making environment. The analysis of this category should unfold into the following subcategories: Decision Making and Types of Decisions. The first subcategory aims to understand the decision of these coordinators in the light of the decision-making process theory, having as words highlighted: “decision,” “making,” “decisions,” “autonomy,” “control,” and “assertions.” According to the coordinator identified as Part4 of FG1, his structural decision is made together with other actors: “this idea that we make decisions alone is very empty; in fact, we make many collective decisions, [...] Structural decisions are shared” (Part4 FG2). Lück (2000) perceives this need to share the decision in an even broader context, as the school management is strengthened when the decision-making process is democratized. Decisions approach the coordinators with the need for action, without the possibility of interfering with the decision that has already been made. Part6 FG2, even participating in a different session from the colleague Part4 FG1, presents an observation along the same lines: “Precisely because there are things that are not decision-making, which are activities to be fulfilled from decisions made in other instances [...]”. To this end, Part2 FG2 raises a question about the autonomy of this decision-maker: “[...] what autonomy will I have, as a course coordinator, to make a decision? [...] how far does your autonomy for decision-making go?”. For Lück (2000) decision-maker's autonomy, when managing educational institutions, is not conditioned to trust, but to a clear model of limited autonomy, which presupposes a standardization imposed by the general board.

The second subcategory, Types of Decision, aims to identify, according to the coordinators, evidence that makes it possible to relate the theories of the decision-making process. There are indications of the four types of decision-making in the excerpts extracted from the group sessions. The Rational theory dates from the beginning of the last century, inspired by the economic theory that advocates the decision-maker as a perfect and rational one always aiming at economic gains (Taylor, 1978). Through the new studies, the possibility that any decision-maker can make a perfect decision is practically ruled out, given the complexity of the environment. Even so, Part2 FG2 identifies this concern: “[...] making a decision-making must be very responsible; it cannot result in a decision that has not taken into account all the pros and cons.”.

Simon (1979) relativized Taylor's rational theory, as man is fallible. Even intending to make the best decision, a decision-maker has limited cognition, that is, they are unable to assimilate

all the resources necessary to create the best solution. Most of the time, the participants were in favor of better conditions for an assertive decision and emphasized the difficulty of accessing information, or even the lack of quality in the information obtained.

The Naturalist theory, by Orasanu and Connolly (1993), values the intuition and experience of decision-makers. The decision is unstructured, that is, not rational. The authors argue that with the experience of the decision-maker, over time, a repertoire of solutions is accumulated and developed. Thus, when a problem arises, coordinators intuitively seek the solution in their repertoire bank. According to Part1 FG1, the following elements are found: experience and intuition, which can be related to Naturalistic theory: My decision making is often intuitive, [...] based on my own experience. [...] For decision-making, a little bit of my experience is in line with my intuition [...] (Part1 FG1). Other participants also brought Naturalist elements: “[...] it is very personal and within the reality of the course, the size of the course, how long you have been at the institution [...]” (Part4 FG2). Also: “I try to be as fair as possible, based on my life stories and the choices I make” (Part3 FG2). On the other hand, another participant made a statement about his decision-making process, in which he admits that he still does not have a significant repertoire for a naturalistic decision. However, to shorten its process, the participant uses the repertoire of coordinating colleagues: “Within the scenario of my decision making, I try to observe how my colleagues are working. Colleagues who have more experience, to try to collect as much information as possible, so that I can make a decision” (Part2 FG1).

The Garbage Can theory is inspired by the theory of anarchy, and its seminal study was conducted at a higher education institution. It cannot be stated, with methodological rigor, that La Salle University conducts its decision under the theory *Garbage Can*. Cohen et al. (1972) base on reversing the logical order of the decision as a process, as if the problem arose from inside a garbage can, or even, in the words of coordinator Part4 FG2, from inside a Kinder Egg.

## 5 Final Considerations

This study addressed decision-making through the perception of coordinators about their decision-making environment. The way this decision-maker perceives the decision environment, assimilates the information and executes the decision, is crucial for the success of the decision-making process. This research showed that the values described in the institutional documents, as well as the values of the Christian-Lasallian philosophy, are perceived by the coordinators and guide their decision-making process. Decision-makers consider the student as the most relevant value and emphasize the importance of placing them at the center of the process. Next, they understand the role of the teacher as fundamental to mediate a possible conflict of interests between the student and the university, and to provide the integral formation of the academic student. They also consider it important to defend the interests of the institution, aiming to care for the 3-century image of the brand, as well as contributing to the economic and financial sustainability of the university.

This article addresses the information regarding access and its usefulness. It aimed to show what these variables would be. Evidence attests that symmetrical, customized, friendly and agile information contributes to making more assertive decisions. They report difficulty in obtaining information due to its fragmentation and personalization. The study showed, based on the theory of RBV, that resources are essential to boast a competitive advantage, and that these resources, due to their need for customization, must be acquired respecting the specific needs of the organization, or building them internally.

Subsequently, the university was identified to operate in a segment that is constantly evolving and that has new international entrants. These new entrants have been moving the market, giving the traditional *players* the need to adapt. However, it should be noted that the university must adapt while maintaining its community identity, as well as its Lasallian philosophy, rooted

in the organization's culture and perceived as inspiring by the coordinators. Also, regarding management procedures, the coordinators indicate that they do not have defined organizational processes, to the point of supporting reliable indicators for decision-making.

As for the interaction of decision-makers with the environment, it was possible to observe that the coordinators make references to decisions made based on the four theories studied: Rational, Limited Rationality, Naturalistic and Garbage Can. However, a higher number of Naturalist decision procedures was obtained, since the decision-makers highlighted the use of experience and intuition. From this perspective, the coordinators promoted debates about the autonomy of the course coordinators and their role in the relevant decisions of the course. Most of the relevant decisions are made collectively or by higher authorities.

In short, the undergraduate course coordinator of this institution is exposed to a complex and heterogeneous tactical environment, working with practically all actors inside and outside the university, at all strategic levels. These decision-maker lacks symmetrical, customized, friendly and agile information to qualify their decision. Thus, an information system based on organizational processes is suggested, aligned with the strategic management of the University. In addition to qualified information, it is advisable to promote this manager's knowledge and repertoire, with education and training in management and shared management practices. The university must face the competition, which has been intensifying in the educational segment, with a strategy that values its essence, supported by the Christian-Lasallian Tradition that spans three centuries, with the adoption of control mechanisms and permanent and systemic strategic adjustments.

As limitations of this study, it must be noted that its qualitative character does not provide sufficient elements for a scientific generalization. Furthermore, the opinion and perception of the participants in the focus group dynamics are subject to interpretation bias, due to the influence of the group. As a suggestion for future research, it is recommended those that aim to understand the unfolding of actions at the operational level. Finally, there is a lack of authors who portray, in a practical and tool way, process management, even more in the context of higher education, providing an opportunity to develop research from this topic.

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## **Competences of the manager of the XXI century from the leader chat series of the newspaper of Canoas**

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### **Abstract**

This research is about theme management and leadership. It aims to identify the main managerial skills for the 21st century in the vision of the leaders interviewed in the Leader Chat Series of the DC Newspaper of Canoas, Rio Grande do Sul, Brazil. For this, we conducted a content review of 41 interviews, primary data, from a survey of leaders in the city of Canoas and the metropolitan region of Porto Alegre. As main results, we highlight that in the interviewees' view, leadership is related to the competencies: a) Teamwork; b) Set of personal principles; c) Good communication and influence and d) Ability to adapt to adverse situations. We emphasize that teamwork is a form of care for others; personal principles guide the actions of the leaders; good communication and influence indicate active listening and dialogue and the ability to adapt to adverse situations occurs due to the search for results. Therefore, the management skills of the 21st century are under construction, with a context of rapid and profound changes to promote assertive responses in this present time.

**Keywords:** Management and Leadership; Manager; Skills; XXI Century.

### **ThIntroduction**

The deep, fast and necessary transformations in all areas of knowledge require a new leadership profile (Taleb, 2015). In this context, a communication vehicle, the Municipal Newspaper of Canoas (DC), in order to understand the successful cases and in order to develop leaders in the region, started a series of reports on the subject in March 2019, with the name of the Leader Chat. Thus, our research has as its theme management and leadership, a subject that

covers society as a whole, private and public companies, self-employed and entrepreneurs. In addition, its relevance is given by the growing need for good and competent leaders. We note that, on the one hand, we have globalization, rapid transformations, digital culture, innovation and entrepreneurship that create new scenarios at every moment and, on the other hand, we see a blackout of leadership, the lack of professionals with skills that the 21st century demands.

The changes in the job market and professional possibilities make this environment unstable and, consequently, new forms of management emerge. The main challenges of the 21st century point to strategic management based on the focus on results, competitiveness, innovation and resilience. The leader's profile is multifunctional, with different skills and functions. In this sense, our research is justified by the context of the 21st century, which is guided by the demand for answers to the new demands of this profile.

We emphasize that leadership has the role of keeping the businesses active and developing them, resulting in the generation of income and jobs. At the national level, larger companies have high survival rates, and in 2018 the survival rates of entities, considering the ranges from 0, 1 to 9 and 10 or more salaried employed persons, were 29.9%, 52, 7% and 62.5%, respectively (IBGE, 2020).

More specifically, the municipality of Canoas represents the fourth most economically prosperous city in the state of Rio Grande do Sul with 12,231 active companies in 2018, which enabled the average monthly salary of formal workers of 3.2 minimum wages with 96,764 employed persons (28% ) of the population (IBGE, 2020b). We understand that the city of Canoas influences the metropolitan region with the local socioeconomic growth and for that it needs leaders who have an effective management.

However, in Canoas, RS, we highlight some alarming data about the duration of the projects. In this city, 28% (11,990) of companies are between 1 and 2 years old, 23% (9,849) between 3 and 5 years old, 14% (6,032) are between 11 and 20 years old, 7% (3,141) are between 21 and 30 years old. years, 4% (1,505) are over 30 years old and 4.1% (1,526) are less than 1 year old (SEBRAE, 2020). These data show that more than half of the city's enterprises are less than 5 years old, which makes us reflect on the mortality of companies in the city and its motivators.

The three main causes of business mortality are related to planning, training and management. The relationship between planning and the mortality of companies resides in the lack of planning, lack of negotiation of deadlines with suppliers and not getting loans from banks. As for training, not taking courses on management and business and not investing in employee training contributes to business failure. As for management, the main elements that

contribute to the closing of companies are: lack of product improvements, not updating, lack of rigor in monitoring income and expenses and products without a competitive advantage (SEBRAE, 2016).

Given this scenario, we understand that managerial skills for leaders reflect on the maintenance and development of business, which can contribute to reducing the mortality of companies. In this way, our objective is to identify the main managerial skills for the 21st century in the view of the leaders interviewed in the Leader Chat series of the DC Newspaper of Canoas. The DC, with more than 25 years of existence, has a print and online version, with 6,600 subscribers (Grupo Sinos, 2022).

For this, we carried out a literature review to understand concepts and verify previous research on the subject to provide theoretical support, as well as a documentary analysis of the 41 leaders interviewed from the city of Canoas and its metropolitan region. Thus, after this introduction, we have a detailed presentation of the research methodology used. Next, we have the theoretical framework and data analysis, described as a synthesis of the skills of 21st century managers based on the analysis of the interviews in the Leader Chat series. Finally, we have final considerations and references.

### **Methodology**

Our study is a qualitative research, which “[...] is not concerned with numerical representation, but with the deepening of the understanding of a social group [...]” (Gerhardt & Silveira, 2009). , p. 31). We emphasize that, in our analysis, quantitative data were used only to support the qualitative data. Thus, we carried out a case study of the Leader Chat series from the DC Newspaper of Canoas, based on 41 interviews with leaders of the city of Canoas. In addition, we used a literature review to verify previous research on the subject.

With regard to the literature review, phase “[...] in which documentary information is collected on the knowledge already accumulated on the research topic.” (Gerhardt & Silveira, 2009, p. 99), we rely on the institution's library and online platforms, namely: Capes Periodicals, Scielo and Google Scholar. The descriptors used in the search for materials were: Leaders of the 21st Century; 21st Century Leadership; 21st Century Management; 21st Century Managers; and Management Competencies. The inclusion and exclusion criteria were: a) Articles published in the last 5 years, except in the case of books and classics; b) Materials available in full; c) Articles and books relevant to the topic; d) Publications and impressions of the DC Newspaper of Canoas that are consistent with the theme.

Concomitantly, we carried out the case study, which “[...] deals in depth with one or a few research objects, so it has great depth and small amplitude [...]” (Zanella, 2009, p. 84). In this sense, it seeks “[...] to know in depth the reality of a person, a group of people, one or more organizations, an economic policy, a government program, a type of public service, among others.” (Zanella, 2009, p. 84). In this study, the group of people that will be analyzed are the 41 leaders interviewed by the DC Newspaper of Canoas in the Leader Chat series. We aim to identify the main managerial skills for the 21st century in the view of these opinion influencers, mainly in Canoas and the metropolitan region of Porto Alegre. Of those interviewed in the Leader Chjat series, 31 are male and 10 are female.

To deepen the characterization of the subjects of this research according to their activities, we have: 5 people or 12% of the public sector; 33 people or 81% from the private sector; and 3 people or 7% from the philanthropic sector. These are divided into the following areas: 26 from Commerce; 4 from Education; 4 from the Law; 3 from Public Security; 2 from Industry; and 1 parliamentarian. These data reveal the diversity among the managers interviewed, as well as the importance of understanding and discussing the different perspectives on leadership in order to achieve a broader view on the subject.

Data analysis was performed according to Bardin's (2011, p. 48) guidelines for content analysis. This methodology refers to “[...] a set of communication analysis techniques aimed at obtaining, through systematic and objective procedures for describing the content of messages, indicators (quantitative or not) [...]” This step was carried out by two of the authors, who organized the materials considering the terms that were most repeated in the speeches of the 41 interviewees by the Diário de Canoas (Bardin, 2011). In this step, the Linguistics software was used, which identifies how many times each word was repeated, from these conjugations were discarded, such as for, of, with, about, among others.” Thus, we performed the categorization of the findings, an action that is conceptualized by Bardin (2011) as the classification of elements by differentiation and grouping by previously defined criteria. Finally, some speeches were chosen, which better evidence the findings, to exemplify each category that emerged from the analysis of terms and contents.

## **Theoretical Reference**

### **Management and Leadership in the 21st Century**

Management and leadership are different concepts, although they are intrinsically related. It is increasingly essential to have leaders with competent people to the point of having a good management of the institutions they manage. From this perspective, for Da Silva and Fossatti (2020, p. 76): “Management is understood as the act of guiding processes based on technical knowledge and previous experiences in handling adverse situations”. In order to deal with adverse situations, assertive decisions that seek positive results are necessary, as Fossatti and Souza (2014) warn: “[...] to ensure that decisions are as assertive as possible, we have to keep in mind the relationship between management and decision making”.

For Braga and Monteiro (2005) management is related to the ability to anticipate changes in order to adjust strategies through coherent decisions focused on results. Thus, managers need to be professionals connected with trends and who consider the past history to make more assertive decisions in the present. In this sense, we have to consider the experienced scenario where “[...] the constant changes in the world of work, consolidated by new technologies and other forms of management, transform working methods and knowledge construction for the productive processes of organizations in the globalized world.” (Calori & De Arruda, 2020, p. 11). Therefore, according to Goleman (2015), globalization has increased the need for empathy on the part of managers and leaders to maintain a good relationship in a multicultural dialogue. Souza and Fossatti (2014, p. 7) add that “[...] the success of an organization is directly related to its ability to meet the needs and expectations of its customers”. Thus, to understand the needs of customers that can be internal - employees and external - buyers, it is necessary to have empathy and focus on solving problems and at the same time. According to Hunter (2004, p. 45) “Leadership begins with the will, which is our only ability as human beings to tune our intentions with our actions and choose our behavior”. Similarly, we have that leadership refers to the act of influencing people, in a process that the leader is followed by the followers when they believe in their posture and values, as well as having similar objectives and goals (Siqueira & Abi Rached, 2022). For Pereira et al. (2021), the objective of leadership is to exalt the potential of behaviors, providing engagement, through an inspiring and common purpose, driving innovation, adding value to the product or service.

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the objective of leadership is to exalt the potential of behaviors, providing engagement, through an inspiring and common purpose, driving the innovation.

We emphasize that leadership is a competence that can be developed with all its characteristics, which includes empathy (Hunter, 2004; NQF, 2019). In this regard, for the NQF –National Quality Foundation (2019) leadership is not innate to human beings, but “[...] a competence that can be developed”. In the same sense, the NQF (2019) states that there is transformative leadership understood as one that promotes profound changes in employees. To promote such changes, it is essential to have constancy of purpose with “[...] acting in an open, democratic, inspiring and motivating way for people, aiming at the development of a culture of excellence, to the promotion of quality relationships and the protection of interests of interested parties.” (Fossatti & Souza, 2014, p.9).

However, changes require courage and the ability to take risks, manage possible conflicts and soften decisions that will always be the best due to the volatile scenario we live in. In this context, for Da Silveira (2020, np): “[...] the leaders should not seek to eliminate all the risks of the business, but rather create a structured process that allows scaling the uncertainties of the business and its possible negative impacts on the company. organization”. This is the role of the transforming leadership, because changing a situation requires courage and facing challenges, but only in the constant search for continuous improvement can reality be different. Thus, we highlight the NQF (2019) definition of transformative leadership:

Leaders act in an ethical, inspiring, exemplary and committed to excellence way, understanding the likely scenarios and trends of the environment and the possible effects on the organization and its stakeholders, in the short and long term; mobilizing people around the organization's values, principles and objectives; exploring the potential of present cultures; preparing leaders and people; and interacting with stakeholders.

So, we can identify the complexity of transformative leadership and the role of leaders with the company and stakeholders, that is, everyone who has any contact with the company - the stakeholders. Also, we highlight the role of people in assuming responsibilities, using their potentials that are encouraged by leaders, which reminds us of Goleman (2015, p. 115) when stating that “[...] a basic task of leadership is to lead the attention. Leaders tell us where to focus our energies.” In addition, we realize that even in uncertain scenarios, leadership needs to think in the short and long term, in a micro and macro environment, always having ethical values permeating each decision.

## 21st Century Managers

The performance of managers in the 19th century requires, in addition to technical management knowledge, effective leadership carried out with internal work in the organization and in the context in which it is inserted. Thus, “[...] in the organizational context, the complexity present in situations requires the manager to develop other capacities in addition to the techniques, in view of the need to recognize the organization as a complex and subjective system” (Calori & De Arruda, 2020, p. 11). Thus, in this challenging environment, it is necessary for the leadership to perceive strengths and weaknesses within the institution that operates and identify opportunities and threats related to the external environment of the organization. In this way, it becomes possible to outline strategies, objectives and tangible goals to succeed in the complex environment of the 21st century. Therefore, the role of the leader of the future needs to be seen in a broad way, because [...] the leader of the future is not just the one who learns the lesson of how to do it, but of "how to be" - how to develop quality, character, mentality, values, principles and courage, transforming leadership not into a place, but in a process, with a set of observable and learnable practices: "knowing how to listen" to your team; "knowing how to learn" with it, so that its members feel part of the organizational community and, consequently, are committed to the company's mission. (Rodrigues, Nogueira & Da Nóbrega, 2005, p. 55)

We perceive the characteristic of the leader of the future of "learning to be" related to transformative leadership, where change occurs first with the leader who is together, inserted in a constant process of learning humbly with the people around him. According to the NQF (2019) it is possible to learn to be a transformative leader that has the following elements: developing employees, setting an example, having behavioral skills, self-knowledge, active listening, empathy, security, adaptability, rapport, recognizing the group with benefits, do volunteer work and get close to other leaders. We emphasize that in order to establish rapport, a relationship of transparency and trust in the team is necessary in order to have a genuine connection among people.

We can observe that there are several characteristics to be developed to the point that managers become transforming leaders and consistent with the moment we live and their needs. We add that the leader needs to be a servant, according to Hunter (2004), that is, to have the purpose of serving people and the results will be obvious consequences. This author reveals the characteristics to be developed in servant leaders: Patience - showing self-control; Kindness - giving attention, appreciation, encouragement; Humility - being authentic, without pretense,



pride or arrogance; Respect - treat people well; Selflessness - meeting the needs of others; Forgiveness - giving up resentment when deceived; Honesty - being free from deceit; Commitment - Sustain his choices; Outcomes: Service - Putting aside his wants and needs; and Sacrifice - seeking the greatest good for others.

We observe that these characteristics can be applied in environments that are not necessarily professional, such as in personal, academic, social and spiritual life. From childhood it becomes possible to acquire the characteristics of being a servant leader, which are inherent in dealing with people's differences for the common good. In this context, Melo et al. (2012, p.11) points out that:

The 21st century leader will achieve status for his ability to deal with differences, respecting them and using them as a decisive factor for the progress of the project and for the common good, at the same time. The leader of the future will be the one who will respect those who are led, allowing and even encouraging the development of the team's skills and abilities, exercising their power in a more humane way.

We understand respect as a fundamental link to achieve the common good, that is, it is about accepting people as they are and encouraging them to expand their potential, according to the rhythm of each one. To complement, about aiming for the greater good, Goleman (2015, p. 137) argues that “[...] our time requires leaders who are not only intelligent, but wise. Wise leaders formulate strategies that aim for the greater good, not just the goals of an organization.” Thus, selfishness and egocentrism have no place on the agenda of nineteenth-century leaders and managers, who need to contribute to everyone, leaving a positive legacy in society and to achieve this.

The new leader must still have a deep knowledge of the human psyche. He must understand and respect the abstract side of the organization, so that he learns to work with differences in such a way as to create a harmonious and cooperative team, where all members will feel integrated and valued. (Melo et al., 2012, p. 12).

To work the differences in the team, achieving cooperation, it is necessary to have a “workplace atmosphere where people feel safe being honest” (Goleman, 2015, p. 78). In this way, when the leadership has empathy, among other qualities, exposed in table 1 to understand the differences, the team tends to be more united and cooperate with each other to face the adversities inherent to the moment we live.

Table 1: The seven qualities of socially intelligent leaders



Qualities	Questions for evaluation
Empathy	Do you understand what motivates other people, even those with different backgrounds? You are sensitive to the needs of others?
Tune	Do you listen carefully and think about how others feel? Are you in tune with the state of mind of others?
Organizational perception	Do you recognize the culture and values of the group or organization? Do you understand social media and know its implicit norms?
Influence	Do you persuade others by engaging them in discussions and appealing to their own interests? Do you get support from key people?
Development of others	Do you train and guide others with compassion and do you personally invest time and energy in guiding? Do you provide feedback that people find helpful for their professional development?
Inspiration	Do you express a compelling vision, build group pride, and promote a positive emotional tone? Do you lead by bringing out the best in people?
Team work	Do you solicit input from everyone on the team? Do you support all team members and encourage cooperation?

Source: Authors' elaboration based on Goleman (2015, p. 107).

According to Goleman (2015) these qualities are indicators related to emotional intelligence, that is, to deal with oneself and with other people in the most varied situations. The questionings, on the other hand, serve as markers of how effective the leadership is in achieving such qualities. These questions can be asked constantly as a form of evaluation for managers and leaders, including their teams. For this, it is necessary to have the humility to listen and accept what can be improved and establish strategies to obtain good results.

Also, it is necessary to make it clear that people work as best they can with the resources provided and therefore the leadership needs to be attentive to meet the essential conditions for the performance of a good job. We understand these resources comprehensively, such as leadership time resources for feedback, resources for work safety, material, technological and financial resources for performing tasks, etc.

So, we have to:

The leader of the future has to provide the necessary conditions for his employees to perform their duties with commitment and as an active member in decision-making, involving everyone in the organization's processes, with an awareness of social responsibility and as an important member of it. (Melo et al., 2012, p. 12).

Of course, in addition to providing resources, managers can encourage people to use creativity to innovate in the work environment for the use resources in other ways. Thus, we understand that there are multiple dimensions of the performance of managers, because “[...] to be a modern manager is to be a lawyer, doctor, teacher, psychologist, administrator, an accumulation of functions, there is still the aggravating factor of technology.” (Machado & Probst, 2017, p. 58). Furthermore, “[...] digital skills play a very important role” (Bianchini et al., 2020, p. 35). So, the manager of the 21st century also needs to have digital skills and deal with technology to speed up his work and the team, among other benefits that make him integrated with contemporaneity.

According to Kenworthy and Kielstra (2015, p. 7, our translation) the skills needed by professionals in the 21st century are: Training; Numeracy; Foreign language skills; Problem solving ability; Team work; Communication; Critical thinking; Creativity; Digital literacy (ability to understand the feelings of others and react accordingly); Entrepreneurship.

### **Competencies of 21st Century Managers and the Leader Chat Series**

The DC Newspaper of Canoas (DC) is a newspaper with a print and online version, which has more than 25 years of existence (DC, 2017). The newspaper has 6,600 digital and/or print subscribers, more than 75,000 likes on Facebook, more than 11,000 followers on Twitter and more than 11,000 followers on Instagram. As far as its website is concerned, DC has over 800 thousand page views/month.

In March 2019, the DC started a special series of reports, entitled Leader Chat, with leaders from the community and region. Comprising more than 41 reports, the series presented different perspectives on leadership, based on the perception of entrepreneurs, managers, presidents, among other professionals with this professional role. We present below the leaders interviewed.

Table 2: DC Leader Chat Series

<b>Date</b>	<b>Interviewee</b>	<b>Role</b>
26/03/2019	E1	President of the National Association of Catholic Education of Brazil and President of La Salle University
02/04/2019	E2	Entrepreneur and president of Federasul
08/04/2019	E3	Entrepreneur and president of the Institute of Business Studies
15/04/2019	E4	Entrepreneur

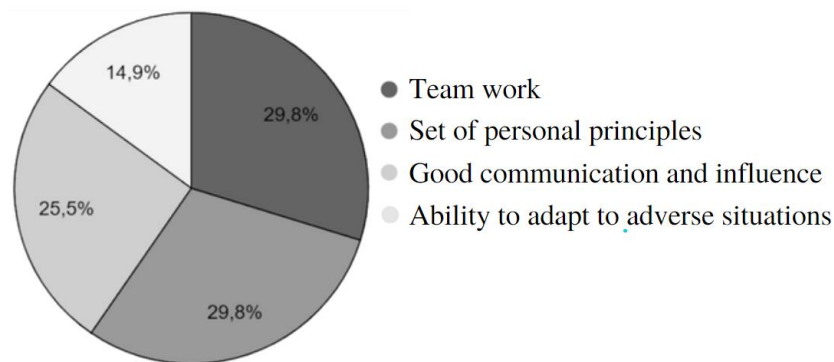
22/04/2019	E5	Lawyer and president of Cics Canoas
29/04/2019	E6	Entrepreneur
06/05/2019	E7	Entrepreneur and president of Sindilojas
13/05/2019	E8	Judge of TJ-RS
20/05/2019	E9	Partner of the Fruki Beverages
27/05/2019	E10	President of the Merchants Trade Union
03/06/2019	E11	Entrepreneur, vice president of CICS and director of the Volunteer Partners of Canoas
10/06/2019	E12	Entrepreneur
17/06/2019	E13	Entrepreneur
24/06/2019	E14	Mayor of Canoas
08/07/2019	E15	President of Simecan
15/07/2019	E16	State Revenue Delegate of Canoas
22/07/2019	E17	Entrepreneur
29/07/2019	E18	Director of Senac Canoas and São Leopoldo
05/08/2019	E19	President of Sindigêneros of Canoas
12/08/2019	E20	President of the Sindimetal of Canoas eand Nova Santa Rita
19/08/2019	E21	President of the Business Entities Forum
26/08/2019	E22	Entrepreneur in the food industry
02/09/2019	E23	Entrepreneur
09/09/2019	E24	Entrepreneur
16/09/2019	E25	Entrepreneur
23/09/2019	E26	Entrepreneur
14/10/2019	E27	Director of the Unificado Canoas
21/10/2019	E28	Entrepreneur in the food industry
28/10/2019	E29	President of Ulbra
04/11/2019	E30	President of the Subsection of the Canoas OAB
11/11/2019	E31	Director of the Colégio La Salle Canoas
18/11/2019	E32	Entrepreneur
25/11/2019	E33	Superintendente do Canoas Shopping
02/12/2019	E34	Superintendent of the Canoas ParkShopping

16/12/2019	E35	Real estate entrepreneur
23/12/2019	E36	Santa Claus
06/01/2020	E37	Colonel commander of the 15th BPM
20/01/2020	E38	Bachelor in Law
27/01/2020	E39	President of Associ
03/02/2020	E40	President of the Business Entities Forum
10/02/2020	E41	President of Consepro Canoas

Source: Own elaboration based on survey data (2021).

From the editions of the Leader Chat series, it is possible to verify that it has contributions from leaders from different segments and positions, which expands the perception of the manager's competences in the 21st century. It is also worth mentioning that among the interviewees we have leaders of public and private institutions, as well as self-employed and entrepreneurs, which further enriches the worked content. Thus, we then carried out our content analysis based on the interviewees' statements, which generated five categories.

Graph 1: Categories emerged from the content analysis of the interview data



Source: Authors' elaboration based on interview data (2021).

Among the speeches of the interviewees, what was most repeated were elements about teamwork and the importance of having a group of engaged and committed people. The team was linked to good leadership by 29.8% of the interviewees, thus generating the category Teamwork, concomitant with authors such as Delors (2006), Goleman (2015), Melo et al. (2012) and Rodrigues, Nogueira and Da Nóbrega (2005). In this way we have that “The good leader advises himself well with people in specific areas who are better than him. This is not demerit, but pride for the institution.” (E1). In the same sense, E16 indicates that “Leadership is being able to convey to those who are led, in a practical way, the objective and purpose of

the organization. Everyone should feel part of the process, understanding its importance within the gear.” In the same sense, Melo et al. (2012, p. 12), indicates that the leader must learn to work the differences and create a harmonious and cooperative team. Finally, we highlight the speech of E27:

Leadership is being able to assemble a group of collaborators that you can really count on in your day to day in a school. One day is never the same, so our people have to be very special and that, for me, depends a lot on the choices we make, the criteria we use.

Within this category, some relevant words mentioned were: people, responsibility, capacity, autonomy, trust, decisions and development. Thus, we understand that teamwork comes with a perspective of caring for the other, listening, joint decision-making, trust, union and commitment.

In this way, our second category, Set of Personal Principles, emerges. Also with a 29.8% prevalence among the respondents' statements, this category highlights the following words: example, purpose, trust, ideas, inspire, engage, ethics, affection, humility and respect. Such findings resume the perceptions of authors such as Goleman (2015) who indicates the leader as the one who guides, sets an example and shows the purpose, as well as Fossatti and Souza (2014) who emphasize that the performance of leadership must be open, democratic, inspiring and motivating.

Interviewee E5 highlights the findings in the direction of this category in his speech: “You have to have respectability to be a good leader, to be followed, heard, to inspire trust and respect, security for people, in addition to knowing how to listen”. Similarly, we have: E18 “A good leader is an ethical person and an example of this, not in speech, but in his actions.”, E23 “Putting himself in the shoes of the person being led all the time.” and E38 “[...] knowing how to listen, having the humility to learn from mistakes, as well as inspiring those around them”.

Subsequently, our data analysis presented the third category with 25.5%, Good communication and influence, which is also justified by the words: listen, speak, act, say, communicate, influence and mobilize. Thus, communication competence stands out, which corroborates with authors such as Bernard (1997), Kenworthy and Kielstra (2015) and Goleman (2015) who discuss the importance of good communication between leaders and followers, as well as their influence inside and outside their space. of leadership.

The E10, on the path of good communication and influence, says that the leader: “You have to be very patient, know how to listen, know how to share the good things as well as the bad.”. E34 adds: “Leadership is to positively influence other people.”. Many other interviewees presented similar passages on the subject, as did E37, who says: “I understand that leading is

to set an example, listen, share experiences and know how to extract from each person the best they have for the collective good of the team.”

In accordance with the diversities of management in the 21st century, the fourth category emerges in our analyses: Ability to adapt in the face of adverse situations, with 14.9% coverage among respondents. From the interviews, the words that stood out in this category are: trust, knowing, opportunities, learning, enjoying and challenges. In this way, Braga and Monteiro (2005) and Calori and De Arruda (2020) discuss the importance of the leader's ability to predict changes and constantly develop.

E7 highlights: “The leader has to know and know more. I cannot teach others if I am not well grounded. Knowing how to listen to people and take advantage of opportunities is necessary, in addition to being prepared.” Souza and Fossatti (2014), Bernard (1997), Gatti (2005), Torrance (2002) and Da Silveira (2020) agree with the interviewees in indicating adaptability as one of the necessary skills for the leader of the 21st century. Thus, we have the speech of E4 who states: “I always try to learn from those who know and who do”.

We justify that the unnamed respondents did not present content directly related to the proposed theme, however, they are people who exercise leadership in the city of Canoas and are opinion influencers and decision makers. After analyzing the positions of these managers, through a cloud of words, some elements similar to the emerged categories emerge: People, trust, listening and example. Thus, we understand that leadership is related to dealing with people, establishing a relationship of trust that can be observed by the act of knowing how to listen and set an example.

### **Final considerations**

The objective of this article was to identify the main managerial competences for the 21st century in the view of the leaders interviewed in the series Leader Chat of the DC Newspaper of Canoas. For this, the theme was around management and leadership in the 21st century. To fulfill the objective, we carried out a literature review and content analysis of 41 interviews with leaders of the city of Canoas and the metropolitan region of Porto Alegre, published in the DC Newspaper of Canoas.

As major categories emerged by the content analysis, we have in the order of prevalence: a) Teamwork; b) Set of personal principles; c) Good communication and influence; d) Ability to adapt to adverse situations. Teamwork represented 28% of respondents and is related to commitment and good leadership that must work on differences to generate

cooperation. In this perspective, leaders help people to use the capacity with autonomy and responsibility, trusting in the development of the team that makes decisions together. Working as a team represents a form of care for the other, which strengthens the bonds among people. The set of personal principles also had 28% of respondents and is related to the leader's ability to be authentic by setting an example with their actions to inspire their followers in pursuit of the same purposes. Furthermore, the actions of leaders are guided by ethical principles, respect, humility, affection and trust in people.

On the other hand, good communication and influence appeared in 24% of respondents in the sense that listening to what the other person has to say, speaking with coherence to influence and mobilize positive actions with those being led. It is about keeping the dialogue open in order to share experiences and good and bad situations, always with the objective of obtaining improvements. The ability to adapt in the face of adverse situations covers 14% of respondents and is related to the leader's ability to have confidence to overcome challenges, always learning and envisioning opportunities to take advantage of them. Adapting to different situations implies being open to changes and seeking development. Finally, 6% of the interviewees perceive leadership as the person's innate ability, which is a perception and not a competence, which is the target of this study.

Based on the authors cited and on the statements of the aforementioned leaders, we came to the conclusion that the skills of managers in the 21st century imply being an example, ethical, knowing how to unite the team with a relationship of trust, leaving a positive legacy, caring and giving direction to people. to lead them to a collective purpose, through active listening and transparent communication.

Finally, aware that no research puts an end to the study needs of a topic, we suggest its continuity, since this article has its limitations, such as the territorial restriction. Future research may explore the theme in other regions of the country or abroad, as well as continue the interviews of the DC Newspaper of Canoas, replicating its questions to other leaders.

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# **Supply Chain Management and Logistics**

## **Inditex's ESG Performance in a Global Financial Market**

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### **ABSTRACT**

Zara has become extremely popular as a global fashion enterprise and remains significantly profitable in the fashion industry. With a leading supply chain operation strategy, they have been a leading retailer for many decades. As the parent company of Zara, Inditex has increased its revenue significantly since its inception. This empirical research study involves research and assessment of Inditex's ESG performance and evaluations based on ASSET4 data source's evaluations, using the Stata software. Results show that Inditex remains a strong competitor in the fast fashion industry when compared to its rivals within 4 different categorical markets: all sample firms in Spain, all global retailers, and all sample firms separated by continent. Inditex consistently outperformed their competition and can be correlated to its overall financial success.

## **INTRODUCTION**

Fast fashion has become a trend of the decade; consumers are looking to purchase apparel to reflect the latest trends and fads in stores of their interest and for new inventory to be replenished frequently. Zara, the largest segment or subsidiary of Inditex, specializes in this consumer fashion trend and therefore has become a global leader in apparel retailing. The question remains: *Does Inditex, as representation of Zara, dominate certain performance variables over their competitors and does this relate to their successful financial implementation?* ESG, in layman terms, are levels of awareness that a company obtains or actively participates in towards areas of social, environmental, and governance related concerns. In hindsight, one can assume that Inditex does in fact conquer ESG performance due to their status in the industry. It should be noted that performance variables generally constitute the following in this empirical research study: environmental, social, and governmental factors ('ESG'). However, the degree to which Inditex implements a successful strategy in these areas are available for research and the degree of success can therefore be established. A hypothesis can be rendered that high ranking Inditex's performance variables such as workforce and diversity, data privacy and security, business ethics, human capital, and corporate governance, will beget a positive ranking in their overall financial statistics such as high revenue, positive net income, large total asset amount, and positive cash investments.

## **INDITEX BACKGROUND**

Inditex is a multibillion-dollar company that has been successfully operated since it was established in 1985. In 1989, this Spanish parent company opened its first American brick-and-mortar Zara in New York City and officially started its journey to global success. In 2001, CEO and founder Amancio Garcia sold 20% of his shares in the company, therefore, making himself the wealthiest man in Spain and Inditex a public company. Inditex operation companies are now located in 216 markets, including both brick-and-mortar stores and online retailing. This company implements a 'fast-fashion' strategy where they do not carry any additional stock in their stores and manufactures limited amounts of each piece of clothing to create urgency within consumer purchasing. For example, Zara's stores do not have a backroom with extra sizes

available for those who are looking for an item on the floor; all of Zara's products are placed on the floor with a "first-come, first-buy" attitude. In terms of advertising, they do not promote their brand on any form of publication and use a 'word-of-mouth' marketing strategy. This allows them to limit their SG&A and storage costs tremendously, while their competitors rely on digital advertisements and storage capacity. They are able to keep up with the short-term fads in fashion while having a two-week production operation. In other words, it only takes about two weeks for the design and creation of a product to be established, manufactured, and on shelves in the appropriate retail store<sup>1</sup>. They have successfully implemented this 'just-in-time' production operation since their manufacturing facilities are so close to the European stores, located mainly in Europe and Northern Africa such as Morocco (Ghemwat 2016). With such strong supply chain management strategies, Inditex has been able to keep their financials in a positive area of growth.

As a top global fast-fashion retailer, Inditex has completely dominated their financials. Inditex operates as a parent company for Zara<sup>2</sup>, Pull & Bear, Massimo Dutti, Bershka, Stradivarius, and Oysho. Zara is the largest of its parent company's chains, "[operating in] 507 stores in countries around the world, including Spain (40% of the total number for Inditex) ...and employing €1,050 million of the company's capital (72% of the total), of which the store network accounted for about 80%" (Ghemawat 2006). According to Statista's online database, in 2019 Zara accounted a net income of €19,564 million, while Bershka (second runner up of net income of the Inditex chains) had €2,384 million; this is over a €17,000 million discrepancy in the chains. Zara is ultimately the meat and bones of Inditex's capital gains.

However, fast fashion is controversial in the sense of its lasting success. Critics may argue that it is a generational fad and that it is not beneficial to the economy in relation to supporting small retail businesses. However, Zara has been successful for decades, and has outperformed other apparel retailers in terms of their profitability for decades; their success has been extremely long-term due to their differences in supply chain operations, such as 'outsourcing' from within their own country. Because of this, it is appropriate to assume that there must be additional reasons as

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<sup>1</sup> Inditex background information derived and paraphrased from Inditex's online database and online educational videos.

<sup>2</sup> For this empirical research study, Inditex will resemble Zara.



to why Zara is so successful, and it seems to boil down to their significant positive performance with their ESG integration.

Looking at Inditex's sustainability, they do have a high ESG performance in all their pillars. According to their 2019 annual report, Inditex has made a few enhancements to help their overall ESG. To start, in March they signed an agreement with the Massachusetts Institute of Technology "to conduct research into the circular economy and, textile recycling, and data analysis" (Inditex 2019). In May, they had a "summit meeting between the President of Inditex... and the mayor of Beijing...about the plan for the Group to reopen eco-efficient stores in Beijing, the first city in China and the world to complete this project" (Inditex 2019). In August, they had a meeting with other fashion brands to help climate change and biodiversity, specifically relating to oceanography. In December, they were included in the Bloomberg Gender-Equality Index which ultimately "assesses the promotion of equality and transparency in relation to gender at businesses" (Inditex 2019). To put this lightly – this is *only* what has happened in the year 2019. Inditex is constantly making positive strides for sustainability and that is why their ESG is so high, making their company so attractive to global shareholders.

Before the start of the research methodology and implementation, it was critical to conceptualize *how* financially successful Inditex is as a company. FactSet's historical data provides insight proving that they are a force to be reckoned with within their industry. Their fiscal years end in January, making their most recent and available fiscal year data to be January 2021<sup>3</sup>. They had \$23.5 billion in sales, which was a decrease of \$8.2 billion from the previous year. Their net income, although was a decrease of \$2.8 billion, was a strong \$1.3 billion. Their total assets had increased, meaning their liabilities and shareholder equity did as well, to reach a total of \$32.1 billion. Lastly, their cash and short-term investments remained at a high \$9.2 billion. It can be assumed that the decrease in financial values was primarily due to the global COVID-19 pandemic that had its peak in early 2020. However, it can be argued that Inditex performed extremely well considering the external pressures that were occurring and they did not have strong negative impact for positive future growth.

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<sup>3</sup> In other words, this is the entire year of 2020 being analyzed.

## **ESG OVERVIEW**

ESG is a significant factor in indicating whether or not a firm is performing well in areas of environment, social responsibility, and company governance. The environment pillar accounts for aspects such as “climate change, energy and water use, carbon emissions, [etc....], while social aspects include “fair trade principles, human rights, product safety, gender equality, health and safety, [etc....]”. Corporate governance includes “[company] board independence, corruption and bribery, reporting and disclosure, shareholder protection, [etc....]” (Galbreath 2013). What is the purpose of ESG investing? The main answer is simple: to regulate risk. ESG accountability has become a way for many stakeholders to determine whether or not a company is worth investing in, how much risk is associated with the company, and how much potential growth and return both the shareholders and the company will receive. Often it can allow the shareholder to invest in stocks to create a more diversified portfolio while gaining a higher return on investment. In the eyes of the company itself, investing in ESG can make their business look more attractive to potential investors and ethically they are allocating their resource and cash flow into appropriate measures. There are many positive and negative consequences for a firm to invest in ESG. It can certainly be attractive to shareholders when a company invests research and development into their ESG; however, it can also be extremely costly and if not performed and executed correctly, destructive. According to Emiel Van Duuren, a professor of Economics and Business at the University of Groningen, “[ESG] analysis is used by a portfolio manager to construct a diversified portfolio. This usually is structured to meet minimum standards with respect to the three dimensions” (2016). Attracting shareholders is often a key driver for a company’s performance and often their performance in the global financial market.

## **COMPETITORS**

As a top global fast-fashion retailer, it can be assumed that Inditex has many competitors. According to FactSet, its top competitors include ASOS, LPP S.A., Lojas Renner, Delta Galil Industries, and Maisons du Monde. Due to the fact that the first three competitors were the only ones presented in the Asset4 data, those three competitors were looked at more closely for accuracy and efficiency of research analysis. It is important to look at the competitors of Inditex

to obtain an accurate analysis of how strong their ESG performance is in the industry. The rivals listed are globally located, similarly to Inditex’s operational companies. In fact, in many of the locations of their rivals, Inditex has its headquarters, brick-and-mortar stores, or manufacturing facilities.

ASOS is a fashion retailer that is based out of the United Kingdom. They sell their items globally and have a heavy presence on the internet as an e-retail company. While Inditex had \$23.4 billion sales in 2020, ASOS had \$4.1 billion; this can show the scale as to how much larger Inditex is as a company. When using the Asset4 ESG performance analysis, the closer the ESG rating is to 100 signifies an overall better performance. According to the Asset4 provided data for the year 2017, ASOS has a strong ESG score of 80.15. As Inditex has a leading rating of 88.98, they are not *significantly* different in their value, as they both have ratings within the same range of being in the 80’s. ASOS has an environmental pillar score of 90.75, a social responsibility score of 67.76, and a governance value of 80.15. LPP S.A. is a manufacturing and distribution company for different clothing companies that is based in Poland. Unlike Inditex and ASOS, they have a smaller sales margin of \$2.4 billion in 2020. They have an ESG rating of 35.97, having an environmental pillar score of 41.22, a social responsibility score of 37.01, and a governance pillar score of 28.92. Their ESG scores are extremely lower than that of Inditex, yet they remain a top competitor as they are a parent company for many competitive retail businesses. Lojas Renner is a clothing and accessory retailer in the fashion industry located in Brazil. Their overall 2020 sales accounted for about \$1.5 billion – less than that of the rest of competitors and Inditex itself. They have an ESG rating of 85.93, having an environmental pillar score of 81.67, a social responsibility score of 86.60 and a governance pillar score of 89.89. Out of all the competitors listed from Asset4<sup>4</sup>, Lojas Renner has the closest ESG score to Inditex, only being 3.4% away. Out of all of the competitors, ASOS has the closest environmental score while Lojas Renner has the closest social responsibility and governance score.

<b>Company/Ticker</b>	<b>Environment Pillar</b>	<b>Social Pillar</b>	<b>Governance Pillar</b>	<b>Total ESG score</b>
Inditex (ITX-ES)	96.86	98.79	68.81	88.98

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<sup>4</sup> Please reference the chart below for a more visual and structured representation of the quantitative data provided.

ASOS (ASC-GB)	90.75	67.76	82.76	80.15
LPP S.A. (LPP-PL)	41.22	37.01	28.92	35.97
Lojas Renner (LREN3-BR)	81.67	86.60	89.89	85.93

## **ANALYSIS**

### **A. PURPOSE**

After living abroad in Spain for four months in the year 2019, it became quite apparent that Zara, specifically brick-and-mortar stores, were of interest and high demand to the Spanish community. Individuals from the United States, categorically in the NorthEast, may attribute the feeling of a Zara store being on every corner to a Dunkin' Donuts franchise - everywhere in sight, or the next exit away. The question as to why Zara is so imbedded in the Spanish culture - other than the fact that it sold trendy clothes - had arisen many times between the American study-abroad students. Upon arrival back into the United States, curiosity towards their heightened success and reputation continued to arise. The opportunity to seek further into this curiosity was presented during a financial analytics course in which the topic of ESG was highlighted. The basics of ESG were taught, specifically towards the conception of how critical it has been in the past decade for companies to invest in ESG to ensure that their company stands out against competitors to gain market share. With the knowledge of ESG and the curiosity towards Zara's success story, the main empirical research question had been constructed: Does Inditex dominate ESG performance and does this correlate to their successful financial implementation?

### **B. METHODOLOGY**

There are three main sources of ESG given data that will be used in this empirical research study: Asset4, Sustainalytics online public webpage, and MSCI. Stata software was used for analysis. In the beginning stages of the thesis and entire methodology, Asset4 was heavily used and relied upon to categorize Inditex and all of its global competitors into excel workbooks. The Inditex's annual reports also provided most of the qualitative data for its overall strategy and implementations. From there, the case study

began of which numerous ESG comparisons were made based off of different factors: Inditex comparisons through the years 2002 to 2017, Inditex versus all sample firms in Spain, Inditex versus all global retailers, and Inditex versus all sample firms separated by continent<sup>5</sup>.

## **C. RESULTS**

### **a. Inditex – Single Time Series Analysis**

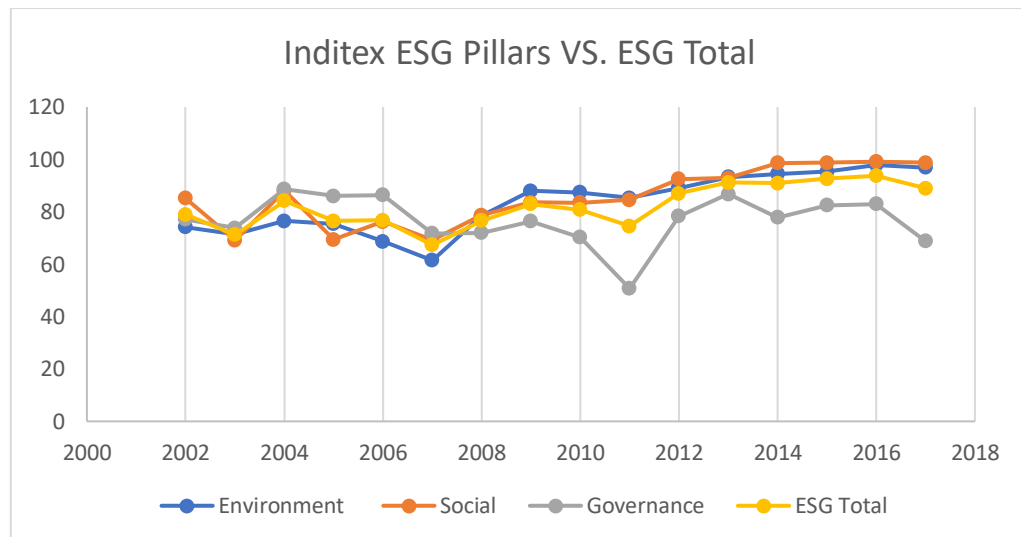
Using the Asset4 data, Inditex's ESG was configured from the years 2002 through 2017. Each year, an ESG score was provided, as well as the ESG pillar scores. Regarding Stata values, the scores are out of 100. In other words, the higher the rating number is to one hundred, the more positive significance there is in relation to the pillar or ESG in total. The average ESG of all of the scores was a high 82.1 with a standard deviation of 8.07. The highest ESG was in the year 2016 with a score of 93.74, while the lowest ESG score was 67.23 in 2007. In breakdown of the pillars, the highest environmental score was 97.83 in 2016 while the lowest was 61.42 in 2007. For the social pillar, in 2016 they had a score of 99.09 while having a score of 69.10 in 2003. Lastly, they had a high governance score in 2004 of 88.62 and a 50.72 in 2011. Overall, there was an upward trend in the total ESG, environmental pillar, and social responsibility pillar, while the governance score had more fluctuation depending on the year.

It can be generalized that Inditex has performed extremely well over the years with regard to their ESG performance. Between the years 2002 and 2017, they had an average environmental pillar rating of 83.33, average social pillar of 85.50, and average governance pillar of 76.88. However, when looking at the year 2011, there is a major dip in their governance score. This can be attributed to two major aspects: executive management change and possible corruption. In 2011, CEO Amancia Ortega retired as a billionaire and Pablo Isla became his new replacement. Having a switch in CEO management can affect a governance score as there may be new and uncertain executive administration strategies. To add, there was a case against Inditex in which they were accused of 'slave labor' in

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<sup>5</sup> Images in Appendix A portray visual representations of these four categories' results.

their manufacturing company in Brazil. According to a Brazilian report released in 2015, “Brazilian federal government inspectors found 15 immigrants working and living under deplorable conditions in two small workshops in São Paulo. Workers had to work for long days – up to 16 hours – and were restricted in their freedom of movement. The inspectors later concluded that the conditions in the two workshops were to be classified as ‘analogous to slavery’. The workers were sewing clothes for Zara, a brand of Inditex, the world-renowned fast fashion pioneer from Spain. The workshops where the abuses took place were contracted by Zara’s supplier” (van Huijstee 2015). Because of their supply chain corruption within the company, it could have decreased their overall governance score in 2011.



#### b. All Sample Firms in Spain

Using the Stata software, the data was properly conditioned so that only the sample firms in Spain were being shown. There were 47 firms headquartered in Spain from which cumulated an average ESG of 65.99. It is critical to note that Inditex remained present in this sample size, as they are a firm located in Spain. From there, a clear judgment was made to say that there was a large gap between the total Spanish firms’ ESG to Inditex’s performance. Inditex, with an average ESG of 88.98, was about three standard deviations off from the Spanish ESG average. Inditex had an ESG rating of 22.99 more, or a 34.84% upside in comparison to the Spanish firms. The Spanish rating is not necessarily poor, as it

is not too far off from 100; however, it is important to acknowledge the difference between the two variables at hand and notice how positive Inditex's performance was.

**c. All Global Retailers**

Inditex is considered a "Retailer" as its industry sector. It is critical that in order to examine the significance of Inditex's ESG, that the company was compared to other firms within its sector regardless of where they are located in the world. Similarly to the sample firms in Spain, the data was conditioned so that only the retailers were exposed for comparison. There was a total of 113 global retailers, all derived from the Asset4 excel workbook.<sup>6</sup> The average ESG for all the global retailers was 52.71. Inditex's rating of 88.98 is significantly higher than the retailer average, being 36.27 values higher constituting a 68.82% upside.

**d. All Global Sample Firms – Continent Comparison**

When comparing the global sample firms, it is effective to see where the firms are headquartered and their overall ESG in contrast to Inditex's. Based off of all the sample firms provided by Asset4, the firms were able to be categorized into the following continents: Africa, Asia, Australia, Europe, North America and South America<sup>7</sup>. Starting with Africa, the average ESG for the 125 cumulative firms was a 54.17. In comparison to Inditex's 88.98 value and 64.26% upside, Africa was 34.81 points less than from Inditex. With regard to the 1,436 firms in Asia, the firms had an average ESG 51.59 while Inditex has an upside of 72.48% with 37.39 values higher. Australia's 423 firms, on the other hand, had an average ESG of 48.25 – a value that is 40.73 points below Inditex's 84.43% upside. Looking at Europe's 1,025 firms, they had an average ESG 60.60; this is 28.37 values below Inditex's 46.82% upside from the European firms.<sup>8</sup> In North America, the average

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<sup>6</sup> Inditex's was also listed in this dataset, as they are considered a retailer. This may construe the data to sway more to a positive direction, as Inditex has a high ESG.

<sup>7</sup> References (d-l) in Appendix A show visual representations of the quantitative data.

<sup>8</sup> Note that this average includes Inditex's value, as they are a European firm. This may have construed the data as Inditex has a higher ESG score than the European average.

of the 41 firms was 49.89: 39.10 points below Inditex's 78.34% upside. Lastly, the 145 South American firms had an average ESG of 50.97: 38.01 points below Inditex's 74.57% upside<sup>9</sup>.

## **ANALYSIS OF RESULTS**

Overall, it becomes quite transparent that Inditex's ESG performance is significantly higher than the variables it was compared to using the Asset4 data. It constantly had an upside of two to three standard deviation points away from the average mean than the compared ESG's.

When looking at the differences in continent outcomes, it becomes clear that Europe had the closest ESG score to Inditex, while Australia was significantly lower. Many hypothetical factors came to mind when this correlation was made: Are ESG scores made more of importance to European businesses? Do European businesses have more cash flow to fund for ESG investment? Does a developed country correlate to a higher average ESG score of its internal companies? What makes Inditex so successful in ESG, and why are some other firms lacking such a critical component in their business?

ESG can be very expensive; obtaining effective resources to implement into a business can be a substantial investment for a firm. According to a Global Sustainable Investment Alliance report released in 2018, "Globally, sustainable investing assets in the five major markets [Europe, the United States, Canada, Japan, and Australia and New Zealand] stood at \$30.7 trillion at the start of 2018". Europe invested a total of \$14.1 trillion into sustainable investing while the United States invested around \$12 trillion. Japan, as representation of a strong economic country in Asia, invested \$2.2 trillion while Australia/New Zealand invested around \$734 billion. These regions have had the highest growth in sustainable investing, by making it more of a promising focus in their business strategies. According to the same Global Sustainable Investment Alliance report, Latin American countries such as Brazil, Chile, Columbia, Mexico and Peru have made great sustainable investing strategies with regards to 'collective assets under management'; \$1.2

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<sup>9</sup> Disclaimer: the number of samples in each continent were not equal which may have caused a wider variation in ESG average outcomes. Africa listed 126 samples, Asia: 1,436 samples, Australia: 423 samples, Europe: 1,025 samples, North America: 41 samples, South America: 145 samples.



trillion accounts for the total collective assets, “although not all these assets use sustainable investment strategies” (GSIR 2018). Africa, on the other hand, had about \$400 billion in assets specifically for strategic investment. In conclusion, Europe and the United States definitely invest more into ESG strategic investment; however, that does not mean it is made more of importance. All the regions listed have accumulated a large amount of capital into ESG enhancement. It can be assumed that countries that are more developed will have additional funds to freely allocate towards ESG investment, as wealth is not much of an issue – this can be shown with the numbers listed above. Inditex, as a retailer of Europe, has successful ESG investment and allocation due to the fact that they are quartered in a region that has enough wealth to invest into it. To add, Inditex has had internal business success as a large global retailer where they have gained enough capital to allocate towards ESG strategies, rather than being a smaller company with less funds.<sup>10</sup>

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<sup>10</sup> This does not signify that a company in Europe or the USA will automatically have a higher ESG rating than a firm in regions such as Africa and Australia. It is simply a reasoning as to why a company in those regions may have an upper hand in terms of allocating resources to ESG investing.

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## **COVID-19 ADAPTATION**

Inditex did fairly exceptional during the recent COVID-19 global pandemic. They did have a €409 million loss due to the pandemic but was able to reach €214 million “in its second quarter (1<sup>st</sup> May to 31<sup>st</sup> July) ... Growth in online sales remained very high, averaging 74% year on year in the first half. One million orders [were] received in a day for the first time” (Inditex 2021). Due to the heightened amount of online shopping that was performed during the pandemic, Inditex was able to gain a competitive advantage by keeping their sale margins high. To add, they also helped their ESG sustainability by “[activating] a global emergency relief programme within [their] community investment effort to which [they] have donated over €40.4 million. That effort enabled [them] to distribute 177 million units of personal protective equipment and other necessities to where they were urgently needed” (Inditex 2021). They did so due to the fact that they had the funds needed and their quartered country needed support. They were able to keep their net cash at an all-time high at €8.3 billion.

Whether or not a higher ESG rating correlates to a smaller financial burden during a pandemic or financial crisis is controversial and not completely swayed one way or another. From the article written by Bae, a test was done that signified corporate social responsibility (CSR) did not have a direct correlation to the degree of burden that a company may experience during times of crisis (2021). In fact, the article states, “When we examine the valuation effect of CSR in the post-crash recovery period, we again find that CSR is unrelated to stock returns in either the MSCI ESG Stats or Refinitiv samples. The lack of a significant relation between CSR and stock returns during or after the crisis period suggests we should be cautious about drawing unambiguous or unconditional inferences about the positive role of CSR in preserving shareholder value” (Bae 2021). However, in many articles such as one from the *Journal of Applied Corporate Finance*, tests were completed to have concluded that “Overall, these findings indicate that more socially responsible companies experienced a smaller decline in value during the crisis, and that this effect was not due to differences in financial strength or corporate governance. These results are consistent with the view that a company’s investments in social capital provided investors with a greater sense of trust in the firm as the crisis was unfolding, leading to relative stock price outperformance” (Lins 2019). This is more transparent to my immediate hypothesis that a higher ESG would account for a better financial turnout during a financial crisis. Whether or not Inditex

had a 'better' performance *due* to their previous ESG value is arguable; however, based off of their past ESG performance and financial performance in the global financial market, it seems that their ESG could have been a contributing *factor* in their overall growth during a time of crisis.

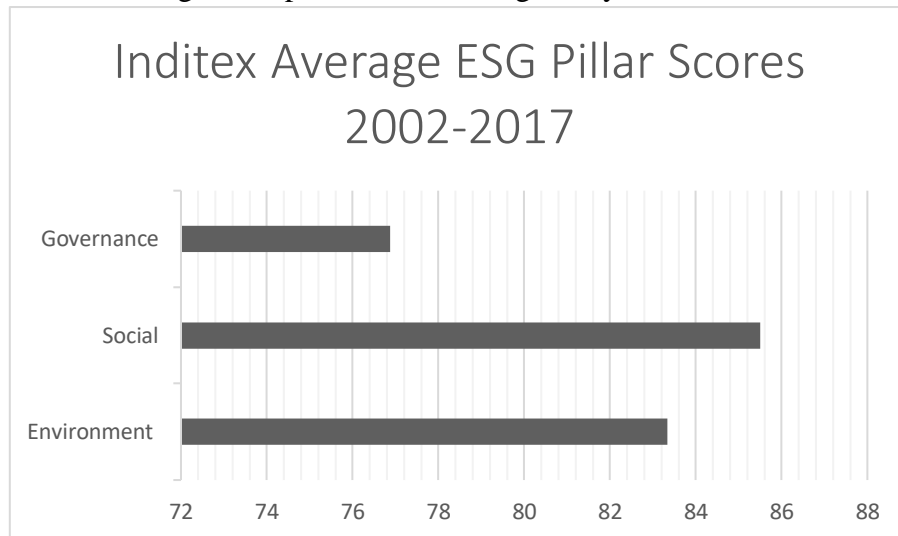
## **CONCLUSION**

Looking back at the overall question, it can be said that Inditex is a strong competitor in the fast-fashion industry and this can be portrayed through their heightened ESG score and successful financials. This study reveals how new and attractive ESG investing is as a business strategy and implementation for companies around the world. However, the study did not capture the fundamentals to a higher ESG score or successful financials. This is because the simple question of 'what comes first: the chicken or the egg?' now arises at the end of the study. Does a company need successful financials and generated cash flow to allocate towards ESG investing to have a higher ESG score, or does a company need to obtain a higher ESG score in order to raise their cash flow from outside investors to then have a more successful financial record? In a simpler question: what comes first – the financial success or a high ESG score? This study has not determined that, but rather shows there is a direct correlation between the two. Pablo Isla, the current CEO, once stated, "there is no contradiction at all between sustainability and profitability" (Patal 2019). The correlation between the two is present in this case study and Pablo Isla would agree that there is a connection between the two aspects. To add, this research study supplements overall existing research on ESG information, but as a deep-dive case study into one company. If more time was allotted, research integrating the three pillars in more depth, by using a regression factor model for example, to see what external and internal factors have the most significant correlation to a higher ESG score would have been beneficial. When looking back at the question - *Does Inditex, as representation of Zara, dominate certain performance variables over their competitors and does this relate to their successful financial implementation?* - it is appropriate to say this empirical research study proves that Inditex dominates in specific performance variables of which may be attributed to their financial success in areas of heightened revenue, profit, and increased market consumption.

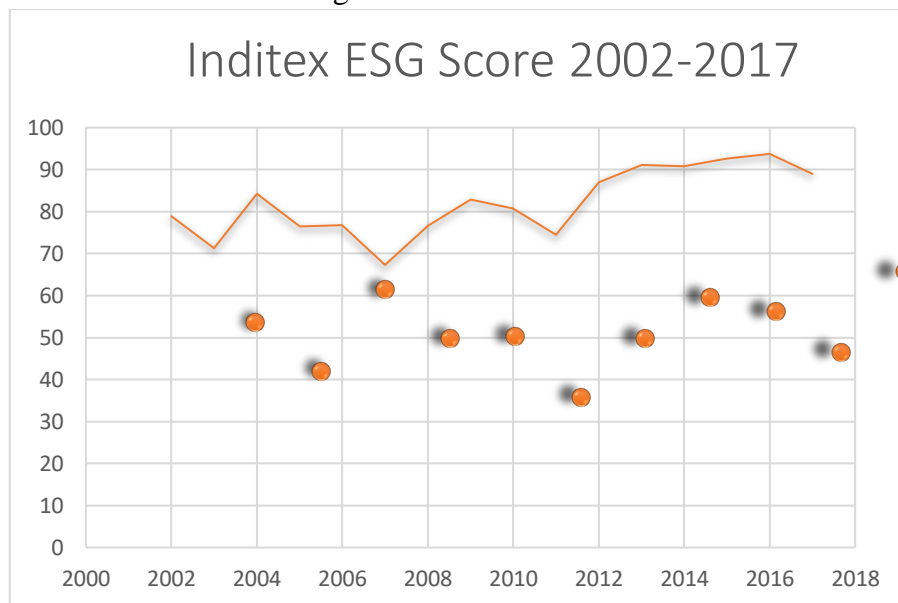
## APPENDICES

### 1. APPENDIX A- Result Charts

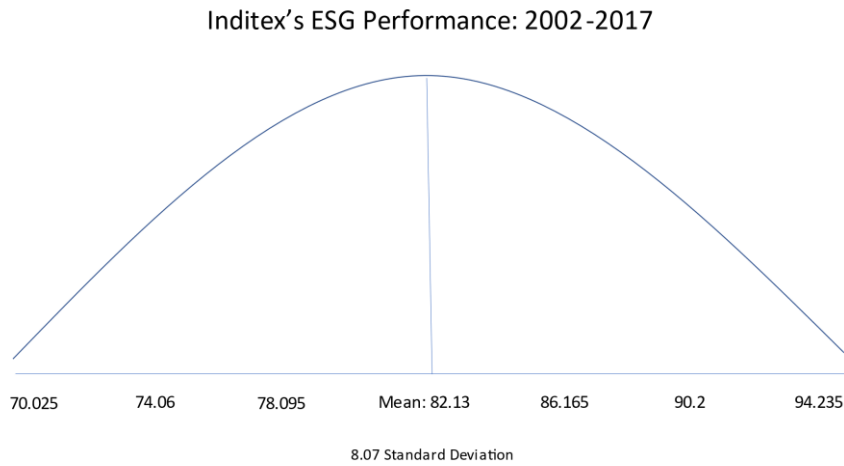
a. Inditex average ESG pillar scores through the years 2002-2017.



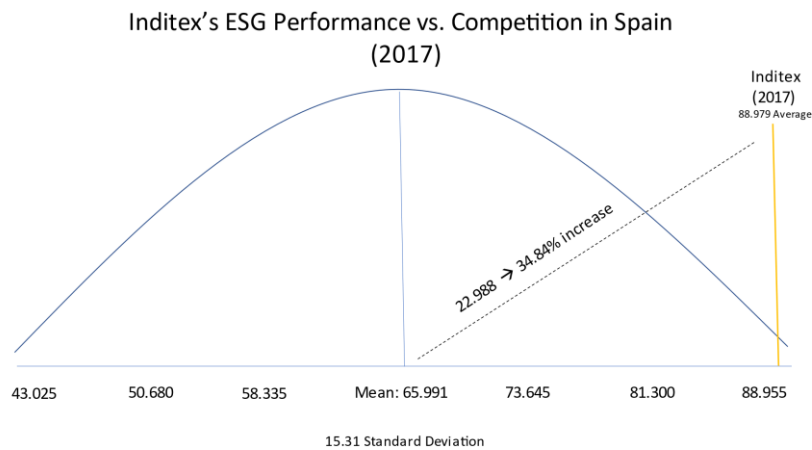
b. Inditex ESG scores through 2002-2017.



- c. Inditex's ESG Performance from the years 2002 through 2017. Stata software used<sup>11</sup>.



- d. Inditex's ESG performance vs its competitors in Spain.

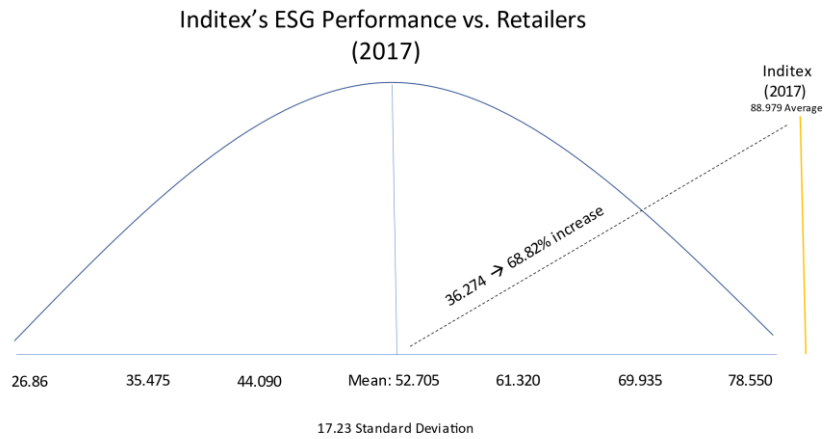


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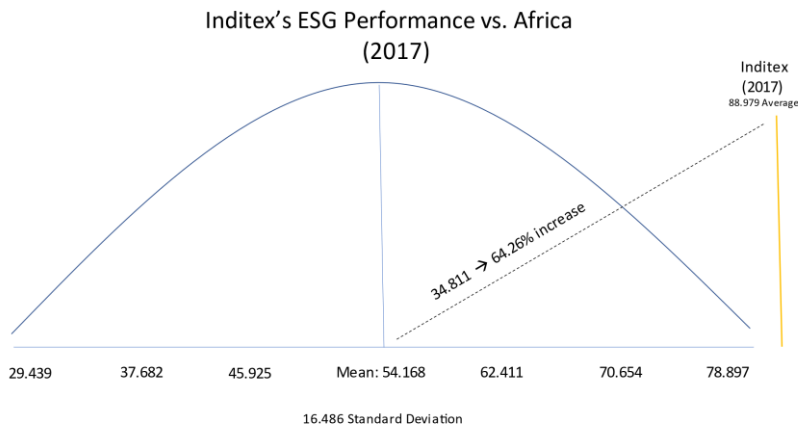
<sup>11</sup> Note that Inditex is typically three standard deviations away from the mean for all images in similar visuals.

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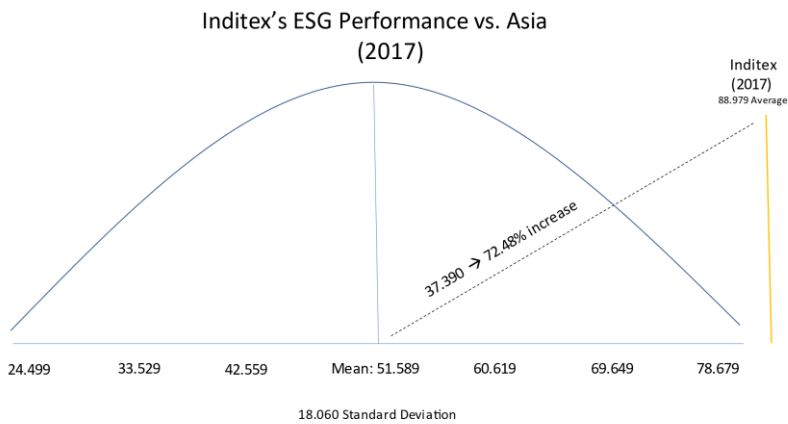
e. Inditex's ESG performance vs. all global retailers



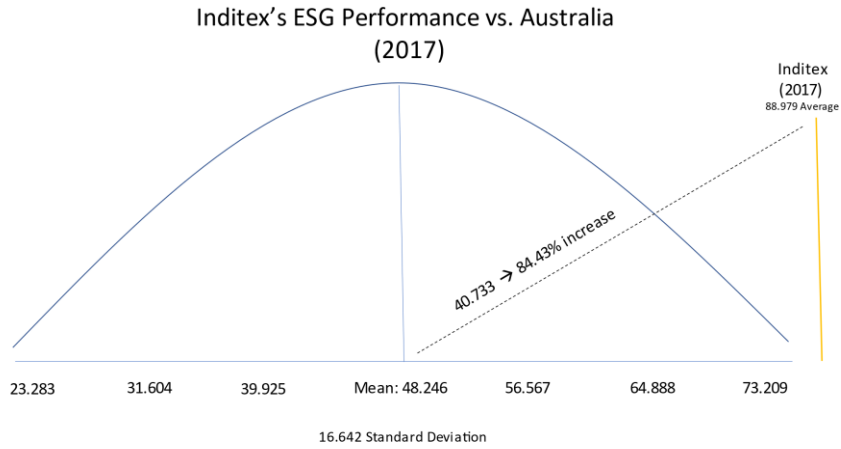
f. Inditex's ESG performance vs. Africa



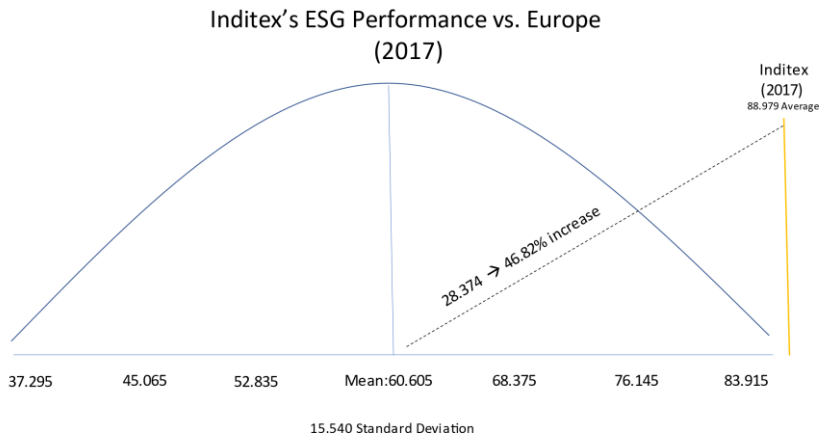
g. Inditex's ESG performance vs. Asia



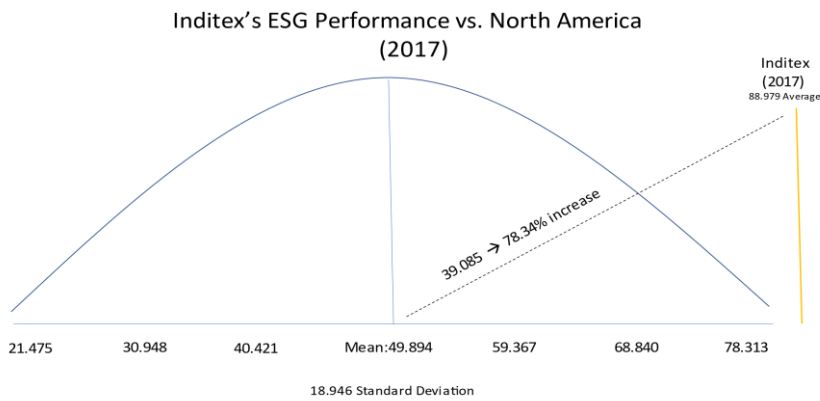
h. Inditex's ESG performance vs. Australia



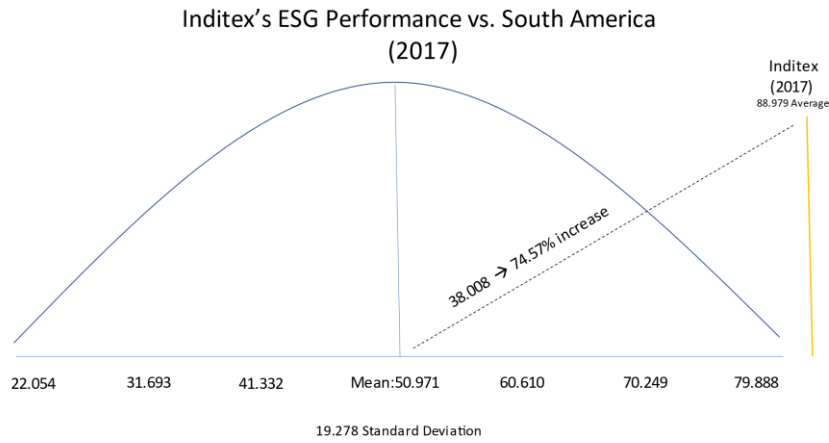
i. Inditex's ESG performance vs. Europe



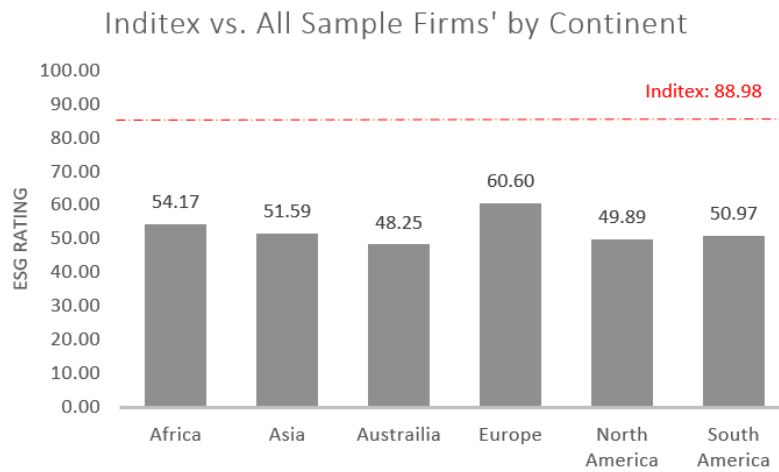
j. Inditex's ESG performance vs. North America



k. Inditex's ESG performance vs. South America



l. Inditex compared to all sample firms' ESG by continent.





**2. APPENDIX B – Additional Useful Information**

- a. Below are common performance variables that are used to determine the rating of each ESG pillar.

Performance Variables examples for each ESG Pillar		
<b>Social</b> <ul style="list-style-type: none"> <li>○ Workforce &amp; Diversity</li> <li>○ Safety Management</li> <li>○ Customer Engagement</li> <li>○ Community Development</li> <li>○ Human Rights</li> <li>○ Labor Relations</li> </ul>	<b>Environmental</b> <ul style="list-style-type: none"> <li>○ Greenhouse/Gas Emissions</li> <li>○ Waste &amp; Pollution</li> <li>○ Land &amp; Water Use</li> <li>○ Clean Technology</li> <li>○ Climate Change</li> <li>○ Sustainable Resources</li> </ul>	<b>Governance</b> <ul style="list-style-type: none"> <li>○ Code &amp; Values</li> <li>○ Data Privacy &amp; Security</li> <li>○ Executive Compensation</li> <li>○ Anti-Corruption Policies</li> <li>○ Corporate Political Contributions</li> </ul>

- b. The image below shows where Inditex stores are located (in red). The region circled in blue shows the main manufacturing facility locations.



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# Port Congestion Chaos and Our Remedy

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## Abstract

Seaports are the pillar of the global economy, as 90% of global trade is done by sea. This research investigates the global shipping chaos that is straining the economy and causing supply chain bottlenecks at seaports worldwide, particularly in the United States. We investigate the port congestion chaos, which has become a serious global supply chain issue that needs to be urgently addressed. Information is collected from various sources including news and business articles, studies, statistics portals, dissertations, and case reports. Our analysis based on the above sources suggests that collective factors, including U.S. resistance to automate ports, lack of cooperation from longshore worker unions, poor port infrastructure, and driver shortages, lead to port inefficiency. In order to stop the U.S. port congestion chaos, which likely will carry on deep into 2022 and beyond, tough decisions must be made and partisan politics needs to be put aside.

**Key words:** supply chain, infrastructure, port congestion, port automation, ocean transportation

## 1. Introduction

American ports are in the middle of an ongoing port congestion crisis, which is dramatically impacting the flow of goods to consumers. The COVID-19 Pandemic and the fluctuation in supply chain demand has put the deficiencies of the U.S. port system on full display, as an unprecedented

number of ships carrying billions of dollars in goods are waiting days and sometimes weeks to enter America's two busiest container ports, Los Angeles and Long Beach.

Recognizing that 90% of global trade is done by sea, the United States must identify its problems and determine a way to remedy its bottleneck issues to keep our economy healthy. Many experts believed the demise of globalization was on the horizon as the volume of cross-border trade in goods and services was falling at a record pace in 2020. Indeed, global trade fell by 18.5% in the second quarter of 2020 as the COVID-19 Pandemic shook the economies of nations worldwide (Dollar, 2020). However, the tide started to turn in the latter half of 2020, with global trade rebounding due to supply chain developments in Asia and China and consumer preferences shifting from services to durable goods. While the COVID-19 Pandemic continues to devastate countless people and industries, international trade has actually surged since 2021. This swell in international trade can be attributed to record-high global connectedness rates (Broom, 2021). Forecasts from the World Trade Organization say that global merchandise trade volume will grow by 10.8% in 2021 and subsequently by 4.7% in 2022 (Swanson, 2021). Taking this anticipated growth into consideration, remedy to resolve the congestion problem is in urgent need.

This paper looks at the different facets of global maritime shipping and examines underlying problems in the U.S. ports. Ultimately, suggested remedies are presented. We start our research with the collection of information related to the port congestion issue. We then analyze the background issues of the problems and address them one by one through our proposed remedies. In particular, we explain how automation, longshore workers, port infrastructure, the trucking industry, and politics are all intricately interwoven and addresses the hard decisions that must be made by American politicians for the U.S. economy to thrive, not only during the COVID-19 Pandemic but for decades to follow. The U.S. port system will need to undergo a myriad of

changes, as will be addressed in this paper. As we are finishing this paper, we have observed the Ukrainian-Russian war and the recent COVID-19 lockdowns in China, which are stalling and changing port traffic for container vessels worldwide. Surely, these developments will add additional complications and logistical nightmares.

## 2. Literature

Many recent papers on port congestion chaos papers simply describe the phenomena. For example, they detail the recent Southern California shipping jam and discuss how it is having a ripple-down effect on a reeling supply chain that is already suffering because of the COVID-19 pandemic (Hanbury, 2021; Dalheim, 2021, LaRocco, 2021; Baertlein, 2021; Gui et al., 2022). Others investigate the effects port congestion on maritime transportation freight rates (Bai et al., 2021; Wang et al., 2020).

Among those pre-COVID-19 papers, some detail various port congestion categories (e.g, ship berth congestion, vehicle gate congestion, cargo stack congestion, ship entry/exit route congestion, etc.) and examine the port-calling chain zones where congestion most often emerges (Gidado, 2015; Meersman et al., 2012). Loh & Thai (2015) analyze the consequences of a port-related supply chain disruption by taking into account important aspects like port functionality and resilience. Interestingly, Jiang et al. (2017) investigate shipping lines' congestion internalization and congestion delays passed on from one port-of-call to another. They find that if a liner's operation increases in one terminal, its operation decreases in another.

Many recent articles address the chaos through the lens of the recent COVID-19 Pandemic crisis (Plimmer, 2021; NAM News Room, 2021). Several articles explain that the recent Southern California Coast congestion is caused by a surge in imports resulting from the shift in U.S. consumer demand (Berger, 2021; Zeiger, 2021). Xia (2021) discusses the origins of the port

congestion issue and propose a few solutions briefly. In our paper, we conduct further analysis research to find out the causes of the chaos and then propose remedies.

### 3. Investigation of the Port Chaos

#### **America's Busiest Ports are Straining the Global Supply Chain**

There is unquestionably a severe capacity issue in the U.S. port system. In 2020, the Port of Los Angeles and the Port of Long Beach were respectively the world's 17<sup>th</sup> and 22<sup>nd</sup> largest container ports by traffic volume (World Shipping Council, n.d.). Los Angeles and Long Beach, the two largest ports in the United States, are only 3 miles apart. When referred to collectively, the Los Angeles and Long Beach ports are termed the San Pedro Bay Port Complex, which is the 9<sup>th</sup> largest port in the world. The San Pedro Bay Port Complex moves 40% of U.S. container imports and 30% of the U.S. exports (The Port of Los Angeles, 2021). Yet, it still had less than 40% of the 2020 container traffic volume of the Port of Shanghai, which is the world's largest port. Indeed, 7 of the world's top 10 largest ports in terms of container traffic volume are in China (World Shipping Council, n.d.). By contrast, despite being the largest consumer market and second largest exporter, the U.S. does not have any port that ranks in the top 10 in the world (World Shipping Council, n.d.).

Conventional wisdom would suggest that the top-ranked Chinese ports would bear the brunt of the fallout from the COVID-19 Pandemic problems and the other supply chain interruptions. However, much of the congestion Chinese ports have faced has simply been related to the Chinese government's enforcement of health and safety mandates and these problems should dissipate when the Chinese government mandates are lifted (project44, 2021). As a result of the recent lockdowns in China, China's ports now account for roughly 33% of the global container backlog. That percentage was only at 14.8% before the lockdowns. However, the Shanghai port

continues to operate and has not suffered severe delays as for now, as its closed loop system keeps staff on-site (Barrett, 2022). Conversely, in the U.S., health and safety regulations are not the crux of the problem, and port congestion is leading up to a full-blown shipping crisis. Unprecedented turmoil in the U.S. supply chain caused by shipping delays has resulted in rising prices and empty store shelves, with no simple solutions in sight.

In a nutshell, the U.S. container logistics market is in shambles and there is congestion at major U.S. ports from New York to Savannah to Houston. Yet, in spite of the rest of the country's problems, the sheer number of vessels waiting to unload cargo outside of the Los Angeles and Long Beach ports is unmatched. A record backlog of 111 container ships, carrying \$25 billion worth of goods, were stuck off the Southern California Coast during the second week of November in 2021 (Hanbury, 2021). As for the containers actually at the San Pedro Bay Port Complex waiting to be unloaded, almost 59,000 of them had been sitting there for 9 plus days, classifying them as "lingering" cargo containers (LaRocco, 2021).

These numbers are staggering given that a month earlier, on October 13<sup>th</sup>, President Biden announced 24/7 operations at the Los Angeles and Long Beach ports (Lockridge, 2021). Also, on October 25<sup>th</sup>, Biden made a "Container Dwell Fee" announcement stating that for every day a container moving by truck lingers past 9 days, shipping companies will be fined \$100 per day until the container leaves the terminal. For a container moving by rail, the maximum dwell time is just 6 days (Macias, 2021). The start date on this Container Dwell Fee initiative has been postponed numerous times and some anticipate that the dwell fee will not ultimately be implemented, given that there has been an overall 46% decrease in long-dwelling port cargo since the October 25<sup>th</sup> announcement (Dalheim, 2021). After a long series of postponements, the most recent update is



that the Port of Los Angeles and the Port of Long Beach have extended the Container Dwell Fee program through July 28, 2022 (POLB, 2022).

### **Container Congestion Crisis**

Many of the world's biggest ports are suffering from severe port congestion in recent months, so named "Containergeddon." Goods are being stranded at ports worldwide, leaving businesses that rely on delivery of goods and services in limbo. Currently, most of the imports that American consumers are demanding are coming from East Asia. Consequently, there is a historic surge of cargo volume coming into America's west coast ports, which are among the world's most inefficient ports. With the demand being so one-sided, shipping companies can charge substantially more to bring goods to the West Coast from Asia than the other way around.

### **Slow Processing at Major North American West Coast Ports**

In May 2021, the Port of Long Beach announced plans to automate its 385-acre Pier T Terminal (Mongelluzzo, 2021). Then, in August 2021, the \$1.5 billion Long Beach Container Terminal at Middle Harbor was completed after 10 years of construction (Littlejohn, 2021). Using electric, automated, and emission-free equipment, the state-of-the-art Middle Harbor Terminal is being billed as the "greenest terminal on the planet" (Richardson, 2021).

Despite the recent modernization efforts, major North American west coast ports still pale in comparison to ports overseas in terms of processing times. For instance, the Long Beach, Los Angeles, and Vancouver ports require an average of 76 seconds to move a container on large vessel calls. In comparison, the average speed at Hamburg, Rotterdam, and Antwerp, the three biggest North European ports, is 46 seconds. Yet, moving a container on large vessel calls only takes an average of 27 seconds at the Port of Singapore and the Shanghai, Yantian, and Ningbo Chinese ports (Tirschwell, 2021). This means it takes the San Pedro Bay Port Complex almost three times

longer to move a large container than its Chinese competitors, which is a huge factor in its abnormally long 2021 ship turnaround time.

### **Long Ship Turnaround Times**

There is perhaps no bigger port performance indicator than ship turnaround time, which is defined as the time elapsed between the arrival of a ship and its departure (CogoPort, n.d.). Simply put, it is the total time spent by the ship at a port. Ship turnaround time is typically a function of port facilities, tending to be shorter at ports with an integrated transport system and truck appointment systems at terminal gates (Port City Logistics, 2021). Ship turnaround time exhibits a port's ability to provide efficient services, so it is also largely dependent on sound port operations.

A short turnaround time indicates that a port is decreasing container discharge times and thus, clearing congestion. However, according to RBC Capital Markets analysts, 77% of the world's major ports experienced above-average ship turnaround times in 2021 (Shah, 2021). Unsurprisingly, of all the major ports, the San Pedro Bay Port Complex had the highest average ship turnaround time in 2021. In fact, its average ship turnaround time was 6.4 days in 2021, significantly higher than the 3.6 days it averaged from 2017 to 2019 (Shah, 2021). Despite seeing a 30% increase in the amount of goods going through the San Pedro Bay Port Complex in 2021, foot traffic is 28% below pre-pandemic levels (Kay, 2021). Put bluntly, the Los Angeles and Long Beach ports' inefficiencies have been exposed with the recent surge of cargo volume.

### **Inefficiency of U.S. Ports**

The World Bank's newly launched Container Port Performance Index (CPPI), which is based on total port hours per ship call, examines key factors such as dwell times and port infrastructure to rank the world's 351 container ports by efficiency (World Bank Group, 2021). The CPPI uses factor analysis to reduce a large port variables dataset into a CPPI ranking score that is single

weighted (Bichou, 2021). The statistical approach rankings show that Asian ports are the world's most efficient, as China alone has five ports that rank in the top 10. Ports in the Middle East and North Africa also rank highly. Notably, no U.S. port cracks the rankings' top 80 and only six U.S. ports even crack the top 150 – Philadelphia (83<sup>rd</sup>), Port of Virginia (85<sup>th</sup>), New York & New Jersey (89<sup>th</sup>), Charleston (95<sup>th</sup>), Boston (113<sup>th</sup>), and Baltimore (138<sup>th</sup>) (The World Bank, 2021). Needless to say, American ports are failing to make the grade on efficiency, particularly on the West Coast.

Indeed, Los Angeles and Long Beach are among the world's very least efficient ports. They rank 328th and 333rd in efficiency respectively, putting them in the bottom 7%. Other U.S. West Coast ports Oakland (332nd) and Tacoma (335th) rank just as low (The World Bank, 2021). It is inconceivable that four main U.S. West Coast ports rank below the Port of Lomé in Togo, an extremely poor country with a 55.1% poverty rate (World Population Review, 2021). Also ranking in the bottom 25% of global efficiency were other major U.S. ports New Orleans (265th), Houston (266th), and Savannah (279th) (The World Bank, 2021). Sadly, these CPPI rankings suggest the U.S. is largely at-fault for the worldwide container shipping industry's lack of balance.

### **Containers Lost At Sea**

The recent surge in consumer demand has resulted in increased containers being packed onto each ship, resulting in jumbled container positioning. Freight containers are being piled up higher than ever, causing a dramatic rise in numbers of containers being lost at sea. Poor container loading and securing practices are being exposed as well. The year 2020 experienced an all-time lull in global trade during its second quarter. Still, over 3,000 containers fell overboard in 2020, marking the highest yearly total since 2013 (Koh, 2021). During a two-month period from late November 2020 through January 2021, there were 2,675 containers lost at sea, from five isolated incidents

(Gil, 2021). This is a staggering number given that between 2008 and 2019, the yearly average of lost containers at sea was just 1,382 containers (Childs, 2021; Link-Willis, 2021).

Lost at sea containers, although still a very small chance, are increasing at an alarming rate. As container ships are larger and filled to higher capacities, ports are facing growing pressure when it comes to loading/unloading cargo and securing freight containers in ships before they undock. The U.S. ports are not handling these mounting pressures adequately, and more attention should be given to correct the problems.

## 5. Causes & Remedies

### **Causes of Extended Wait Times at U.S. Ports**

#### ***Shortage of Longshore Workers***

One reason for the abnormally long turnaround times is that there's a shortage of longshore workers, who are responsible for securing and then unloading/loading the ships arriving at ports. Longshore workers are responsible for getting 90% of U.S. consumer goods into the country. Longshore workers have historically been among the highest paid blue-collar workers; they also have established very powerful worker unions. In fact, in 2015, when a labor impasse threatened to shut down the entire port system on the U.S. west coast, the Pacific Maritime Association reported the average annual salary of a full-time longshore worker was \$147,000, plus generous healthcare and pension benefits (Rede, 2015). This salary dwarfs the pay of other logistics employees, as the average U.S. Amazon warehouse worker today makes just over \$32,000 (ZipRecruiter, 2021).

Unless there is an increase in the number of longshore workers, slow operations speed will continue to be an issue. It is likely that an increase in workers will be met with resistance if it coincides with lower pay, but this is a complex logistical problem that needs to be dealt with.

### ***Poor Port Infrastructure***

Secondly, poor port infrastructure is at the root of the long ship-discharge time problem, as bridge or depth limitations restrict many U.S. ports from receiving large or post-Panamax vessels. A post-Panamax vessel is a massive ship with a carrying capacity between 85,000 and 110,000 DWT (Dead Weight Tonnage) that can fit within the Panama Canal (Yieldstreet, 2019). The increase in large ship cargo is overwhelming the outdated infrastructure near many ports. The result is that most container traffic on large vessels is flowing through only the select few U.S. ports that have the onshore and offshore capacity to handle them, which includes the Los Angeles and Long Beach ports as well as the Seattle and Tacoma ports (DePuyt, 2021). As a matter of fact, these west coast ports are the only U.S. ports able to handle Post-Panamax III vessels, which are the largest container ships requiring a channel depth greater than 50 feet (The Geography of Transport Systems, 2021). Channel depth limitations for accessing many east coast ports exist because the St. Lawrence Seaway limits access to the Atlantic Ocean. Major east coast ports Philadelphia and Charleston can only handle container ships up to 6,000 TEU. Boston, MA and Wilmington, NC are even more limited in access (The Geography of Transport Systems, 2021). Specifically, Wilmington is a prime example of a U.S. port hindered by inadequate channel capacity. Despite being only a few miles from the Atlantic Ocean, commercial ships have to travel 26 miles up the shallow winding waters of the Cape Fear River in order to offload goods at Wilmington's port (Mannion, 2017). The water paths are also not wide enough, making it difficult for ships to turn around and head back to sea (Reed, 2021).

President Biden recognized that U.S. port infrastructure needed funding. So, as part of the \$17 billion Infrastructure legislation to improve port infrastructure, \$2.6 billion is targeted for equipment upgrades, but not for port automation (Boehm, 2021). Undeniably, U.S. ports are

lagging far behind overseas ports automation-wise. Chinese port terminals operate 24/7 with many automated tasks. The Port of Rotterdam, which ranks top 10 globally in efficiency and capacity, is the most automated port in the world (Scharffetter, 2020). Moreover, the world's busiest port, the Port of Singapore, has invested \$10 billion and counting in port automation projects (Moore, 2021).

Likely, the reason that port automation is not included in the budget is because Unions have been known to protest through work slowdowns or strikes, as they did in 2015. During the 2015 labor dispute between 14,000 west coast longshore workers and the major shipping companies, the International Longshore and Warehouse Union (ILWU) staged work slowdowns that were estimated to cost the economy \$2 billion per day (Pinsker, 2015). Especially considering the current labor shortages and cargo delays, the President does not want to risk angering longshore workers. So, politics in appeasing the unions are taking precedence over the practicalities that are calling out for greater port automation.

Clearly, the U.S. needs to undergo systematic changes to match the performance of foreign ports, and a focus on port automation is necessary. Equipment upgrades at port terminals are needed. Automating ports would also provide truck drivers with more consistent loading schedules, which would help improve the ongoing issues in the trucking industry.

### ***Shortage of Truckers***

Hauling over 70% of domestic cargo shipments, the trucking industry's significance to the global supply chain cannot be overstated (Lee, 2021). Before the COVID-19 pandemic, trucking companies had been growing rapidly as the economy expanded. When the COVID-19 Pandemic hit and the lockdowns started, trucking industry lost more than 88,000 jobs in April 2020 (Cassidy, 2020). The surge in customer demand has left many truck fleets unable to hire enough drivers, as

the trucking industry is short a record 80,000 drivers (Yurkevich, 2021). Intensified freight backup, pay, long hours, and retention are all plaguing the trucking industry.

One of the main factors worsening the truck driver shortage is the crackdown on drug and alcohol program violations. Since the Federal Drug & Alcohol Clearinghouse was established in January 2020, government data shows that 72,000 U.S. truck drivers have been barred from work (Jones, 2021). To date, 56% of all Clearinghouse violations have been for marijuana use (Fickenscher, 2021). The challenge for dealing with marijuana-related failed drug tests is that marijuana can stay in one's system for 30 days or longer, long after the intoxicating effects have worn off (McKnight, 2021). A driver may test positive for marijuana and actually be perfectly safe to drive. Predictably, many have been calling for tests on real-time impairment. Undoubtedly, strict marijuana crackdowns continuing to take drivers off the road will only worsen the already chaotic port congestion problem. Now that marijuana is legal throughout so much of the country, This raises the question of whether the method of determining a driver's impairment needs to be updated.

The surge of freight has left port truckers who make those short runs tired and burned out. Some port truckers who make those runs have switched to become long-haul drivers and others have turned to local delivery work or have just left the industry altogether, opting for jobs with more predictable hours (Evans, 2021). With all the turnover, the American Trucking Association estimates that 1 million new drivers will have to be recruited into the industry over the course of the next decade (McNally, 2021). There needs to be improvement in driver training and education as well as a change in the perception for truck driving careers. The marijuana crackdowns on truck drivers also especially make it difficult to recruit additional drivers in California, where marijuana has been legal for recreational use in the state for nearly 5 years. Obviously, there is an immediate

need for drivers to unload and load cargo at the bottlenecked Southern California San Pedro Bay Port Complex. In the long term, the possibility of utilizing automated trucks as well as increasing reliance on railway could provide alternative options to sole reliance on truck drivers.

### **Warehouse Shortage**

Finally, the warehouse vacancy rate recently dropped to an all-time low of 3.6% and first-year rental rates have jumped nearly 10% in 2021 (Street, 2021). If this trend continues, securing increased warehouse space near ports will be more difficult than ever. With the surge in consumer demand and spending, there are more goods needing to be stored. Linking this with a lack of warehouse space is a disaster in the making for U.S. ports. A shortage of truckers and longshore workers combined with a lack of warehouse space is causing even greater disruption in the global supply chain. There needs to be a higher priority in the communities surrounding ports to invest in warehousing facilities.

## 6. Conclusion

In conclusion, fluctuation in supply chain supply and demand has resulted in a global shipping crisis and there are record traffic jams outside of major U.S. ports, particularly the Port of Los Angeles and the Port of Long Beach. The congestion in U.S. ports is caused by collective results of disarray and lack of sufficient automation, outdated infrastructure, shortage of truck drivers, longshore workers, and warehouse space. Also, politics continue to get in the way of making practical decisions. Port congestion has already become a bottleneck in U.S. supply chain management. The U.S. must be willing to adapt on the maritime front if it seeks to remain economic development and prosperity.



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## SHUFFLED FROG LEAPING ALGORITHM FOR SOLVING MULTI-OBJECTIVE U-SHAPED DISASSEMBLY LINE BALANCING PROBLEM

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### **Abstract**

Environmental protection is getting much needed attention since pollution and waste problems are accelerating in the world. One obvious example is the speed at which electronic and electrical devices are updated and introduced in the market resulting in alarming number of end-of-life (EOL) products than before. With increasing environmental protection awareness, traditional practice of landfilling EOL products is discouraged and, in many cases, banned. Consequently, ecofriendly ways like product recovery are becoming much more important. Product recovery not only aims to reduce the number of EOL products sent to landfills but also tries to recover parts and materials from EOL products. In product recovery, remanufacturing, reuse, and recycling are three popular options. Disassembly is the first and one of the most important steps in product recovery. Disassembly tasks are performed on a paced disassembly line linked with workstations. Disassembly lines are of various types. Of these, U-shaped disassembly line allows operators and/or robotic machines to work across the parallel positions of the workstations which improves the efficiency and effectiveness of disassembly line. To achieve best objective values, balancing the disassembly line is most important. Real world disassembly cases are complex and single profit, or a cost-oriented objective is not enough or practical. In this research, four objectives viz., minimizing the number of workstations, balancing the line smoothness, removing hazardous part(s) early, and removing high demand part(s) early, are considered. Since disassembly line balancing problem (DLBP) belongs to the NP-hard class, a novel meta-heuristic algorithm called Shuffled Frog Leaping (SFL) algorithm is proposed to help find near-optimal solution(s). A case study is considered and the SFL algorithm is implemented and tested on a U-shaped line and a straight-line separately. The case study shows that U-shaped disassembly line is superior to the traditional straight-line disassembly line. Results show that SFL can find optimal solution(s) and has better performance compared to several meta-heuristic algorithms in many aspects.

**Keywords:** Remanufacturing, Disassembly line balancing problem (DLBP), U-shaped disassembly line, shuffled frog leaping (SFL) algorithm.

## Introduction

Fast updated electrical and electronic products attract individuals to purchase them as they are introduced in the market (Li and Janardhanan, 2021). However, one obvious consequence is that the number of end-of-life (EOL) products generated is getting increasingly large. This problem can lead to waste and is one of the most critical problems around the world since it threatens the health of both the environment and individuals (Wang et al., 2021). Therefore, green concept should be added to dealing with EOL products. Gungor and Gupta (1999b) first highlighted the concept of environmentally conscious manufacturing and product recovery (ECMPRO) and this research aims to add to environmental protection of the whole life cycle of a product. Product recovery is a relatively ecofriendly option compared to the traditional method of landfilling (Akpınar, Ilgin, and Aktas, 2021). In product recovery, three popular options exist, viz., remanufacturing, reuse, and recycling. Disassembly is the first and one of the most important steps in product recovery. Harmful substances, high demand parts and usable parts are separated after disassembly. Disassembly tasks are operated on a paced disassembly line linked with different workstations. U-shaped disassembly line is used which a special line type that allows operators or robotic machines to work across the workstations leading to improved line efficiency and effectiveness. Balancing the disassembly line is most critical for optimum operation of the line. In real world industrial cases, disassembly of EOL product is complex and complicated. Thus, the goal of disassembly is not only aiming at recovering usable parts, but also considering other problems like line smoothness and environmental protection. That means, only a profit or cost-based objective is not enough or suitable. In this research, four objectives viz., minimizing the number of workstations, balancing the line smoothness, removing hazardous part(s) early, and removing high demand part(s) early, are considered. Disassembly line balancing problem (DLBP) was first proposed by Gungor and Gupta (1999a), which aims to optimally assign disassembly tasks to different workstations within the domain of precedence relationships and cycle time constraints.

The rest of paper is structured as follows. Literature review is included in the next section. The third section presents a mixed-integer non-linear programming mathematical model, detailed constraints, and the description of DLBP. This is followed by a section that covers detailed results and comparison of the performance of several algorithms. The last section provides the conclusion and directions for future research.

## Literature review

In DLBP research, there are four popular disassembly line types, viz., straight-line, parallel, U-shaped, and two-sided. Many of previous studies consider straight-line disassembly line. The use of U-shaped layout is limited. U-shaped disassembly line was first applied in Agrawal and Tiwari (2008) and they proposed a collaborative ant colony algorithm to find optimal solutions. Avikal and Mishra (2012) and Avikal, Jain, and Mishra (2013) introduced different heuristic methods to balance a U-shaped disassembly line. Zhang et al. (2018) combined genetic algorithm with pareto hybrid ant colony optimization to solve multiple objectives. Li, Kucukkoc, and Zhang (2019), for the first time, studied sequence-dependent U-shaped DLBP with iterated local search method. Wang, Gao, and Li (2020) considered partial disassembly on a U-shaped disassembly line. Most recently, Li and Janardhanan (2021) designed a mixed-integer linear programming model to figure out U-shaped partial destructive mode of DLBP. Yao and Gupta (2021a) and Yao and Gupta (2021b) have, for the first-time, applied cat swarm algorithm (CSO) and small world optimization algorithm (SWO) on a U-shaped disassembly line respectively. Wang et al. (2021) combined a meta-heuristic algorithm with multi-criterion decision making (MCDM) and variable neighborhood search (VNS) theory to balance a U-shaped layout. Yao and Gupta (2021c) and Yao and Gupta (2021d) introduced ant colony optimization algorithm (ACO) and invasive weed optimization algorithm (IWO) on a U-shaped line respectively and compared their performances with several other meta-heuristics. Li et al. (2021) improved two meta-heuristic algorithms to help solve multi-objective U-shaped DLBP. Yao and Gupta (2021e) and Yao and Gupta (2021f) implemented and tested teaching-learning-based optimization algorithm (TLBO) and fish school search algorithm (FSS) on a U-shaped disassembly line respectively.

After Gungor and Gupta's (1999a) pioneering work in DLBP, many theories and methods have been continually applied on DLBP. Exact methods and mathematical approaches could find optimal solution(s) in a short time for small-sized instances. However, they cannot find optimal solution(s) in reasonable computational time for large-sized, practical instances. McGovern and Gupta (2007) systematically proved that DLBP belong to NP-hard class, and since then novel heuristics and meta-heuristic algorithms have been proposed in the DLBP area. Inspired by natural memetics, shuffled frog leaping algorithm (SFL), which is a population-based cooperative search algorithm, was first introduced in the paper by Eusuff and lansey (2003). In this paper, this meta-heuristic algorithm is implemented and tested on a U-shaped and a straight disassembly line and their performances are compared with the performances of several other meta-heuristic algorithms.

To the best of the authors' knowledge, SFL, for the first time, has been applied on a U-shaped disassembly line in this paper. A real instance is used to help compare the performance of SFL and the performances of other meta-heuristics. Results show that SFL has a better performance in some

areas. In addition, the same case was performed on both a U-shaped disassembly line and a straight-line configuration and compared. The results show that the U-shaped layout indeed has some advantages compared to the straight-line layout, especially when considering line smoothness.

### **Problem definition**

Disassembly line balancing problem (DLBP) aims to optimally assign tasks to workstations to fulfill multiple objectives and predefined constraints. Four objectives are considered in this paper, viz., minimize the number of workstations, minimize the total of idle times, remove hazardous part(s) early, and remove high demand part(s) early. Two constraints considered are precedence relationship constraint and cycle time constraint. Precedence relationship constraint describes tasks' sequencing order and cycle time constraint ensures that the cycle time will not be exceeded. The assumptions of the problem are as follows:

1. Complete disassembly is considered in this paper.
2. There is only one type of EOL product and the number of EOL products is enough.
3. Task processing time is known and deterministic.
4. Cycle time is known.
5. Sequence-dependent relationship is not considered in this paper.

### **Notation**

$N$  Number of tasks

$i, j$  Task index,  $i, j = 1, 2, \dots, N$

$M$  Number of workstations

$m$  Workstation index,  $m = 1, 2, \dots, M$

$ws_m$  binary variable, 1, if workstation  $m$  is opened; 0, otherwise

$t_i$  Processing/removal time of task  $i$

$h_i$  binary variable, 1, if task  $i$  is hazardous; 0, otherwise

$d_j$  demand value of task  $j$

CT Cycle time

$T_m$  Total task processing times of workstation  $m$

$F_a$  Objective function,  $a = 1, 2, 3, 4$

### **Decision variables:**

$x_{im}$  1, if task  $i$  is assigned at the front side of workstation  $m$ ; 0, otherwise

$y_{jm}$  1, if task  $j$  is assigned at the back side of workstation  $m$ ; 0, otherwise

$s_i$  Position number of task  $i$  in sequence

### Objectives:

$$\text{Min } F_1 = \sum_{m=1}^M w s_m \quad (1)$$

$$\text{Min } F_2 = \sum_{m=1}^M (CT - T_m)^2 \quad (2)$$

$$\text{Min } F_3 = \sum_{i=1}^N (s_i * h_i) \quad (3)$$

$$\text{Min } F_4 = \sum_{i=1}^N (s_i * d_i) \quad (4)$$

The first objective is to minimize the number of workstations. Equation (2) is non-linear with the goal of balancing line smoothness. Equation (3) presents removal of hazardous part(s) early and equation (4) tries to remove high demand part(s) early. Since four different objectives are used in this paper, pareto optimal theory is proposed to classify near-optimal solutions.

### Constraints:

$$\sum_{m=1}^M (x_{im} + y_{im}) = 1 \quad (5)$$

$$\sum_{i=1}^N (x_{im} + y_{im}) \geq 1 \quad (6)$$

$$CT \geq T_m \quad (7)$$

$$x_{im}, y_{im} = \{0,1\} \forall i, m \quad (8)$$

Constraint (5) strictly follows the rule that one task can only be assigned to one side of one workstation. Constraint (6) describes one workstation can perform one or more tasks. Cycle time constraint is presented in (7), which means the predetermined cycle time should be larger than or equal to the total task processing times at each workstation.

### Results

SFL algorithm was coded in MATLAB software on Apple M1 and implemented and tested on a straight-line and a U-shaped line separately. Case instance used in this paper is acquired from McGovern and Gupta (2006) and is used to test the ability of SFL algorithm for solving DLBP. SFL is run 20 times on a straight-line disassembly line and a U-shaped disassembly line separately. Case information, viz., task number, task processing time, hazardous index, and demand value are shown in Table 1. Precedence relationship diagram is not presented, but it is coded in testing SFL algorithm.

**Table 1.** Case information

Task number	Task processing time	Hazardous index	Demand value
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

Since pareto optimal theory is used to help classify near-optimal solutions, Table 2 presents part of the solutions found by 20-runs. There are total of eight solutions presented in Table 2, four for the straight-line and four for the U-shaped disassembly line. In Table 2, all these solutions found the best value of minimizing the number of workstations. The first solution of U-shaped line found the best value of  $F_2$ , which is 207. Three solutions found the optimal value of  $F_3$ , which means hazardous part (task 7) can be removed in the third place. Also, the last solution of U-shaped line found the best value of removing high demand parts early. Comparing with straight-line disassembly line, U-shaped layout indeed has a better performance, and it is superior at reducing line idle times.

**Table 2.** Performance of straight-line and U-shaped disassembly line

Line type	$F_1$	$F_2$	$F_3$	$F_4$	Task sequence
Straight-line	5	249	<b>3</b>	8685	5,6,7,4,9,1,8,10,2,3
	5	219	5	8165	6,4,5,9,7,1,8,10,2,3
	5	211	4	9730	5,10,6,7,9,4,8,1,2,3
	5	211	5	9605	6,4,10,5,7,1,8,9,2,3
U-shaped	5	<b>207</b>	<b>3</b>	8325	5,6,7,9,4,8,1,10,2,3
	5	249	<b>3</b>	7935	6,5,7,4,9,1,8,10,2,3
	5	370	4	<b>7150</b>	6,9,5,7,10,4,8,1,2,3
	5	287	5	7445	6,9,5,1,7,10,4,8,2,3

Table 3 and Table 4 present detailed comparison results of different algorithms. The proposed SFL algorithm is compared with 10 meta-heuristics, viz., genetic algorithm (GA), ant colony optimization (ACO), improved ant colony optimization (IACO), hybrid group neighborhood search algorithm (HGNS), improved artificial bee colony optimization (IABC), small world optimization algorithm (SWOA), cat swarm optimization (CSO), invasive weed optimization (IWO), teaching-learning-based optimization (TLBO), and fish school search algorithm (FSS). Detailed performance data of various algorithms are taken from McGovern and Gupta (2006), Zhang et al. (2018), Zhu et al. (2014), Zhu, Zhang, and Guan (2020), Yao and Gupta (2021a), Yao and Gupta (2021b), Yao and Gupta (2021c), Yao and Gupta (2021d), Yao and Gupta (2021e), Yao and Gupta (2021f). In Table 3, all these 11 algorithms are applied to a straight-line disassembly line to solve the same case instance. From Table 3 and Table 4, it is obvious that SFL has a great ability to find near-optimal solutions and SFL performs better than many other algorithms especially in minimizing number of workstations and minimizing total of idle times.

**Table 3.** Comparison results of 11 meta-heuristic algorithms

Objective	GA	ACO	IACO	HGNS	IABC	SWOA	CSO	IWO	TLBO	FSS	SFL
$F_1$	5	5	5	5	5	5	5	5	5	5	5
$F_2$	211	211	211	219	211	211	211	211	211	211	211
$F_3$	4	4	4	4	4	4	5	4	6	5	5
$F_4$	9730	10090	9730	7510	9730	9480	8880	9480	8100	8885	9605

**Table 4.** Performance of algorithms on U-shaped disassembly line

Objective	SWOA	CSO	IWO	ACO	TLBO	FSS	SFL
$F_1$	5	5	5	5	5	5	5
$F_2$	207	207	207	207	207	207	207
$F_3$	4	5	5	5	5	5	3
$F_3$	8980	9696	8915	8915	8915	9695	8325

## Conclusion

DLBP has been an active research area in recent years. This paper has, for the first time, proposed SFL algorithm on straight-line and U-shaped disassembly lines. Comparison results show that SFL algorithm has a great ability to find near-optimal solutions and its performance is better than most of other compared meta-heuristic algorithms. In the future, special disassembly types like partial and sequence-dependent disassembly will be interesting to explore. Combined algorithms and searching strategies can also be applied on DLBP especially on U-shaped, parallel, and two-sided disassembly lines.



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## **STRATEGIC DESIGN OF HUMANITARIAN SUPPLY CHAIN SYSTEM USING GENERAL TWO-STAGE NETWORK DEA MODEL**

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### **ABSTRACT**

The humanitarian supply chain network (HSCN) design has been a challenging problem whose goal is to relieve and minimize the effects of disasters and pandemics. For designing more balanced HSCN schemes consisting of emergency response facility location and allocation, a goal programming (GP) model is applied to generate various HSCN configurations. The general two-stage network (GTSN) data envelopment analysis (DEA) model is applied to evaluate these developed supply chain network schemes to identify the most efficient ones.

### **KEYWORDS**

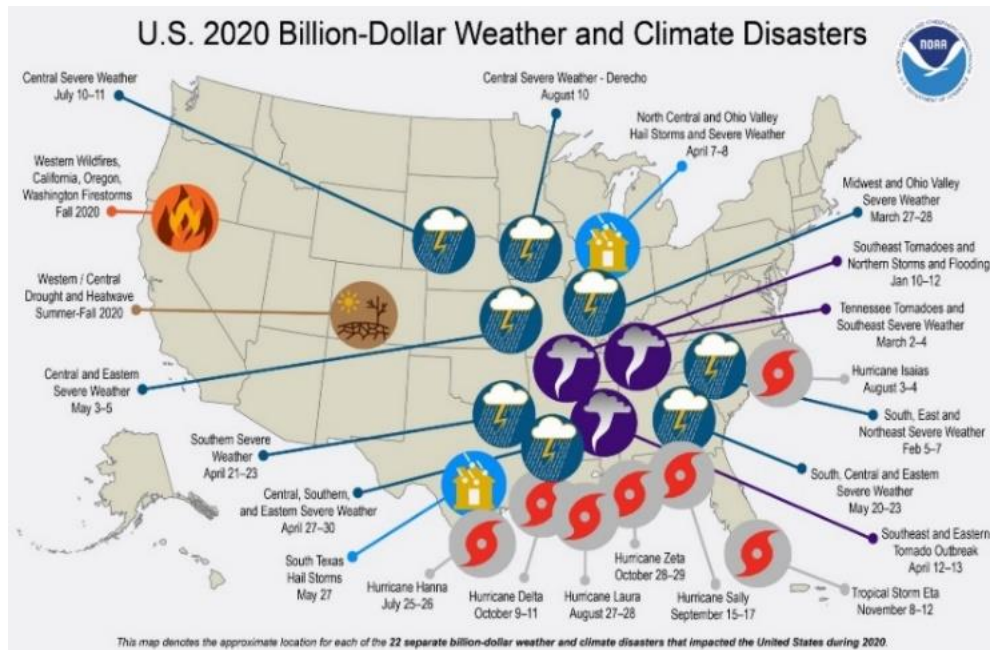
Humanitarian supply chain network, Goal programming, Two-stage network data envelopment Analysis

### **INTRODUCTION**

The year 2017 became a historic year of weather and climate disasters for the United States, which, in total, was impacted by 16 separate billion-dollar disaster events, including three tropical cyclones, two inland floods, eight severe storms, a crop freeze, drought, and wildfire. In early 2019, Alaska, the coldest state in the U.S., posted its warmest March on record by a landslide, and the powerhouse storm in the central U.S. became the second billion-dollar weather disaster of 2019. Letting alone COVID-19, 2020 set the new annual record of 22 events, breaking the previous record of 16 events in 2011 and 2017, as shown in Figure 1. According to the data developed by the NOAA's National Climatic Data Center, the U.S., on average, faces ten severe weather events yearly, exceeding one billion dollars in damage (see Figure 2). A comparison with an annual average of only two such events throughout the 1980s clearly may force us to speculate that a warming climate could be making these disasters more frequent and

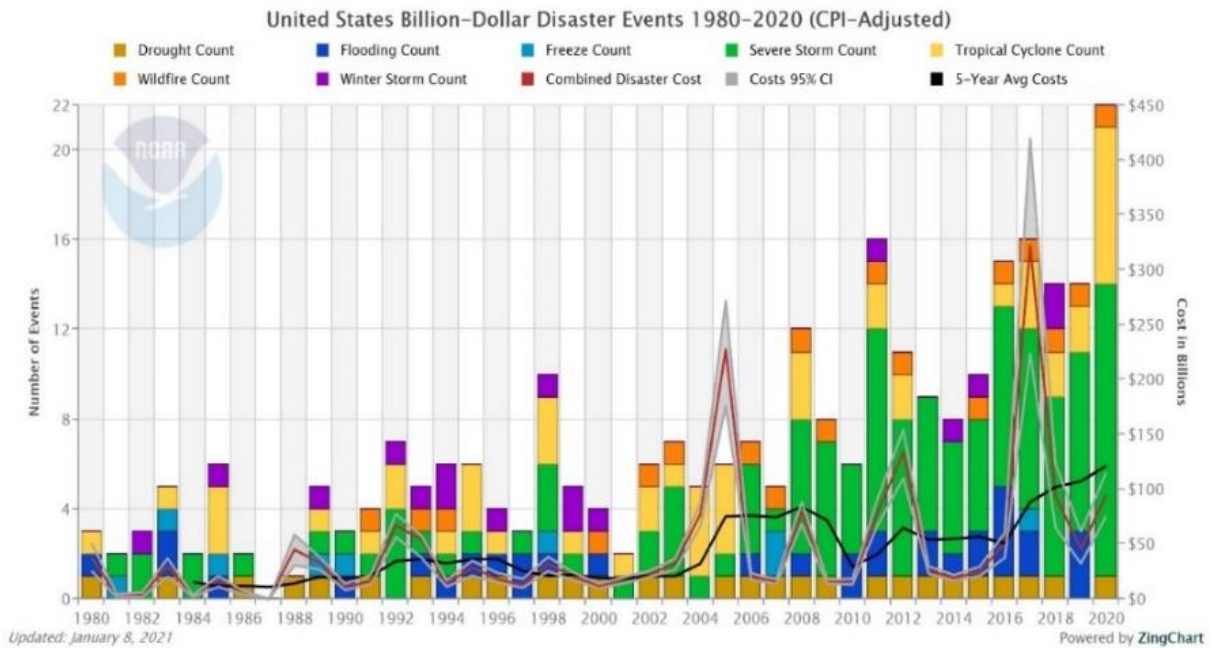
more intense. In this respect, an HSCN design has become an important strategic decision due to the significant damage inflicted by several natural disasters (Petrucci et al., 2020). Moreover, COVID-19 and its variants have brought issues of emergency relief planning through the HSCN again.

**Figure 1:** U.S. billion-dollar weather and climate disasters (2020)



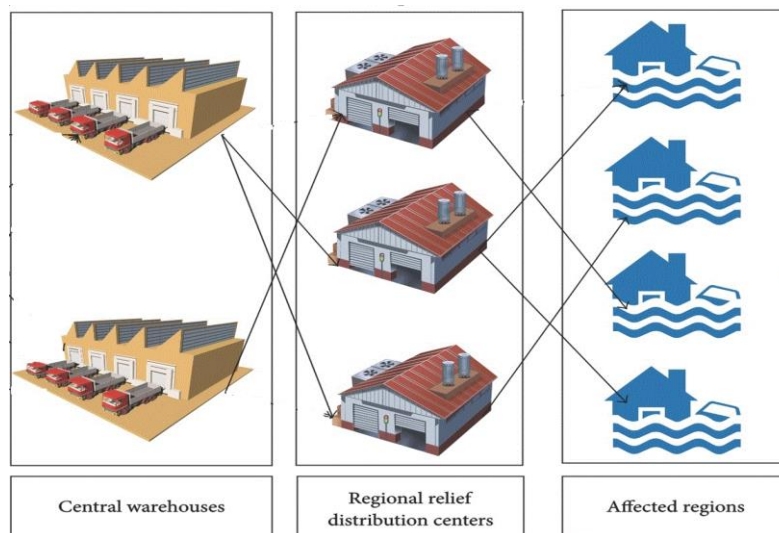
As Big Data research becomes an important area of operations analytics, DEA has evolved into a tool for Big Data analysis. As Cook and Zhu (2014) mention, an important development area in the DEA applications has been devoted to applications wherein DMUs represent network processes. In fact, a network DEA (N-DEA) has been major stream that controls various sub-stages' efficiencies in a complex structure. A significant body of DEA research has focused on N-DEA since N-DEA can satisfy three defining properties of Big Data, volume, variety, and velocity (Zhu, 2020). In reality, DMUs may consist of two or more stage network structures with intermediate measures. Monfared and Safi (2013) state that the SSN-DEA model considers a DMU as a 'black box' and neglects intervening processes, i.e., different series or parallel functions. Thus, the 'black box' approaches for the single-stage process provide no insights regarding the inter-relationships among the components' inefficiencies and cannot offer specific process guidance to DMU managers to improve DMU's efficiency.

**Figure 2:** Billion-dollar disasters by type, from 1980 to 2020



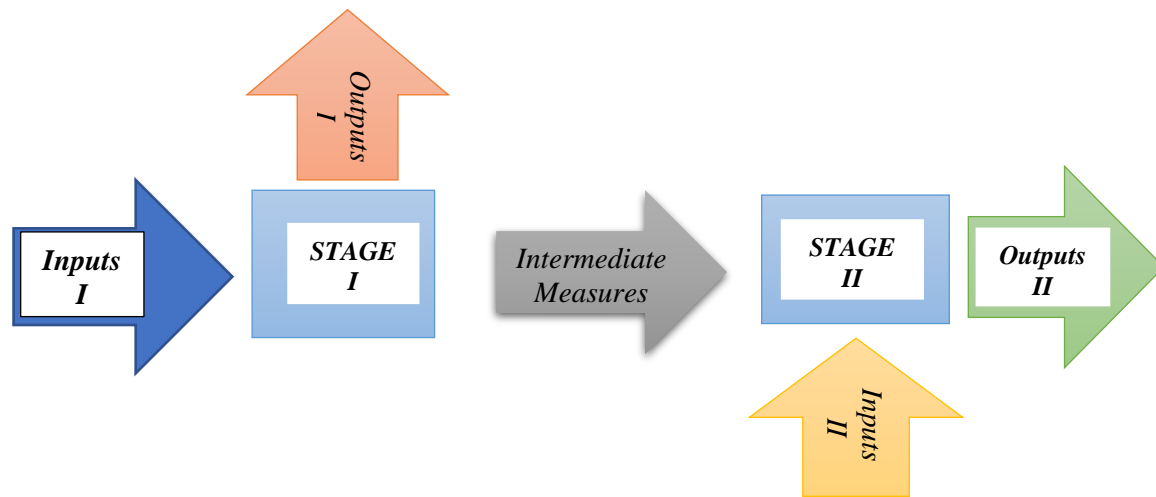
The ERFs considered in this paper are three distinctive ones. They are (i) Central Warehouses (CWHs) or Distribution Warehouses, where emergency relief commodities are stored, (ii) intermediate response facilities termed Relief Distribution Center (RDC) or Commodity Distribution Point, and (iii) neighborhood sites (NBSs), which are affected areas in need of humanitarian items. These ERFs are depicted in Figure 3 by modifying Habib et al. (2016).

**Figure 3:** Distribution framework of humanitarian supply chain



This study considers a general two-stage network DEA (GTSN-DEA) model, where the first stage produces two kinds of outputs, one of them, called the intermediate measure, is an additional input to the second stage. See Figure 4, depicting the GTSN-DEA structures. This paper applies the GTSN-DEA method for the HSCN design problem in a pre-disaster scenario, which consists of finding the optimal emergency response facilities (ERFs) under the risk of facility disruption.

**Figure 4:** General two-stage network DEA structure



## CASE STUDY

A case study uses major disaster declaration records in South Carolina (SC). We cluster forty-six (46) counties based on proximity and populations into twenty (20) counties. Then, one location from each clustered county based on a centroid approach is chosen by assuming that all population within the grouped county exists in that location. Federal Emergency Management Agency (FEMA) database (FEMA, 2017) shows that SC has experienced sixteen (16) major natural disaster declarations from 1964 to 2017. The database also lists counties where a major disaster was declared. This paper assumes that the county's emergency facility is disrupted and shut down when a major disaster is declared. Based on the historical record and the assumption, each neighborhood's risk probability (a county or a clustered county) is calculated in Table 1. The five potential locations for CWHs are selected based upon population, the proportion of area that each site would potentially cover, and the proximity to Interstate Highways in SC.



**Table 1:** Data for locations of ERFs.

No	City	County	Population (K)	Risk Probability
1	Anderson	Anderson/Oconee/Pickens	373	0.125
2	Beaufort	Beaufort/Jasper	187	0.063
3	Bennettsville	Marlboro/Darlington/Chesterfield	96	0.375
4	Conway	Horry	269	0.375
5	Georgetown	Georgetown/Williamsburg	93	0.438
6	Greenwood	Greenwood/Abbeville	92	0.125
7	Hampton	Hampton/Allendale	33	0.188
8	Lexington	Lexington/Newberry/Saluda	318	0.313
9	McCormick	McCormick/Edgefield	35	0.250
10	Moncks Corner	Berkeley	178	0.313
11	Orangeburg	Orangeburg/Bamberg/Calhoun	123	0.375
12	Rock Hill	York/Chester/Lancaster	321	0.313
13	Spartanburg	Spartanburg/Cherokee/Union	367	0.313
14	Sumter	Sumter/Clarendon/Lee	157	0.375
15	Walterboro	Colleton/Dorchester	135	0.250
16	Aiken†	Aiken/Barnwell	184	0.313
17	Charleston†	Charleston	350	0.250
18	Columbia†	Richland/Fairfield/Kershaw	461	0.375
19	Florence†	Florence/Dillon/Marion	203	0.438
20	Greenville†	Greenville/Laurens	521	0.125

†potential locations for CWH

The numbers of RDCs and CWHs to be built are pre-specified in most cases. We simplify the total logistics cost function by excluding the fixed cost terms for RDCs and CWHs. If the actual data are available for the fixed cost terms, such restrictions can be readily lifted to produce more revealing results. The GP model is solved for various values of weight. Each weight alters between 0 and 1 with an increment of 0.1, subject to the sum of all weights equaling 1. Two hundred eighty-six (286) configurations arising out of the combinations of the weights are reduced to 68 consolidated configurations since several cases yield the same values of the four-performance metrics. Each of the 68 configurations is considered a DMU, representing the optimal locations and allocations of ERFs. See Hong (2021) for detailed numerical examples.

## SUMMARY AND CONCLUSIONS

The humanitarian supply chain network (HSCN) design has been a challenging problem whose goal is to relieve and minimize the effects of disasters and pandemics. This paper proposes

converting a single-stage HSCN design problem into a two-stage network (TSN) process. For designing more balanced HSCN schemes consisting of emergency response facility location and allocation, a goal programming (GP) model is applied to generate various HSCN configurations. The general TSN-DEA (GTSN-DEA) model finds efficient HSCN configurations among the schemes generated by solving the GP model for different weight set values for the transformed TSN process.

The case study demonstrates that the proposed approach produces consistent and robust rankings. In contrast, the ranks generated by the single-stage process's CE- and SE-DEA models are not as consistent or robust as the GTSN-DEA. We observe that different humanitarian supply chain network (HSCN) configurations are ranked highly by the proposed approach. These schemes are ranked very low by the SSN-DEA method. In addition, the rankings produced by GTSN-DEA are not affected by the network schemes to be rated, while the ranks by the SSN-DEA models depend upon them under evaluation. Thus, the contribution of the proposed approach is to reveal the could-be hidden network schemes, if SSN-DEA is only applied, that the decision-makers would not consider as the candidate schemes for their final decision. This study demonstrates that the proposed GTSN-based approach would be an essential tool for designing these kinds of supply chain network schemes.

## **ACKNOWLEDGMENTS**

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# **Marketing and Consumer Behavior**

## **DECISION SCIENCE INSTITUTE**

### **A Game-theoretic Model of the Consumer Behavior Under Pay-What-You-Want Pricing Strategy**

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### **ABSTRACT**

In a digital age where companies face rapid changes in technology, consumer trends, and business environments, there is a critical need for continual revision of the business model in response to disruptive innovation. A pillar of innovation in business practices is the adoption of novel pricing schemes, such as Pay-What-You-Want (PWYW). In this paper, we employed game theory and behavioral economics to model consumers' behavior in response to a PWYW pricing strategy where there is an information asymmetry between the consumer and supplier. In an effort to minimize the information asymmetry, we incorporated the supplier's cost and the consumer's reference prices as two parameters that might influence the consumer's payment decision. Our model shows that consumers' behavior varies depending on the available information. As a result, when an external reference point is provided, the consumer tends to pay higher amounts to follow the social herd or respect her self-image. However, the external reference price can also decrease her demand when, in the interest of fairness, she forgoes the purchase because the amount she is willing to pay is less than what she recognizes to be an unrecoverable cost to the supplier.

**KEYWORDS:** Pay-What-You-Want, Game Theory, Consumer Behavior, Behavioral Economics, and Disruptive Innovation

## INTRODUCTION

Over the past decades, technological shifts such as the widespread availability of broadband internet, open-source software, the sharing economy, big data, and the digitization of products, on the one hand, and influential management theories such as disruptive innovation and open innovation on the other hand, have encouraged corporations to rethink their business models. In fact, many studies show that disruptive innovation is a viable, or even the only, option to cope with rapid changes in a globalized economy (see Saki, 2016; Hopp et al., 2018). However, while revising pricing strategy should lie at the heart of any business's innovative practices, most companies stick to traditional pricing models such as cost-plus pricing and value-based pricing, primarily due to fear of revenue loss. Nevertheless, the technological shifts have transformed not only businesses, but consumers as well. Today, consumers have better real-time access to information and more options than in the past. Hence, aligning with this shift in consumer behavior, businesses should explore new pricing strategies, e.g., participative pricing mechanisms that enable consumers to determine the price they pay for a product or service.

Pay-What-You-Want (PWYW) is a participative pricing strategy that empowers consumers to determine the price they pay and gives suppliers the opportunity to apply additional price discrimination, to position their products in the market, and to beat the competition (Kim et al., 2008; Fernandez and Nahata, 2009; Schmidt et al., 2015; Chao et al., 2015; Wagner, 2019; Chen & Wyer, 2020). As compared to other participative pricing mechanisms, such as Name-Your-Own-Price (NYOP), auctions, and bargaining (Hann & Terwiesch, 2003, Spann et al., 2004), in the PWYW mechanism the consumer has more control over pricing because the supplier sets no fixed price and so the buyer may offer any price (including zero) and the supplier cannot reject it (Dorn & Suessmair, 2017; Greiff and Egbert, 2018; Ariely et al., 2018). Though PWYW can be regarded as a particular form of voluntary contribution mechanism (see Natter & Kaufman, 2015; Lynn, 2017; Spann et al., 2018; Bluvestein and Raghbir, 2021), it differs from other voluntary contribution mechanisms such as tipping and donation because it applies to the core products and services of the supplier, not to its supplementary services, and the consumer pays for himself, not others.

Several studies have considered potential applications of PWYW pricing in industries such as hospitality (e.g. Matilla and Gao, 2016), food and drink (Riener and Traxler, 2012; Chawan, 2019), art (Bimberg et al, 2020; Golinski, 2020; Gross et al., 2021), and entertainment (Gneezy et al., 2010; Kim, et al, 2014; Borg et al., 2020; Boonsiritomachai and Sud-on, 2021). Also, Chung (2017) refers to several real-world instances of organizations utilizing PWYW pricing, from restaurants and cafes such as Soul and Panera Bread to The Metropolitan Museum of Art.

Many studies highlighted the processes and drivers influencing PWYW pricing. Recent empirical studies looked at consumers' behavior in PWYW settings through different lenses like perceived product and service quality (Weisstein et al., 2019), perceived price fairness (Chung, 2017; Narwal and Nayak, 2020), altruism (Peschla et al., 2019) or social acceptability (Mills and Groening, 2021). Although, mixed results in some cases justify further scrutiny (Stangl and Prayag, 2017; Gravert, 2017; Park et al., 2017; Spann et al, 2018). Moreover, the role that information asymmetries play in shaping the payment decisions of consumers in PWYW settings is overlooked in most theoretical and empirical studies.

In addition to empirical research findings, theoretical considerations help disentangle possible mechanisms in the PWYW price setting. Our goal in this paper is to propose a game-theoretic conceptual model representing how information asymmetries affect prices paid in a single consumer–single supplier interaction under the PWYW pricing mechanism. In particular, the model reveals that PWYW pricing can be profitable under certain conditions and can be used not only for short-term promotional purposes but also as a practical pricing strategy in the long term.

In the following section, we briefly summarize the recent literature on PWYW pricing and drivers which likely influence consumer payment decisions under this pricing scheme. Then, in

the next section, relying on game theory, we first describe a linear model for a PWYW game and then extend it to incorporate fairness and minimize information asymmetries that influence the effectiveness of PWYW pricing. The final section provides a conclusion and discusses possible future research directions.

## LITERATURE REVIEW

While PWYW pricing has drawn the attention of scholars from Marketing, Operations Management, and Economics disciplines (Gneezy et al., 2010; Gneezy et al., 2012; Kim et al., 2014; Kim et al., 2009; Schmidt et al., 2015; Chawan, 2019), the findings are sometimes ambiguous. Experimental studies have pointed out the importance of several motives that drive positive payments by consumers in the PWYW pricing setting, including product type (e.g., Weisstein et al., 2019), quality of service (e.g., Narwal and Nayak, 2020), fairness (e.g., Machado and Sinha, 2013), reference price (e.g., Roy et al., 2016), income (e.g., Kunter, 2015), loyalty (e.g., Marett et al., 2012), social distance (Kim et al., 2014), self-image (e.g., Gneezy et al., 2012), price consciousness (e.g., Kim et al., 2009), inequity aversion (e.g., Schmidt et al., 2015), and usage (e.g., Marett et al., 2012), among other factors. Furthermore, some procedural conditions such as design variations (e.g., Christopher & Macado, 2019), payment timing (e.g. Viglia et al., 2019), anonymous exchanges (e.g., Soule and Madrigal, 2015), time pressure (e.g., Sharma et al., 2020) or using textual cues (e.g., Kunter, 2015) affect the economic success of PWYW.

Reference points play a crucial role in making payment decisions. In general, there are two types of reference points: the External Reference Price (ERP) and the Internal Reference Price (IRP). The ERP can be defined as a price suggested by the supplier in the purchase environment based on the average price of the item in the market or what others paid (e.g., Soule & Madrigal, 2015; Gross et al., 2021). The IRP is defined as an internal price-evaluation scale rooted in the past payments for similar products or services or personal preferences and values of the consumer (Gneezy et al., 2012; Khashay & Samahita, 2015; Narwal & Nayak, 2020). In a PWYW setting, external and internal reference prices significantly influence consumers' payment decisions (Johnson & Cui, 2013; Nieto-García et al., 2017).

The effects on ERPs on payment decisions are mixed. On the one hand, the availability of an ERP can reduce the consumer's uncertainty in making payment decisions and lead to higher prices paid compared to when no reference price is presented (e.g., Weisstein et al., 2019). On the other hand, in some studies no significant relationship is found between external reference prices and the amount paid (Gneezy et al., 2012; Weisstein et al., 2019), and in some cases (e.g., when setting a minimum and maximum for the suggested price) ERPs may even have a negative impact on the price paid (Johnson & Cui, 2013; Roy et al., 2016; Gross et al., 2021).

In general, three variants of external reference price strategies are known in the literature: the minimum price set by the supplier, which consumers should not underbid (Sayman and Akcay, 2020); a maximum price, which consumers are not allowed to overbid (Ahunbay et al., 2020); and the provision of a short list of predefined prices, from which the consumers can choose the price level they are willing to pay (Christopher and Machado, 2019). Weisstein, Choi and Andersen (2019) found that when an ERP is absent, consumers who purchase hedonic products are more willing to contribute higher PWYW payments since they perceive the quality of the product higher. However, in presence of an ERP, consumers who purchase utilitarian products are primed to pay higher within the PWYW mechanism because they perceive it as a higher quality product. On the other hand, in a PWYW context, consumers often rely on their own internal reference price as a memory-based intuition helps them to estimate the value of the purchasing item and to determine the price they are willing to pay (Kim et al., 2009; Johnson and Cui, 2013). Through an empirical study, Roy et al. (2021) depicted that in the PWYW setting, customers' willingness to pay increases depending on their internal reference price, when they understand their payment is visible to the others.

When both internal and external reference points are available, the interplay between the two will influence the consumer's payment decision. Several empirical studies shed light on the mediating role of an external reference price, which prompts as an anchor in purchasing decisions, influencing consumers' willingness to pay, and shifting their internal reference price towards a socially acceptable amount (Chandarshekar & Grewel, 2006; Johnson and Cui, 2013; Roy et al., 2016 Weisstein, Choi and Andersen 2019). Kukla-Gryz and Zagorska (2017) conclude that in a PWYW context, where no external reference price is presented, consumers base their payment decisions on individual factors such as internal reference prices. Logically, consumers seek their economic benefit and use their decision power to minimize their losses and maximize their surplus. However, regarding loss aversion, as a cognitive bias that prompts consumers to prefer avoiding loss to a same-size gain (Kahnemann & Tversky, 1979), if a consumer perceives the external reference price as being above her internal reference point, she frames it as a "loss". By contrast, in the consumer's view, a price below the internal reference point is framed as a "gain". Consequently, in a PWYW setting, consumers tend toward underpayment rather than overpayment, gaining instead of losing (Johnson & Cui, 2013).

Looking through the lens of distributive justice, Jang, and Chu (2012) defined the distribution of the ratio of price paid to the willingness to pay as a measure of fairness and showed a similarity between the distribution patterns of the price paid to that seen in dictator games. Krawczyk et al. (2015) show that consumers tend to match their payment with the mean price of past contributions to follow social norms. Betray, Sussemair and Dorn (2017) examined the relationship between the perceived price fairness and the payment in the PWYW context, finding that consumers evaluate the fairness of the external reference price against their internal reference point.

## **THE MODEL**

This section describes the sequence of events in a consumer–supplier interaction within a PWYW context. Referring to the literature review section, several researchers outline that fairness perceptions are essential for consumer prices. In our model, we aimed to incorporate price fairness and minimize the impact of information asymmetries on prices paid under PWYW pricing.

The PWYW Game is a sequential game of incomplete information whereas a typical PWYW interaction happens between a single supplier that produces a product or service at unit cost  $C$  and a single consumer who has an internal reference price, as private information which represents the value of that product or service to her. The supplier's cost is recoverable, either through disposal or funding resources, or non-recoverable (a sunk cost), but this information is unknown to the consumer. The consumer decides whether to buy the item or forgo the purchase. If the consumer decides to buy the item, she chooses a price less than or equal to her  $IRP$ , pays it, and takes the product. Generally, the buying interaction's resulting payoffs would be  $V - P$  for the consumer and  $P - C$  for the supplier.

### **General Assumptions**

For the proposed model, there are some considerations as follows. First, the supplier has no option to refuse a consumer's offer even if the proposed price is less than its production cost ( $P < C$ ), implying that the consumer determines the payoff of both the consumer and the supplier in this interaction. Second, the consumer's valuation of the product or service is determined based on her internal reference price as "an average of the price most recently paid for a given good and the price usually paid for products of the same category", according to Kim et al. (2009) definition and is not changing in the short-term. Third, aiming to minimize the effect of product quality or experience on consumer's payment decision, we assume that the payment happens before consumption not after that. Forth, regarding loss aversion as underlying priority of consumer's economic decisions, we assumed that the payoff for consumers who choose to buy

the item is always non-negative. Finally, for a purpose of simplicity we use single-consumer-single-supplier setting rather than single-consumer-multiple-suppliers. As a result, the bystander effect will be removed from our model – as some studies report that this effect impacts the behavior in similar economic games (see Panchanathan et al., 2013).

**Description**

For simplicity, the consumer’s total utility from purchasing the good at price  $P$  is assumed linear according to the following:

$$U_B = V - P, \tag{1}$$

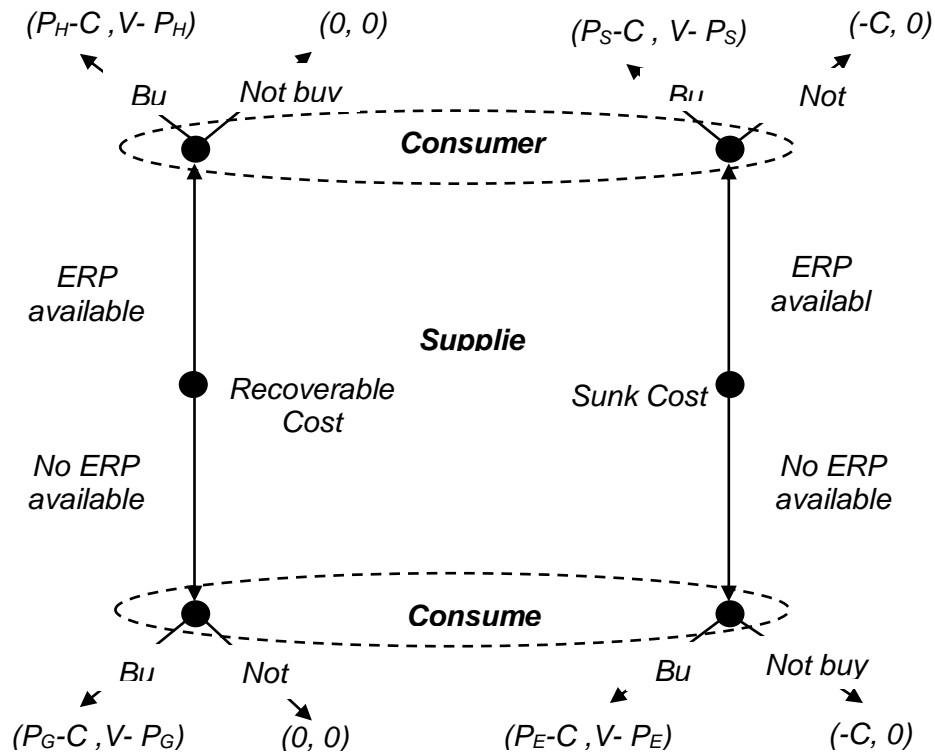
where  $V$  is the item’s perceived value, or alternatively, the consumer’s internal reference price for the item.

On the other side, buying an item produced at cost  $C$  by the consumer at price  $P$  yields a payoff, or alternatively, a margin as following:

$$M_B = P - C \tag{2}$$

If the consumer decides to not buy the item, the supplier’s payoff will be either zero or  $-C$ , depending on being type  $R$  (with recoverable cost) or type  $S$  (with sunk cost), respectively. Figure 1 depicts a schematic representation of the PWYW game.

Figure 1: Schematic representation of PWYW game



As shown in Figure 1, depending on the supplier's type and its decision to whether decrease information asymmetry through providing an external reference price, optimal price paid by the consumer varies based on the following scenarios.

*Gain Seeking.* At the beginning, let's assume that the supplier provides no external reference price. So, if the consumer believes that the supplier is of type  $R$ , with recoverable cost, incentive for gain seeking would be the dominant driver of consumer's payment decision. The portion of free riders in this case will be probably highest amongst the four scenarios. Excluding a proportion of consumers who are free riders, let's assume each consumer has a unit demand and is fair-minded paying an amount,  $P_G$  more than zero but less than her internal reference price,  $V$ . So, according to the Eq. (1), the payoff of buying for the consumer will be:

$$U_G = V - P_G \quad (3)$$

At the same time, regarding Eq. (2) the payoff of buying the item by consumer at price  $P_G$  for a supplier with cost  $C$ , or alternatively, the supplier's margin would be:

$$M_G = P_G - C \quad (4)$$

and, given that the cost of supplier is recoverable, its payoff will be zero if the consumer decides not to buy the item.

*Herd Behavior.* Now, assume that the supplier provides information of an external reference price either in form of the average amount of the other consumer's payments or the average price of the similar item in the market. If consumer believes that the supplier is of type  $R$ , with recoverable cost, she follows the social norms by paying an amount,  $P_H$ , close to the external reference price, if it is less than her internal reference price for that item,  $V$ . In case that the external reference price is higher than consumer's internal reference price, she adjusts her payment only regarding her internal reference price. So, according to the Eq. (1), the payoff of buying for the consumer will be:

$$U_H = V - P_H \quad (5)$$

At the same time, regarding Eq. (2) the payoff of buying the item by consumer at price  $P_H$  for a supplier with cost  $C$ , or alternatively, the supplier's margin would be:

$$M_H = P_H - C \quad (6)$$

Similar to the gain seeking scenario, since the cost of supplier is recoverable, its payoff will be zero, if consumer decides to not buy the item.

*Inequity Aversion.* In this scenario we assume the supplier suggests no external reference price for the item, but the consumer believes that being of type  $S$ , the supplier is unable to recover the product/service's initial investment, through product disposal or funding resources. In this case, inequity aversion plays the most important role in consumer's payment decision because she concerns supplier's loss. Therefore, if the consumer chooses to buy, she pays  $P_E$  close to her internal reference price and as a result, her payoff, regarding Eq. (1) would be:



$$U_E = V - P_E. \quad (7)$$

At the same time, regarding Eq. (2) the payoff of buying the item by consumer at price  $P_F$  for a supplier with cost  $C$ , or alternatively, the supplier's margin would be:

$$M_E = P_E - C \quad (8)$$

Since the supplier cannot recover its cost in this scenario, if consumer decides to not buy the item, its payoff would be as much as its production unit cost,  $C$ .

*Self-image.* In this scenario, we assume that the supplier provides an external reference price and like the Inequity Aversion scenario, the consumer believes that the supplier is unable to recover its production cost, if she chooses to not purchase. In this case, concerning her self-image, the consumer decides to pay  $P_S$  close to the external reference price, only if it is less than her internal reference price. If the external reference price is higher than the consumer's internal reference price, she decides to not buy to respect her self-image. So, the consumer's payoff, regarding Eq. (1) would be:

$$U_S = V - P_S \quad (9)$$

At the same time, regarding Eq. (2) the payoff of buying the item by consumer at price  $P_F$  for a supplier with cost  $C$ , or alternatively, the supplier's margin would be:

$$M_S = P_S - C \quad (10)$$

Since the supplier cannot recover its cost in this scenario, if consumer decides to not buy the item, its payoff would be as much as its production unit cost,  $C$ .

The above scenarios of consumer's response show that providing an external reference price, probably increases the amount paid by the consumer, though it might decrease her demand. Now, if the supplier decides to reduce the information asymmetry further by revealing its cost to the consumer, the consumer will have additional reference points in hand to make her payment decision. To be specific, excluding a proportion of consumers who are free riders, let's assume that the consumer is fair-minded paying at least  $C$  and therefore will not purchase the good if her internal reference price,  $V$ , is less than the supplier's cost,  $C$ . As a result, a fair-minded consumer splits the surplus  $V - C$  out of reciprocity for the supplier having chosen a PWYW scheme (Schmidt et al., 2014). Let  $\lambda$  be the proportion of surplus shared with supplier,  $0 < \lambda \leq 1$ . This parameter represents the strength of social preferences in the economy and can also be interpreted as an exogenous social norm — typically assumed to be 0.5 in an equal sharing rule, but in a richer and more generous economy the norm may be to give more and vice versa (see, for example, Mrkava et al. (2020) who find cross-cultural variations in reciprocity).

In a one-supplier-one consumer interaction, the fair-minded consumer's PWYW payment is therefore defined to be:

$$P_{fair} = Ci\lambda(V - C) \quad (11)$$

Substituting (11) into the Eq. (1) then gives the fair-minded consumer's PWYW utility when the supplier's cost is known:

$$U_{fair} = (1 - \lambda)(V - C) \quad (12)$$



In general, let's assume that consumer's utility from purchasing the product is determined by two factors: an internal surplus (the difference between consumer's internal reference price,  $V$ , and the price she pays to the supplier,  $P$ ) and utility loss from unfairness (the difference between the price  $P$  and the fair price). We build our model based on the (Fehr and Schmidt, 1999) parametrized inequity aversion model through adding the possibility of consumer concerns supplier's loss:

$$U(P_R, P, C) = (P_R - P) - \alpha \max\{(P - C) - (P_R - P), 0\} - \beta \max\{(P_R - P) - (P - C), 0\} - \gamma \max\{C - P, 0\} \quad (13)$$

where  $P_R$  represents consumer's reference price (internal or external),  $P$  denotes price paid by the consumer,  $C$  is the unit production cost for supplier and,  $\alpha$  and  $\beta$  are envy and altruism parameters that determine his or her attitude towards the disadvantageous and advantageous inequality respectively and, parameter  $\gamma \geq 0$  determines consumer's sensitivity to the supplier's losses. That is, when a price is decreased by one dollar, the consumer's psychological penalty decreases by  $\alpha$  if her surplus is lower than supplier's and increases by  $\beta$  if her surplus is higher than the supplier's, but the supplier's payoff is still positive.  $\alpha$  will be further referred to as an "envy factor" and  $\beta$  will be referred to as a "altruism factor". The model assumes  $\alpha \geq \beta$  and  $0 \leq \beta < 1$  (see (Fehr and Schmidt, 1999) for justification of these assumptions). If a supplier suffers losses, a consumer experiences a penalty of  $\beta + \gamma$  for every dollar decline of the price.  $\gamma = 0$  means that the consumer evaluates supplier's gains and losses equally, and our model is reduced to a classic Fehr-Schmidt model.

Let  $P_f$  be the "fair price" – a price that results in an equitable split of the surplus created between the seller and the consumer:

$$P_f = 0.5(P_R + C) \quad (14)$$

When  $P = P_f$ , the consumer does not suffer any unfairness-related utility loss. Let us further assume that the price is limited to be  $P \geq 0$ . Then the optimal price for consumer would be:

$$P = \begin{cases} 0, & \text{if } \beta < 0.5 \text{ and } \beta + \gamma < 1; \\ C, & \text{if } \beta < 0.5 \text{ and } \beta + \gamma > 1; \\ P_f, & \text{if } \beta > 0.5. \end{cases} \quad (15)$$

If  $\beta = 0.5$ , the consumer is indifferent between any price within the interval  $[C, P_f]$ ; if  $\beta < 0.5$  and  $\beta + \gamma = 1$ , the consumer is indifferent between any price in the interval  $[0, P_f]$ . Note, that if  $\gamma = 0$ , like in the original Fehr and Schmidt model,  $\beta < 0.5$  implies  $\beta + \gamma < 1$ , and the option  $P = C$  can never be selected.

## DISCUSSION AND CONCLUSIONS

Disruptive innovation in theory and recent technological changes in practice push businesses to adopt innovative pricing strategies like Pay-What-You-Want. This paper discusses different scenarios of consumer's response to PWYW price setting regarding the most important drivers that influence consumers' payment decisions. Therefore, we proposed a linear model of interaction between one supplier and one consumer under a PWYW price setting. We incorporated two parameters that might affect the price paid by the consumers under PWYW: the supplier's cost and the consumer's reference price. Literature review shows that presence of reference prices is one of the most important drivers affecting the consumer's payment decisions. Also, if the supplier's unit production cost is known to the consumer, information asymmetry is

reduced. Moreover, some studies argue that empathy can induce altruistic behavior, and conclude that empathy concerns increase sharing in interactions similar to dictator game (Von Bieberstein et al., 2021). Assuming a consumer does indeed empathize with the supplier's loss aversion, some of the buyers who will otherwise make the payment decision based on their own internal reference price may raise their prices if they learn about the supplier's costs, ensuring that the supplier will not go out of business after a while. This aspect has not been mentioned in previous interpretations of empirical findings on PWYW pricing and can complement existing models.

Our proposed conceptual model resembles the dictator game. In a typical dictator game (Bolton et al., 1998; Bardsley, 2008), there are two kinds of players: dictator, and receiver. The dictator has full power on deciding how to allocate a given endowment between herself and the other player. The receiver must accept the dictator's offer, even if the amount offered is zero. Game theory predicts that a rational dictator seeking to maximize her gain, should keep the whole amount for herself and transfer nothing to the receiver. However, most dictators do not maximize their payoffs and transfer positive amounts to recipients instead (see Camerer, 2003; Oberholzer-Gee & Eichenberger, 2008; Korenack et al., 2013). The average transfer is reported to be 20 percent of the endowment (Camerer, 2003; Ploner & Regner, 2013). It shows that, even in a laboratory setting, the dictators have concerns beyond pure gain-seeking.

However, there are some differences between our PWYW game and the standard dictator game. First, PWYW game outcomes are more realistic since you can hardly find a real-world interaction happening based on a dictator game, but many interactions, in reality, can be modeled using the PWYW game. The second difference is that in a typical dictator game the payoffs are restricted to be non-negative, but in a PWYW game the supplier's payoff from an interaction with a consumer could be negative where the consumer chooses to pay a price less than the supplier's production cost. The third difference is that if the price that a consumer is willing to pay is below the supplier's cost, the consumer might refuse to buy the good because of self-image concerns (see Gneezy et al., 2012; Kahsay & Samahita, 2015).

For future research, it is suggested to study suppliers' profitability regarding the proposed model. Also, the model needs to be tested empirically to confirm the assumptions about the effect of reference prices and price transparency on consumers' payment decisions.

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Shortening The Sales Cycle:  
A Quantitative Study Linking Construal Level Theory  
And Choice In Financial Services

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**Abstract**

Financial advisors often struggle with the dichotomy of the time required to build a trusting relationship with prospects/clients and the time-pressured demands of corporate-imposed sales goals. If advisory firms can better understand how people leverage recommendations, then there are widespread implications for business development and for hiring practices in the industry. In this study, we examine the role of referrals through social networks, its impact on interpersonal trust, and ultimately, how that trust translates to the selection of a wealth services provider. Surveys collected from a broad sample of respondents, many of whom are in the high-net-worth space, show that greater temporal distance (time horizon for a prospect to make a decision) and higher levels of risk tolerance increased the likelihood of behavioral intention to switch to the new advisor. Potential takeaways for wealth management firms in view of those findings are discussed.

**Keywords:** Interpersonal Trust, Familiarity, Temporal Distance, Construal Level Theory



## 1. Introduction

Let's imagine, for a moment, an industry where trust and relationship building are foundational for business development. Let's imagine the same industry now riddled with the time-pressured demands of stringent top-down, corporate-imposed sales goals. This juxtaposition is likely familiar for anyone working in the services sector, in which building a book of business is predicated on fostering strong, healthy client relationships and doing so time and time again. Financial advisors, and advisory firms, certainly fall into the aforementioned [bucket] of services jobs that face these challenges. It takes time to develop trust, and in many cases, it depends on the quality of service (Gounaris & Venetis, 2002). Different elements of trust come through as relationships develop (Tyler, Patton, Mongiello, Meyer, & Stanley, 2007). The prior research in the trust domain is expansive, covering areas like interpersonal relationships, temporal effects, and behavioral intentions. This study takes the view that "... trust and time should not be viewed in isolation" (Huemer, 2014, p. 568).

As practitioners in the advisory space, we can attest that a good book of business is one that builds on itself. Leveraging satisfied clientele who are willing to recommend and refer new business is one of the most effective ways of business development. Morningstar's (2020) Advisers' Insights Survey, which gathers responses from financial professionals in the U.S., showed that the two biggest growth challenges for advisors are *acquiring new clients* and *hiring new advisors*. In the same vein, the most effective channels for growing business are *requests for referrals from existing clients* and *requests for referrals from other financial professionals*. The pool of talent in the industry is deep with experienced professionals who are highly educated and credentialed. If the gap in expertise amongst seasoned advisors is minimal, then what drives consumer choice in this field? Most of the time: Trust! But if prior literature suggests that trust

takes an inordinate amount of time for relationship building or performance to show adequate returns, then the decision-making process to choose an advisor seems too stretched from reality, especially in an environment where personal expectations, and corporate expectations, are in the now.

If trust is a key determinant for business development, then the question remains: how do we build trust? Over the last decade or so, the investment advisory services space has experienced a major shift toward low-cost providers and solutions largely driven by the advances in technology and readily available, efficient information. The issue, however, is that many novice investors don't know where to start when looking for an advisor. As a result, consumers tend to rely on familiar information sources to aid in their decision-making process. This can take many forms; among which, are client referrals. Client referrals can help to expedite the trust-building process earlier on in the client/advisor engagement. To no surprise, "social referrals have become a distinct business model..." (Hong, Pavlou, Shi, & Wang, 2017, p. 788). With this in mind, the goals for this research are to answer the following questions:

- How is behavioral intention to switch a financial advisor (given that one already has an advisor) affected by interpersonal trust in, and familiarity with, the advisor?
- To what extent do temporal distance and risk tolerance affect the behavioral intention to switch to a new advisor?

We created a survey instrument, adapted from previously validated scales, and distributed it among respondents in the high-net-worth range of investable assets. The data support the hypotheses that temporal distance and risk tolerance affect behavioral intention to switch to a new advisor.



## 2. Literature Review

### *2.1 Marketplace Context*

The fact of the matter is such that changing times, demographics, the advent of technology and more have altered the landscape of financial services. And as organizations look for ways to drive sustainable growth, the current environment continues to squeeze out the ‘traditional’ money manager. The information science literature cites convenience, among other factors, as a critical component leading to behavior and/or choice (Connaway, Dickey, & Radford, 2011). While Connaway et al. (2011) discuss convenience as a contextual construct that depends heavily on a number of variables such as personal needs and other constraints, the literature seems to hone in on the “why.” Why do people choose one thing over another? Our research looks to answer a similar question, but it adds value by closely examining a referral source as a conduit to building initial trust in financial advisors, which should then affect a prospect’s behavioral intention.

The trust factor here does not examine whether or not Party B trusts Party A, and vice versa; that much is already implied. Rather, the objective of this study is to see to what extent does Party A’s trust in Party C (the advisor) transfer to Party B through a recommendation/referral. And if so, what enhances this level of trust? One possible explanation for a trust transfer is that people want and need a sense of understanding to make sense of their social environment (Gefen, Karahanna, & Straub, 2003). As a result, people seek avenues to reduce complexity and uncertainty, and absent other risk reduction methods, trust may prevail (Gefen et al., 2003; Luhmann, 1979). Moreover, if a transfer of trust can enhance levels of familiarity between the prospect who seeks out the recommendation and the new advisor, perhaps the prospect now has a better understanding of what to expect of the financial advisor. Assuming, of course, that the recommendation is a positive one, the expectations of the advisor would then reduce fear and

alleviate unknown conditions, as in familiarity builds trust (Gefen et al., 2003; Gulati, 1995).

### *2.2 Familiarity with the Advisor*

Familiarity helps create a baseline for understanding and expectation, and this is largely predicated on past interactions and experience (Gulati, 1995; Gulati & Sytch, 2008), as also shown in the case of electronic services such as ecommerce (Gefen, 2000). In the context of the referral, the shared past experiences between the aforementioned parties A and B will elicit a belief in the credibility of the referral itself. The referral can remove uncertainties and give way to an expectation of future events. While we know that trust can simplify external unknowns, we also know that “trust is easier with familiarity,” (Luhmann, 1979, pp. 15, 55). On the basis of Luhmann (1979), the two constructs serve to reduce complexity in their own ways: familiarity creates a structure for understanding, while trust establishes expectations for future behaviors (Gefen, 2000). It’s imperative, especially among business-oriented transactions, that there be structures in place to guide behaviors. Gulati (1995) supports the logic that business transactions are predicated, to some degree, on frequency of interaction and looser contracts, which is a consequence of familiarity and trust.

H<sub>1</sub>: Familiarity with the advisor increases behavioral intention to switch an advisor.

### *2.3 Construal Level Theory*

Construal level theory (CLT) embodies an interconnectedness between construals and psychological distance (as represented by a number of different dimensions such as in space, time and social distance) (Trope & Liberman, 2010). Okay, so what does that mean? Well, we can think of construals as a point of reference relative to the self and future dated happenings. People use

construals to make abstract (high level) or concrete (low level) representations or references to help make sense of the world around them, to provide and process information, and to assist in risky decision-making processes. The classic example highlighting construals used in literature is making arrangements for travel. The more distant the object, the more abstract, the higher the construal level (i.e. "... next month's vacation...") (Liviatan, Trope, & Liberman, 2008, p. 1257). Most/everyone can identify with a vacation, and as a result, conceptualize what that vacation might look like. But if we were to say, "We're going to Hawaii," then the construal level is less abstract psychologically. Similarly, temporal distance as a structural form of CLT, compounds these construal levels. The more distant the event, the more abstract the thinking is in terms of planning: "I am going to get some sun and relax." As the vacation nears, however, there is a temporal shift toward a lower construal level: "I need to make reservations for activities, dining, etc." The theory suggests that people use higher construal levels to identify with objects or plans as the psychological distance from said objects (plans) increases (Trope & Liberman, 2010). And as we move along the scale from high to low levels of construal (and vice versa), our imagery and representation of objects changes. As such, descriptors with language or inferences from experience are either added or omitted based on the individual's perspective or relevance to the communicated goal (Trope & Liberman, 2010).

Past studies have shown that consumption behavior and preference are likely to change depending on time construals, or how we evaluate our choices based on near-future vs. distant-future events (Trope & Liberman, 2000). And although theories around time discounting are broadly sourced with notable references to the valence of outcomes, much of the literature in the preference and choice domain deals with a specified activity. For instance, temporal distance can influence a person's feeling or preference with respect to their next vacation or which restaurant

to go to for dinner (Trope & Liberman, 2000). With that said, however, there appears to be relatively little research linking temporal distance (time discounting) and a preference for a service that is continual. Using temporal distance to moderate a trust-based model certainly adds a level of complexity to the traditional construal level theory (CLT) research. Because of CLT, though, we know that with lower temporal distance comes a preference for practicality (with respect to reaching a goal); and with greater temporal distance, we can expect people to place more of an emphasis on desired outcomes (Shen & Chiou, 2010, p. 47).

The idea, here, is that temporal construals of distant future events are correlated with more abstract thoughts and perceptions of the event, compared with lower level construals, which are more concrete in nature and might allow for more risk to enter into the person's psyche (Liberman & Trope, 1998). This is consistent with like research showing heightened levels of anxiety and uncertainty related to behavioral intention as temporal distance decreases (Castaño, Suján, Kacker, & Suján, 2008). The reason being a difference in the psychology of a cost/benefit analysis. In other words:

Temporal construal level theory (Trope & Liberman, 2003) proposes that as psychological distance to events decreases, two types of shifts occur: People shift toward using concrete mental models to construe or represent options, and they concern themselves with costs rather than benefits (Castaño et al., 2008, p. 321).

If we zero in on the risk/cost side of the equation, a near-term event is more likely to add risk, uncertainty and elevated perceived costs compared to more distant events. Among the aforementioned perceived costs are switching-costs (i.e. the relative difficulty to switch from one product to another) and the level of uncertainty therein (Castaño et al., 2008; Hoeffler, 2003).

Bringing it all back to our model, which is fundamentally intended to reduce uncertainty, research has shown that communicative intervention can effectively enhance behavioral intention for distant events by reducing performance uncertainty, and it can also enhance behavioral intention for near term events by reducing switching-cost uncertainties (Castaño et al., 2008, p. 330). Applying this to the context of this study suggests,

H<sub>2</sub>: Temporal distance increases behavioral intention to switch an advisor.

#### *2.4 Interpersonal Trust in the Recommender of the New Advisor*

When we think about trust, for the purpose of this study, we are talking about the transfer of initial trust in the financial advisor from one person to the next. To be clear, initial trust is defined as trust being present before one person knows the other (McKnight, Cummings, & Chervany, 1998). Practical experience in the services space has shown that it takes time to build trust, and this also holds true to a degree for many theories in the trust-based literature. As such we propose that the same applies in this study too.

H<sub>3</sub>: Interpersonal trust in the recommender increases behavioral intention to switch an advisor.

#### *2.5 Risk Tolerance*

Risk tolerance, in the investments universe, is often associated with portfolio construction and asset allocation (Nguyen, Gallery, & Newton, 2016). Defined as “the maximum amount of uncertainty someone is willing to accept when making a financial decision,” risk tolerance helps to shape the portfolio mix for investors given certain risk/return characteristics (Grable, 2000, p.

625). The literature in this area cites two primary stances to identify antecedents to a person's level of risk tolerance: that of rational behavior as referenced in utility theory, and the other being that investors behave irrationally based on inherent biases, which is popularized through behavioral finance and prospect theory, or the individual's differences in perception of gains vs. losses (Kahneman, 1979; Tversky, 1984). Prior research focuses on predictive models using risk tolerance as a key determinant for making investment decisions; again, typically in the form of asset allocation (Nguyen et al., 2016). But our study views risk tolerance somewhat differently. For the purposes of our research, by which we try to connect a prospect to an advisor based on external relationships and personal characteristics, risk tolerance is viewed as a personality trait (Roszkowski & Davey, 2010). It doesn't serve its typical purpose as a prerequisite for investment advice; but rather, can risk tolerance, as a personality trait, help predict how a person might switch to do business with an advisor present other interpersonal circumstances?

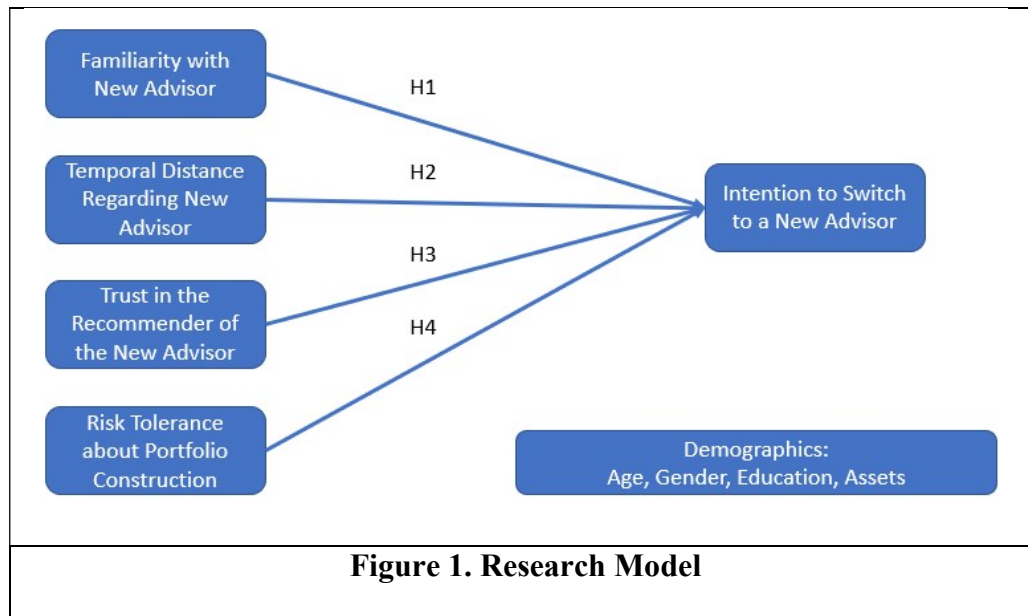
Much of the literature in the finance and risk space leads to an end game of asset allocation or portfolio construction. For instance, we know through prior studies that risk-tolerant individuals are less likely to invest in conservative asset classes (Hariharan, Chapman, & Domian, 2000). But to what extent does the behavioral intention go beyond asset allocation decision making? We intend to see if risk tolerance, at the portfolio level, has any bearing on behavioral intention when it comes to switching an advisor. In order to better understand risk tolerance's place in this model, we need to understand a supposed baseline assumption that people are rationally risk-averse. This is supported by research in the financial markets that studied the impact of surprising news, both good and bad, on the changing values of stock securities (dependent on the timing of resolution). The findings suggest that negative news, which was resolved, had a positive price reaction for the securities "caused by rational risk-averse investors' demand for higher expected returns to

compensate them for the increased uncertainty induced by the surprise,” (K. Brown, Harlow, & Tinic, 1988, p. 358). Furthermore, even a perceived reduction of uncertainty through anticipated action can seemingly mitigate the assumed risk (Brewer, Weinstein, Cuite, & Herrington, 2004). The logic being, “If I choose to work with a financial advisor, my perceived risk of uncertainties around wealth management is transferred to the advisor, and as a result, I am more likely to act on said intention.”

H4: Risk tolerance increases behavioral intention to switch an advisor.

In all the above hypotheses, the dependent variable is behavioral intention to switch an advisor. Behavioral intention is the primary antecedent of behavior as outlined through the Theory of Reasoned Action (Ajzen & Fishbein, 1980) that proposes that people process information and use social and contextual cues, which then influences their actions; these influences coming in the form of attitudes, beliefs, past experiences, etc. The research model is shown in Figure 1. Added to the research model are the demographics of age, education, gender, and level of investable assets. Personal experience in the field of wealth management would suggest that age and level of investable assets may impact decisions. The wealth management industry is predominantly older when it comes to financial advisors. Intuitively, many would agree that it takes time and experience to develop a well-rounded knowledge base to competently run a book of business. Also, if we can assume that high-net-worth individuals and families are more likely to match an older demographic, then we could likely deduce that an older clientele might be more inclined to want to do business with a more established professional. For context, the Federal Reserve Survey of Consumer Finances from 1989-2019 shows that the highest average net worth in the U.S. in 2019

was for those aged 65-74 and was just over \$1.2 million. These statistics seemingly pose a challenge to the ‘younger’ advisor demographic trying to climb the ranks. Interestingly, though, experience has shown that younger people with wealth actually prefer to work with an older advisor with more experience, and the inverse, at times, is true as well. The ‘older’ client seems to like the idea of working with a younger advisor who could grow with the family and outlast the patriarch/matriarch, thereby offering a stable and familiar relationship across different stages of the family’s wealth planning and wealth transfer needs. The level of investable assets was also added because we know from experience that individuals and families with higher levels of wealth often have more complex financial plans. That being the case, we wanted to make this study applicable to the high-net-worth space, and as such, we included a demographics question in the survey with a range of investable assets that best aligns with the respondent.



### 3. Data Collection

The scales in the study were adapted from previously validated scales. Behavioral intention is measured using an adaptation of a number of existing scales to best capture the respondent’s



intention to switch to another advisor, in the event that he or she already has a financial advisor (Chang, Liu, & Chen, 2014; Lee & Lee, 2009; Liu, Marchewka, Lu, & Yu, 2005; Woodside, Frey, & Daly, 1989). Familiarity is advised by existing scales measured by experience and is measured as a question of quantity: “How many times have you interacted with the financial advisor?” (Gefen, 2000; Prestopnik & Roskos–Ewoldsen, 2000). Temporal distance is measured through an adaptation of existing scales used to examine time as a factor in the decision-making process (Trope & Liberman, 2000). Trust in the recommender of the new advisor is measured using an adaptation of existing scales from prior studies within the trust literature domain (Gefen, 2000; Johnson-George & Swap, 1982). Risk tolerance uses an adaptation of an existing risk tolerance scale that identifies perceived risk characteristics at the personal level as well as at the portfolio level (Grable & Lytton, 1999). The survey items are shown in Table 1.

Before respondents began filling out the questionnaire, it was important that we provide context for the survey items so that the respondents could place themselves in the given scenario to better navigate through the questionnaire. This context should enhance readability and comprehension, and as a result, garner more thorough, precise and thoughtful responses. With that in mind, we provided a prologue at the front of the survey to set the scene. We described a hypothetical scenario in which the respondent has inherited a sum of money and is relying on referrals or recommendations in order to come to a decision to switch to a new financial advisor. We received 852 complete, or partially complete, questionnaires. 195 declared as males, 575 as females, and 143 skipped the question. Age, 23 were in their 20s, 128 in their 30s, 107 in their 40s, 55 in their 50s, and 456 in their 60s. Education, 2 had Less than High School, 45 had High School Diploma or GED, 37 had an Associate's Degree, 242 a Bachelor's Degree, 303 a Master's Degree. 73 a Professional Degree, and 68 a doctorate. Asset levels were 23 up to \$.5M, 33 \$.5M-\$1M, 76

\$1M-\$1.5M, 82 \$1.5M-\$2M, 85 \$2M-\$2.5M, 105 \$2.5M-\$3M, and 366 more than \$3M.

#### 4. Data Analysis

The convergent and discriminant validity of the scales was evaluated through a Principal Components Analysis (PCA), shown in Table 1. Color coding was superimposed for easier reading. Convergent validity is shown when items that reflect the same latent construct load highly ( $>.60$ ) on the same principal component. Discriminant validity is shown when items that do not reflect a certain construct load low ( $<.40$ ) on its principal component. The reliability of the scales reflected by the principal components is shown as Cronbach's Alphas together with their descriptive statistics in Table 2.

**Table 1: PCA Factor Analysis**

Item Code	Item Wording	Factor1	Factor2	Factor3	Factor4
Trust in the Recommender of the New Advisor					
TR_1	I trust the recommender/person making the referral.	0.15	0.89	0.15	0.21
TR_2	The recommender/person making the referral is trustworthy.	0.10	0.93	0.09	0.15
TR_3	The recommender/person making the referral is benevolent.	0.11	0.92	0.10	0.13
TR_4	The recommender/person making the referral tells me the truth.	0.12	0.92	0.11	0.15
Risk Tolerance about Portfolio Construction					
RISK3_3	How likely are you to invest the full inheritance in high risk growth stocks?	0.39	0.04	0.71	0.26
RISK3_4	How likely are you to invest the full inheritance in domestic U.S. stocks (moderate risk)?	0.04	0.19	0.82	0.03
RISK3_5	How likely are you to invest the full inheritance in global, non-U.S. stocks (elevated risk)?	0.31	0.11	0.78	0.22
Temporal Distance Regarding New Advisor					
TEMP_1	I need to choose a financial advisor sooner rather than later.	0.34	0.16	0.24	0.79
TEMP_3	Time is a factor in choosing a financial advisor.	0.28	0.28	0.26	0.73
TEMP_4	I would like to choose a financial advisor within the next couple of years.	0.36	0.24	0.03	0.66
Intention to Switch to a New Advisor					

BI_S_1	I am likely to switch to the referred advisor.	0.89	0.12	0.19	0.28
BI_S_2	I intend to switch to the referred advisor.	0.90	0.14	0.18	0.26
BI_S_3	I am willing to switch to the referred advisor.	0.88	0.15	0.16	0.21
BI_S_4	I am determined to switch to the referred advisor.	0.86	0.11	0.24	0.27

**Table 2: Descriptive Statistics**

Variable	Mean	Std. Dev.	Cronbach's Alpha
Intention to Switch (BI_S)	3.9696	1.8173	0.96
Trust in the Recommender of the New Advisor (TR)	5.5651	1.3205	0.96
Risk Tolerance about Portfolio Construction (RISK)	4.5828	1.5833	0.79
Temporal Distance Regarding New Advisor (TEMP)	4.4802	1.6103	0.81
Familiarity with New Advisor (How many times have you interacted with the financial advisor?)	5.5077	9.6209	Single item
Age	5.0260	1.2989	
Gender	1.7468	0.4352	
Education	4.6753	1.1910	
Asset levels	5.5351	1.7665	
Familiarity with New Advisor (How long have you known the financial advisor?)	8.0656	10.9383	

The hypotheses were tested with a general linear model (GLM). The model successfully predicted behavioral intentions to switch an advisor ( $F=58.48$ ,  $p\text{-value}<.001$ ,  $R^2=58\%$ ). Behavioral intentions were increased mostly by Temporal Distance ( $\beta=.42$ ,  $p\text{-value}<.001$ ), supporting  $H_2$ , Risk ( $\beta=.17$ ,  $p\text{-value}<.001$ ), supporting  $H_4$ , not so by Trust ( $\beta=.06$ ,  $p\text{-value}=.137$ ), not supporting  $H_3$ , and counter to the hypothesis, reduced by Familiarity with New Advisor ( $\beta=-.01$ ,  $p\text{-value}=.005$ ), not supporting  $H_1$ . The intercept was significant ( $\beta=3.08$ ,  $p\text{-value}<.001$ ). Age reduced behavioral intentions to switch ( $\beta=-.42$ ,  $p\text{-value}<.001$ ). Gender was insignificant ( $F=.46$ ,  $p\text{-value}=.500$ ), as was asset levels ( $F=.77$ ,  $p\text{-value}=.594$ ). Among the education levels, only Associate's Degrees marginally reduced behavioral intentions to switch ( $\beta=-.50$ ,  $p\text{-value}<.043$ ). The other education levels were all insignificant. As a post-hoc analysis, we re-ran the GLM on behavioral intention to switch to a new advisor without temporal distance and found that trust in

the recommender of the new advisor became highly significant ( $\beta=.22$ ,  $p\text{-value}<.0001$ ).

## 5. Discussion

Based on a combination of theory and personal experience, we thought that a reliance on referrals would build trust in the financial advisor; and that transfer of trust would influence the choice of the prospect to switch to the new advisor. The findings, however, show that our hypotheses around trust and familiarity were not fully supported. The findings on temporal distance and risk tolerance, on the other hand, were statistically significant in predicting behavioral intentions to switch to a new advisor. The negative coefficient on age is noteworthy, meaning the older you are, the less likely you are to switch to the advisor receiving a referral. Given the surprising result of trust (statistically insignificant) on behavioral intention to switch, the post-hoc analysis added another layer to our story. Upon removing temporal distance from the GLM, trust became a predictor of behavioral intention to switch, which means that temporal distance fully mediates the relationship between trust in the recommender of the new advisor and behavioral intention to switch to a new advisor. This mediating effect is verified by the following significant correlations ( $p\text{-value}<.001$ ): TR to TEMP  $\rho=.47$ , TR to BIS  $\rho=.32$ , TEMP to BIS  $\rho=.67$ .

### 5.1 Contributions

Trust-based models have been studied in some shape or form over the past several decades to gain insight into consumer behavior and behavioral intentions. Trust, familiarity and behavioral intention are staples in the information systems literature. Construal level theory weaves its way through much of the social psychology research, and components of risk and risk tolerance are oft-studied throughout the areas of business psychology and consumer finance. While each of these respective domains helps us understand how and why each of our constructs are interconnected, there seems to be a gap in the literature that 1) brings them all together, and 2) does so in the

context of financial services and private wealth management.

Perhaps our most notable contribution to the literature is the linking of our industry context with construal level theory. Consider that much of the research on CLT attempts to conceptualize the psychology behind choice and behaviors based on near and distant events, relationships, etc. But when the behavioral intention involves choosing a financial advisor, which can have personal and familial consequences, it's possible that the underlying risk and uncertainty can affect the outcome accordingly. We discussed earlier how different lenses of uncertainty (i.e. performance uncertainty or the uncertainty of switching-costs) impacts construal levels differently. Our study can be interesting and a value-add across any and all of the aforementioned domains of research pertaining to our model, particularly as it relates to CLT and financial services. For instance, if varying types and/or levels of risk are influencing these direct effects, then pinpointing the specifics can only bring about more clarity to advance the research in a meaningful way.

### *5.2 Managerial Implications*

This research was geared toward identifying key antecedents predicting the investor's level of trust in the financial advisor even before an in-person interaction takes place. If we could do this, then maybe we could truncate the time required for new client acquisitions from prospecting to onboarding. The intent was to help guide the financial advisors so they could shape their business plans accordingly to be better positioned within the marketplace. With this as a backdrop, we think the practical use implications are many. First and foremost, understanding the drivers behind trust and behavioral intention are paramount when engaging in a prospect/advisor relationship. If advisors can grasp the impacts of familiarity, temporal distance and risk tolerance on trust levels and/or the likelihood for behavioral intention, then this can affect everything from business models to resource allocation, event planning, hiring practices, etc.

### *5.3 Limitations and Recommendations for Further Research*

Because we wanted the study to be meaningful in the private wealth management space, it was important that we had a sample size of respondents who met the minimal assets thresholds to qualify for the high-net-worth metrics. Of course, we recognize that each institution defines high-net-worth differently, but for our purposes we define high-net-worth as having a minimum of \$3 million in investable assets. Ideally, we could distribute the survey to clients who already work with financial advisors within this field, but there are client confidentiality restrictions at the institutional level that made this nearly impossible. With that said, we had to compromise our scales for the investable assets demographic per panel restrictions. We wanted to make sure we had a significant sample size for our research, and as such, we included investable assets scales of \$2,500,001 - \$3,000,000 and > \$3,000,000. We do have respondents in this study who fall below these thresholds, but perhaps there is an opportunity for further research to tap into a demographic group with higher, more defined levels of investable assets and with different breakpoints to see how the data might differ.

Echoing an earlier point, the financial advisory industry is riddled with stringent, competitive sales goals. The challenge, however, is that financial services is very much a ‘trust’ business; and past experience and prior research has shown us that trust takes time to develop in order to foster a strong, healthy business relationship. This fundamental concept is the practical business case ‘problem’ we’ve identified, which serves as the basis for our research. In essence, what we are trying to solve for is a way to shrink the time required for the courtship process between financial advisors and prospects. This is just one way to think of the problem though. Alternatively, what if we tried to solve for a way to change the ever present, and ever demanding sales cycle (in terms of time constraints)? In other words, instead of trying to shrink the time

needed to bring in new business, how can we justify, from a practical business case, lengthening the sales cycle to ensure there is ample time for a trusting relationship to develop appropriately? One recommendation to address this idea is to re-examine the *temporal distance* construct. Instead of looking at this variable from the perspective of ‘how much time the prospect has to make a decision on a financial advisor,’ perhaps it should be looked at from the financial institution’s point of view to see how much time can and should be allotted for new client acquisitions.

To continue this research, we could expand upon the referral as a precursor to our Trust construct. Referrals have long been considered one of the more important factors contributing to consumer behaviors (J. J. Brown & Reingen, 1987). There has been extensive research linking referrals and trust, especially most recently in the technology domain and within information systems research. Studies over the past couple decades have focused on electronic word-of-mouth (eWOM) and the subsequent effects on trust and behavioral intention. While the specificity of eWOM as a mode of communication is just outside the purview of our research, we can still reference the findings to make cogent connections between our central constructs.

#### *5.4 Conclusion*

This research reviews the relevance of referrals and the inherent transfer of trust as a necessary aid with respect to client acquisition in the field of financial services. It also reviews findings throughout the trust-based literature that make connections between familiarity and trust and their pivotal role in predicting behavioral intentions. Lastly, we learned that construal level theory certainly has a place within our defined context, but our study merely scratches the surface as to the potential for new and interesting discoveries in this area.

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## Using Analytics to Quantify the Best Advertising Medium

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### Abstract

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.

### Keywords

Data analytics, Social media, Organic search, Advertising, Referral, Paid search, email

### Introduction

When it comes to online advertising a business, two significant factors to consider are budget and where to spend that budget. Relatively large corporations generally have a larger budget of advertising dollars to spend. In 2005, companies such as General Motors and Proctor and Gamble spent \$3.43 billion and \$3.32 billion respectively (Bagwell, 2005). Small and medium sized businesses, which act as economic drivers for employment in the US, have significantly smaller advertising budgets (Torres et al., 2021; Harvard Review, 2013). Each dollar must count and needs to yield the largest impact possible. The internet has provided access to a captive audience seeking products or quick access to information. In 2003, 24% of online users accessed the internet to make a purchase while in 2016, this number had grown to 79% (Manju et al., 2003).

There are multiple channels of online advertising to consider with internet marketing. These channels are organic search, referral, social media, paid search, and email. Organic search refers to websites or businesses that appear during a search, without paying the search engine for ad placement. Referral is defined as traffic that comes from another website, also known as a source. Social media marketing is defined as posting text, images, and videos to reach the intended audience. Paid search refers to websites or businesses that appear during a search by paying the search engine for ad placement. Email is essentially the same as directly mailing material using the postal service but realized electronically.

Investing time and money advertising across all channels can be wasteful and ineffective depending on the targeted consumer you want to reach. Narrowing down a specific focus for a targeted demographic across all these channels is a challenge. Most businesses contemplate how to spend their advertising dollars using these channels and consequently selectively pick one or two as a focus. Some businesses find that they spread their budget so thin across all these channels that they yield almost no measurable results budgets (Torres et al., 2021; Harvard Review, 2013). Using measurable data can help to determine the most optimal channel to spend the advertising budget. Businesses that decide to ignore the significance of online advertising are likely to fall by the wayside. Individuals of all demographics are turning to the internet to find products and services, which is not a surprise. It has been widely accepted and recognized that the internet has influenced lowering transaction costs and increasing the level of competition (Haucap et al., 2013). With the closure of many brick and mortar stores, a strong emphasis has been placed into online sales. The businesses that choose the best and most optimal places to put their advertising budget should ultimately have the best results from their online campaigns.

What generates the most traffic of new users to a business's website? As a starting point to answer this question we contend that businesses already have implemented a good customer retention model and that the most value is generated through new potential customers discovering a website for the first time. The objective of this study is to quantify online traffic across all demographics and measure their results independently of any other factors. Several studies have been done looking at online behavior based primarily on age and gender, but this question observes behavior in a more general everyday usage pattern, an industry benchmark, that has not been measured inclusively. (Croes et al., 2021; Hernandez et al., 2021).

The goal of this study is to answer the question, "Where is the most effective place online to invest a business' marketing budget?" Entering this study, we have initial hypotheses about what is most effective. On a broad spectrum, organic search and social media are likely to be the two channels with the best results. In recent years a very large emphasis has been placed on social media, even much more than traditional search. Does social media generate more new business than other methods? Our initial thought is that it does not. This assumption is grounded in the idea that an internet user will likely experience or be introduced to a brand outside of social media initially. Engagement with social media are likely individuals, who are aware of the brand. Customer retention is crucial, but to retain a customer, they must first discover the business.

## **Literature Review**

This research is focused on studying the role or impact that various online advertising channels have on first time site visitors. The researchers take a quantitative approach towards looking at the data collectively. One of the key areas of the study is the effectiveness of organic advertising. Organic search refers to websites or businesses that appear during a search, without paying the search engine for ad placement. These site links are listed in a relative to their relevance to the search phrase (Xu et al., 2012). While organic traffic is unpriced by the search engine, it has been reasonably estimated that it is at least as valuable as paid search (Edelman, 2016). An example of a paid search is the use of Search Engine Optimization (SEO), which focuses on increasing the rank of search results. Advertisers in 2013 spent \$18.4 billion in Search Engine Optimization (Edelman et al., 2016).

Studies of eye movement on search engine results observed that nearly all study participants gave most of their attention to the top three organic links (Xi et al., 2012). This idea fits into our initial theory going into the study, namely that organic search is going to be the top driver of consumer traffic. It has been suggested that organic results are more relevant forms of advertising because the keywords and message closely fit the search phrase that was entered by the consumer (Yang et al., 2010).

In a study by Johnson, Lewis, and Nubbermeyer (2017), the researchers developed a methodology to measure the effects of advertising. We are not focused on this type of metric but instead this research paper determines the online channel that most people utilize to find a desired website. By using businesses in a wide array of industry, this will provide us with a snapshot of average user traffic and how they discover websites.

Two other channels, namely referral and social media do not have as much research associated with them in terms of their effectiveness for advertisers. However, they do have a large user base. The most popular social network that advertisers engage is Facebook, which is not surprising with its large quantity of users. Both the US Federal Trade Commission and The European Commission are becoming increasingly skeptical if companies like Facebook actually offer market power (Haucap & Heimeshoff, 2013).

Our research sets out to look at a snapshot of internet traffic, across multiple demographics, over a three-year period and to make conclusions on advertising dollar effectiveness based on measurable trends.

## **Methodology**

In this study, we measure internet user behavior and how consumers find a business for the first time. Therefore, to ensure the foundation and stability of the data, we had to develop a method that was not specific to gathering data and that was unique across all demographics to get a snapshot of overall online user behavior. Many studies outline behavioral differences between members of various age groups, but that does not provide an overall sample of all internet users (Croes et al., 2021 & Hernandez et al., 2021).

Much detail and selection went into preparing a proper data sample that would allow for data to reflect the broad demographical differences. It was determined that a sample of businesses and organizations that covered different industry verticals would be a good fit for our initial study group. Twelve participants were selected for participation based on their level of investment in digital marketing. The participants in this study were primarily in one of four primary industry verticals. This encompassed specialty online retail, home service providers, business consultants, and realty. By design, these broad participants were selected to provide an unbiased sample of internet traffic that covered geographic regions across the United States. Additionally, these participants were selected so that the demographics of their target market such as age, gender, education and income level were all equally accounted.

Utilizing Google Analytics to qualify behavior actions, data collection began in January 2017, and we concluded the data collection in January 2020. This provided a visual data log of user behavior over a period of 3 years. We narrowed the data down to website visitors that fit the following criteria:

- The internet user had never visited the website of a study group member prior to the study

- The internet user did not manually enter in the website URL
- The internet user discovered the website through a measurable traffic channel

The criteria for narrowing the collected data were critical. The interest of this study is to measure online behavior of internet users finding a website for the first time. Removing repeat visitors and excluding data for users that manually entered the website address into their browser ensured that the user was both visiting for the first time and discovered the website through an online channel rather than some other form of traditional advertising.

To measure the effectiveness on various online strategies we determined various channels or groups to combine various online services. When defining these groups, services or websites with little impact under 1% of engagement in their channel demographic were considered *other*, since their results were not relevant to answering the question of this study.

*Organic* referenced organic search or an individual discovering a website through a search engine. The organic channel is comprised of services including Google, Bing, Yahoo, Ask, AOL, Baidu and others. The referral channel classification is when a discovery method such as the internet user finding a site from an online directory or link from an affiliated website. A *social channel* referenced internet users that discovered a website through a social media service such as: Facebook, Yelp, Pinterest, LinkedIn, Instagram, Twitter, YouTube and others. The *paid channel* referenced any internet user that discovered a website through an online advertisement, such as a display ad or search ad. The email channel is based on adds sent/received to a user’s email address. Therefore, we are placing multiple online services and methods into these five primary channels of organic, referral, social media, paid search, and email. This will allow us to measure each unique channel effectiveness to then break down those that perform the highest to have a more granular outlook on which online method yielded the most relevant website traffic.

**Results**

At the conclusion of the thirty-six-month data collection period, we began to quantify the data and determine what data was relevant to the study based on the method outlined above. Over the period, data was gathered on over several million online interactions. We narrowed down the targeted data to 383,030 users that were first time visitors to a website within our study. From the first-time users, we then eliminated any users that may have discovered the website from other forms of marketing such as radio, billboard, or print advertising. This left us with a solid sample of 270,006 internet users that we could, with a high level of certainty, conclude were first time visitors of the website and discovered it through an online channel that we were observing. We added a sixth channel called *other* that contained first time traffic generated primarily through lesser-known services that were not yet categorized by Google Analytics. This accounted for a small, but measurable amount of traffic.

New User Discovery by Channel	
Organic Search	68.51%
Referral	16.36%
Social Media	4.58%
Paid Search	7.83%
Email	1.74%

Other	0.97%
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**Table 1: Percentage of New User Discovery by Channel**

There are several aspects of the results that were surprising when completely quantified. While our initial hypothesis was accurate on organic search generating the greatest number of new users, the total percentage of new user traffic was higher than anticipated. We had expected paid search to have a larger attribution of new user acquisition, however it accounted for only 7.83%. Additionally, we expected the social channel to have a larger impact than the 4.48% of traffic the sample attributed. The results of email marketing campaigns were expectedly low, scoring 1.74%. By taking the results and evaluating the marketing strategies of the twelve companies that participated in the study, we were able to make some further determinations. The primary determination was that approximately half of the companies in our sample actively participated in paid search programs. This explained the surprisingly lower number of new user acquisition from paid search. However, all twelve confirmed participations in social media marketing. We determined that further research is needed to determine the effectiveness of email marketing because only one company reported active campaigns. The results gathered for organic, social, referral and paid search were all very strongly correlated with less variance.

### Organic Dominance

While our hypothesis was that organic search would be a top performer, it was not expected to account for over 68.51% of new internet traffic. Based on company spending and focus, we expected a much closer gap between organic and social channels. By contrast, while all participants participated in social media, less actively focused on organic. For all the effort in social, a little over 4.58%, reflects a very disappointing under performance. Social media in this study was also outperformed by paid search and referral traffic. While other studies have shown it performing higher, those studies tend to focus on a specific age or other defining characteristic of the consumer (Croes et al., 2021 & Hernandez et al., 2021). These results indicate that the social channel far under performs the expectations that business owners perceive it to provide.

By determining that 68.51% of internet traffic for new site discovery resulted from organic search, we took a more detailed look at the organic channel to see which conduits were producing the best results from the channel group.

Organic Channel Group	
Google	91.05%
Bing	5.34%
Yahoo	2.61%
DuckDuckGo	0.48%
Yandex	0.01%
AOL	0.03%
Other	0.49%

**Table 2: Percentage of Organic Channel Group**

The results of the breakdown in traffic by search providers in this channel was not surprising. Over 91% of new users that discovered a website for the first time through organic search, found it through Google. From this observation, if a business wants to gain the most exposure to new users, they should focus on organic search and specifically Google Search.

### Referral Channel Observations

Referral traffic, which was not initially thought to provide a significant amount of traffic was the second most prevalent channel after organic search. Referral traffic is defined as traffic that comes from another website, also known as a source. The one inconsistency we found with the referral data was that in many instances it included traffic from search engines such as DuckDuckGo or Badiu. The reason for this is due to how these search engines behaved and how Google’s Analytics platform categorized them. Technically we can associate 10% of the referral traffic to other search engines, which should be categorized as organic. Similarly, direct email marketing also appeared in the referral data. After investigation, it was determined that most email marketing software’s track user engagement on emails. This creates an interaction that is interpreted as a referral, because the email came from a third-party service.

Affiliate links proved to be the supplier of most of these first-time interactions. Some participants in this study had active referral programs where a website would get some form of commission for their referral. These links were included on a variety of online blogs, where bloggers would write about and promote the company or product. Some of these affiliate links were in the form of paid placement such as a banner ad and others were in-text links. Affiliate programs are a common way for bloggers to monetize their writing. Industry blogs also accounted for 25% of traffic in this channel. This would be references to a specific business within their industry vertical. Online directories were also a common source of referral traffic. This segment includes Chamber of Commerce Directories, Association Listings and professional referral sites such as Angie’s List.

Referral Channel Group	
Affiliate Link	68%
Industry Blog	25%
Online Directories	10%
Other Search Engine	10%
Direct Email Marketing	2%

**Table 3: Percentage of Referral Channel Group**

### Social Media Observations

With the conclusion that Google dominates the organic channel, we investigated how the metrics for social traffic broke down across platforms. Again, all study participants said that they engaged in social media marketing to promote their business. Not surprisingly, the businesses in the sample reported a concentrated focus on Facebook, Instagram and Twitter.

Social Channel Group	
Facebook	79.26%
Yelp	5.86%
Instagram	6.57%
LinkedIn	0.98%
Reddit	3.98%
Pinterest	0.99%
Twitter	0.66%
Youtube	0.44%



Other	1.25%
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**Table 4: Percentage of Social Channel Group**

It was not surprising that Facebook dominated the social channel, but it was shocking that with our sample, it comprised nearly 80% of all social traffic. Considering the efforts and advertising that businesses in our sample applied to Yelp, LinkedIn, and Instagram, we had higher expectations for their performance.

### Further Research

From the perspective of new user discovery, we can confidently determine that Google generates the largest amount of discovery for websites. The social channel performed much lower than was anticipated considering the monetary amount put in by each company in our sample. Additional study is required to look at the growth overtime for the social channel to determine the amount of overall channel growth as users are exposed to a brand. However, this study concludes that a focus on organic traffic and Google search yields the best results for businesses looking to acquire new first-time customers online.

### Acknowledgements

For Aunt Marie, Shadow, John, and Maria

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# What Factors Influence Hypermarket Sales? Using Buyer Behaviour Framework to Explore the Consumer Buying Habits

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## **Abstract**

The buyer Behaviour theory talks about the purchasing decisions that the people make. The pattern of buying Behaviour has been observed to be very repetitive in nature. The data for this research was collected in the form of online reviews as well as structured interviews. Text mining was used to find the variables that were important and influenced consumer buying Behaviour. Later on, a questionnaire was applied to analyse the relative importance of these variables. T test was conducted, followed by factor analysis. Recommendations were made to the hypermarket based on the findings, on the steps that need to be taken to improve growth in their sales.

## **Keywords**

Text mining, Factor Analysis, T test, Discriminant Analysis, Buying Behaviour, Variety, Bundling, Store environment.

## **1. Introduction**

The way the buying Behaviour of the consumer has evolved in the last decade has been responsible for the shaping up of the retail sector to quite some extent. Retailers are continually pursuing new retail strategies and implementing various marketing approaches in response to

changing consumer purchasing behaviour in order to ensure that customers return time and time again. Marketers, in general, find it difficult to understand why consumers behave the way they do. Aside from innate characteristics such as attitudes and behaviour, there are other external elements such as product variety, pricing, and ongoing promotions that have a role in the customer's purchasing decision. The framework of Buying Behaviour used here emphasises the relevance of the response variable, as well as the stimulus, exogenous variable, and speculative constructs.

## **2. Literature Review**

The buyer Behaviour theory talks about the set of processes that take place while making a buying decision. The buyer generally goes through five stages that starts with problem recognition. (Kotler & Keller, 2006). The second stage is the search for information. The examination of alternatives comes next. After all of this, the purchase decision is made, and after that, the post-buy behaviour occurs, which is the final stage.

Store features include a variety of parameters like the layout, how involved the staff of the store are, as well as the atmosphere of the store (Tinnie et al., 2010). Aside from them, the product positioning and store design are key considerations. There is also a decoy effect noticed in hypermarkets as a result of offers and bundling. The salesperson's persuasion approach also effects the customer's behaviour.

Consumers are looking for solutions rather than products (Rowley et al., 1997). They tend to buy a cluster of product features instead of a product, but they may only want one or two of them. So, solutions are something that the consumers tend to look at more.

Uncertainty is the primary driver of customer search (Bettman, 1979). Utilitarian value is related to the task while hedonic deals with the emotional angle of the experience. (Holbrook & Hirschman, 1982; Babin et al., 1994).

## **3. Research Questions**

Here we intend to answer the following research questions.

- How does the variety of the product as well as the product placement affect the purchasing Behaviour of the consumer?
- Is it required to group complementary product items? What is the significance of the pricing factor?
- How significant is location to consumer preferences? Would you be more likely to buy if you received better and friendlier customer service?

## **4. Methodology**

We interviewed the consumers who were present. Text mining was used to determine the elements that buyers valued the most during their purchasing experience. Based on this, we

found a set of criteria that shoppers valued. We did descriptive research across geographies to acquire customer insights.

A questionnaire was floated to cover the various aspects of the generated insights from the Qualitative Research. The survey received 341 responses, and for the analysis, SPSS was employed. T-Tests were performed which was followed by Cluster Analysis, Factor Analysis, and Discriminant Analysis.

Null Hypothesis was that  $H_0$ : Independent Variable = 0.

Alternative Hypothesis  $H_a$ : Independent Variable not equal to zero

The following variables that were found out using the text mining were tested. These variables were the mood of the customer, Behaviour of the staff, selling price, store environment, the diversity of the products being sold, Promotions as well as Bundling Offers and Customer Loyalty Programs.

## 5. Results

The results of the one sample T-test will be shown here, indicating whether variables are statistically significant. The variables on which the T-tests were done are listed below. The sample size of the respondents, as well as the mean, standard deviation, and standard error mean, are presented in the tables below. The other table displays the results of the one sample T-tests. All of the variables have values that indicate they are statistically significant.

### 5.1 One Sample Statistics

	N	Mean	Std Deviation	Std Error Mean
Store Environment	341	3.01	1.067	0.078
Product Assortment	341	2.35	1.033	0.081
Selling Price	341	2.79	0.873	0.095
Staff Behaviour	341	3.09	1.072	0.097
Customer Mood	341	3.51	1.065	0.093
Promotions	341	1.99	1.323	0.098
Loyalty Programs	341	2.03	0.915	0.083

### 5.3 Discriminant Analysis

To find the multivariate differences between the two groups, discriminant analysis was done. Here the grouping variable was taken to be gender.

**Male:** Most Important Factor was found to be Price. Hence, they gave a lot of importance on the Discounts that were available on the Products.

**Female:** Most Important Factor was the assortment or the diversity of the Products that were available and the Least Importance was given to the Behaviour of the sales representatives.

### 5.2 One Sample Test

	t	df	Sig. (2-tailed)	Mean difference	95% Confidence Interval of the Difference (Lower)	95% Confidence Interval of the Difference (Upper)
Store Environment	25.723	341	0.00	1.303	1.12	1.73
Product Assortment	17.539	341	0.00	2.035	1.57	1.99
Selling Price	35.625	341	0.00	1.057	2.07	2.59
Staff Behaviour	29.123	341	0.00	3.093	3.53	3.85
Customer Mood	35.235	341	0.00	2.157	2.73	3.09
Promotions	25.953	341	0.00	2.987	2.17	2.73
Loyalty Programs	27.723	341	0.00	3.011	1.35	1.95

### 6. Theoretical contributions and Implications for practice

The first addition is that it applies buyer behaviour theory to the context of a hypermarket. It demonstrates how this theory supports stages such as need awareness and buying decisions in the hypermarket setting.

The second theoretical addition is that it can be employed in market segmentation when customer segmentation is done by gender and individual distinguishing characteristics between the two groups are to be considered.

Another essential tip is to focus on Customer Lifetime Value (CLV) rather than single purchase value when developing long-term connections with clients.

Home delivery choices should be made available through intra-day delivery to provide clients with convenience. Everyday Low Pricing should be made known to customers. Customers have strict time constraints and are unable to accommodate dynamic discount offers and answer on the same day.

### 7. Conclusion

The primary purpose of our research was to investigate how hypermarkets can enhance their sales while accounting for numerous external and internal factors influencing the shopping habits of persons with excessive buying behaviour.

The text mining approach ensured that all variables were correctly detected before constructing the questionnaire questions in such a way that they cover a wide variety of topics in an attempt to understand customers' behaviour before and after visiting hypermarkets.

Every stage of the consumer decision-making process when shopping in hypermarkets was investigated, beginning with need awareness and progressing to product information gathering.

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# **Abstracts**

# **Accounting, Finance, Economics**



# A Comparative Analysis of the Determinants of the United States and United Kingdom Banks' Profitability

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Abstracts

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Since the 2008 financial crisis, banks in the United States (U.S.) and the United Kingdom (U.K.) have experienced poor and fluctuating profit performance. In addition to the financial crisis, the ensuing economic recession, the European debt crisis, and the negative impact of lockdowns during the COVID-19 pandemic did great harm to both economies of the UK and the U.S. The withdrawal process of the U.K. from the European Union (BREXIT) in 2020 could be one of the external factors that contributed to this U.K. banks' poor profit trend.

A successful flow of investments to households, corporations, individual investors and governments depends to a large extent on a healthy and stable banking sector. This is more so for the U.K. than the U.S. as the U.K. is more reliant on the banking system for financial intermediation.

This study investigates the determinants of the profitability of U.K. banks and compares them with already established and published determinants of the profitability U.S. banks. Employing quarterly data, this paper further examines the historical and recent trends for all U.K. banks from 1996 to 2019 in the relationship between return and assets (ROA) and other bank internal (or endogenous) profitability contributors such as net interest margin (NIM), loan loss reserves, ratio of non-performing loans to gross loans, and external (or exogenous) macroeconomic variables, such as the 30-year average mortgage rate, Gross Domestic Product (GDP) economic growth rate, unemployment rate, interest rate, inflation rate and openness by using the Generalized Method of Moments (GMM) estimator technique.

# Disruptive Education of College of Business Students after the 2008 U.S. Financial Crisis in a Post-Pandemic World

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Abstracts

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***Dr. Carmen Quirvan***<sup>1</sup>

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## ABSTRACT

We must consider the pandemic as an opportunity to change the education of college of business students. During the last years of this century, the 2008 U.S. financial crisis and the 2020 pandemic are two main economic events that have directly affected the education of these students. Indeed, I consider the pandemic a crisis of the health system around the world.

This is the time that colleges need to improve the curriculum for college of business students including concepts such as the economic events of the 2008 U.S. financial crisis and the 2020 pandemic. Among the areas impacted are management, finance, accounting, supply chain management. We need a strong economy in the U.S. with students who are aware of the real problems to solve to transform this nation from a debtor nation to a lender nation with a strong currency.

# Disruptive Taxation—A Case Study of How Financial Engineering Failed to Enhance Shareholder Value

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Abstracts

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***Dr. A J Stagliano***<sup>1</sup>

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This research reports on an empirical investigation of whether low-tax-rate jurisdiction shopping practices, an unsophisticated means of financial engineering, actually create value for owners. By using examples of tax-inversion reincorporation actions, an analysis is conducted using rate of return on assets to determine if the simple act of tax jurisdiction realignment leads to enterprise value enhancement. The project examines the impact from the lowest corporate tax rate country among developed nations, providing a strong likelihood of uncovering the existence of artificial value creation that can arise as a consequence of income tax avoidance.

# Employee Reviews Dispersions and Firm Performance

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Abstracts

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This paper examines whether the dispersion of employee social media disclosures is informative of the firm's future performance. Prior studies show that outsiders' forecast dispersion contains finance information. We believe that as insiders, employees might have more useful information. Thus, using topic modeling methods to partition textual reviews into five topics, we calculate the textual dispersions based on topics. After controlling for analysis forecast dispersion and some other information sources, we find that both employee ratings and textual topics dispersions are associated with subsequent firm performance. Later investigation finds that reviews which reflect employee satisfaction are related to firm performance rather than reviews which reflect employee concerns.

# Extreme Weather Patterns and Risk Assessment Strategies by Banking Industry: A survey

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Abstracts

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***Dr. Demetri Tsanacas***<sup>1</sup>

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## Abstract

The recent hurricane that hit the East Coast, the West Coast wild fires, the intense heat in the South and other catastrophic events are having a profound and lasting economic and financial effects for the USA economy. The financial services industry is among the industries that has been impacted at both the operational and the investing areas and has been exposed to substantial risk

The scope of the paper is to assess the current methodology regarding weather related risk management , as well as, changes in the risk management methodology considered by Bank Executives.

Over 150 Bank executives of banks in the Second Federal Reserve District were invited to response to a survey regarding extreme weather risk related adjustments in their organization at: the operational level, the asset allocation level and the organizational with respect to: risk identification and management, scenario analysis implementation and transparency

The author will present and analyze the results, identify key issues and offer recommendations to assess and mitigate extreme weather risk impact on the banking sector.

# Option pricing with machine learning

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Abstracts

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Stock options are typically priced using closed form solutions or numerical methods that are dependent on several assumptions and a specification of the stochastic process followed by the underlying stock price. A misspecification of the stock price dynamics or violations of other assumptions can lead to significant mispricing of the option. An alternative approach to pricing options is a data driven approach, where no assumption is made about the parametric form of the underlying asset price dynamics and the machine learning model is allowed to learn the pricing model from the data. We investigate the effectiveness of such data driven machine learning based approaches in pricing American style exchange traded single stock options and stock index options. We evaluate several different machine learning models on a dataset of 396 stocks in the S&P 500 with active options markets and the S&P 500 index options. We find that data driven machine learning models perform with adequate precision and outperform a parametric approach for pricing these options. Our findings suggest that data driven machine learning models that do not rely on simplifying assumptions can outperform parametric models that rely heavily on underlying assumptions and hence should be considered for use by practitioners.

## Simplification May Not be so Simple: Adoption of ASU 2021-08

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Abstracts

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***Dr. Nathan Slavin<sup>1</sup>, Dr. Jianing Fang<sup>2</sup>***

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The Financial Accounting Standards Board (FASB) issued Accounting Standards Update (ASU) No. 2021-08, Business Combinations (Topic 805) – *Accounting for Contract Assets and Contract Liabilities from Contracts with Customers* in an attempt to address the diversity in practice on accounting for contract assets and contract liabilities acquired in a business combination. Under this ASU, the acquirer will account for the contract assets and contract liabilities acquired in a business combination in accordance with ASC 606, *Revenue from Contracts with Customers*, as if it has originated the revenue contract. This ASU creates a scope exception to ASC 805, under which assets and liabilities acquired in a business combination are generally measured and recognized at fair value. The issuance of this ASU appears to align with the FASB's recent movement to simplify the Generally Accepted Accounting Principles (GAAP). However, in a close examination of the final rules of this ASU, we believe that practitioners may encounter unintended complexities in the adoption. Measurement of revenue and resulted contract assets and contract liabilities under ASC 606 is complex and requires significant management judgment. The final rules of ASU 2021-08 may not alleviate the acquirer's burden of making those judgements.

# Toward a Single Framework of Environmental and Financial Disclosure by Companies, An Unsustainable Silence

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Abstracts

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***Dr. Carmen Quirvan***<sup>1</sup>

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**TOWARD A SINGLE FRAMEWORK OF ENVIRONMENTAL AND FINANCIAL DISCLOSURE BY COMPANIES, AN UNSUSTAINABLE SILENCE**

**CARMEN QUIRVAN, Ph. D.**

**THE UNIVERSITY OF RHODE ISLAND**

**ABSTRACT**

Without any doubt the Security and exchange Commission (SEC) of the United States needs to perform an active role requiring the public companies to disclose their environmental and financial risks over the only one environment and planet that we have.

However, until very recently, the SEC has launched some regulations regarding these issues and others are in process. It will be important that the SEC performs leadership work with other private organizations to finally build a single framework of environmental and financial disclosure by public companies and provide reliable information to investors and to society. In addition to this, the universities must educate business students with an interdisciplinary background in business and sustainability topics for the future professionals that the accounting profession, companies, and society currently are requiring (Quirvan, 2020) in this post pandemic world.



# **Big Data, Analytics, and Knowledge Management**

# AI-Enabled Knowledge Management in Organizations: Incentives for Knowledge Sharing

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Abstracts

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This paper presents and studies an analytical model of AI-enabled knowledge management in organizations, focusing on incentives in facilitating knowledge sharing and applications. We explore the design of incentive schemes to motivate knowledge workers' interactions with an AI system to improve its quality and the application of the system in producing an enhanced output. Our research provides insights for practitioners to promote the success of their AI implementations and lays the foundation for future research.

# An Investigation of the predictability of uncertainty indices on Bitcoin returns

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Abstracts

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***Dr. Carolyn Wang<sup>1</sup>, Dr. Geoffrey Ngene<sup>2</sup>, Dr. Yan Shi<sup>3</sup>***

*1. New Jersey Institute of Technolohg, 2. Mercer University, 3. University of Wisconsin*

We investigate the predictabilities of the thirteen uncertainty indices derived from the newspaper-based, internet-based and report-based measures on Bitcoin returns using machine learning algorithms. Based on the feature analysis, we find that Singapore economic policy uncertainty (SEPU) impact the most on Bitcoin returns. Financial crises uncertainty and world trade uncertainty are important features following SEPU. The empirical results reveal an interesting finding that the predictabilities of uncertainty indices derived from the international trade related category is stronger than other categories. The study also finds that the impact from the internet-based uncertainty is stronger than the uncertainty indices derived from the newspaper-based and reports-based measures on BTC returns. The results are tested by the various machine learning methods.

Jinghua Wang, Geroffrey Ngene, Yan Shi

# Big Data Analytics and Supply Chain Management, and Firm Performance

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Abstracts

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***Dr. Steve ZHOU***<sup>1</sup>

*1. University of Houston Downtown*

In this paper, we analyze big data analytics, lean supply chain management, and their impact on firm performance. Data were collected via a research questionnaire that catches the current practices of BDA along with supply chain management. Through statistical analysis, we find that there exist some significant differences in BDA practices among the surveyed companies. More importantly, our results show that BDA has a significant and positive impact on firm performance. We conclude the study with a discussion of theoretical and managerial implications along with future research directions.

## Big Data: Concerns and Clarifications

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Abstracts

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***Dr. Jinchang Wang***<sup>1</sup>

*1. Stockton University*

Big data refers to a bunch of techniques of processing huge amount of data. With its power of handling data big data is bringing benefits, and posing threats, to the world. Misunderstandings and misconceptions about big data are diffusing. We ponder over seven myths with the intention of clarifying the concepts, avoiding unnecessary worries, and alerting people to the dangers and threats. We argue that: (i) Big data makes trivial data untrivial. (ii) Further development of big data does not rely on breakthroughs of science and technology, but on “demand and supply”. (iii) In the era of data, “being known” is unavoidable, and not equivalent to “being hurt”. (iv) The most threat of big data on individuals is at the stage of data-abuse rather than at the stage of data-collection. (v) “Despotic big data” causes more serious threats in this world than “democratic big data”. (vi) US is left behind to the despotic countries in development of big data because of self-regulating with the concerns of ethics and individual liberty. Competition on big data is actually “a game of care and dare”, i.e. how much human rights are cared about and how much the government dares to get it explored. (vii) Despotic big data is not only infringing the rights of the people in despotic countries, but also posing an imminent threat to the democratic countries.

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# Latent Dirichlet Allocation Topic Modeling and Doc2Vec with Genism: A Survey of Text Analysis Methods on Yelp Reviews

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Abstracts

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***Mr. Mojtaba Talaei-Khoei<sup>1</sup>, Prof. Asil Oztekin<sup>1</sup>, Prof. Ann Kronrod<sup>1</sup>, Prof. Ali Dag<sup>2</sup>***

*1. Manning School of Business, University of Massachusetts Lowell, MA, USA, 2. Heider College of Business, Creighton University, Omaha, NE, USA*

Platforms such as Yelp usually use average star rating as an indicator of overall consumer sentiment about the product, but this may be misleading. Using Yelp review dataset from Kaggle, we performed sentiment analysis via VADER sentiment analyzer included with NLTK to estimate the sentiment scores for all reviews. The sentiment scores of the high-star (i.e., 4-5) reviews are more uniformly concentrated around the top of the sentiment scale, while the sentiment scores of the low-star (i.e., 1-2) reviews are scattered along the whole scale. The possible underlying psychological mechanism for this finding is discussed. Moreover, we used a few natural language processing methods to identify the similarity among reviews. We weighted the terms using Term Frequency-Inverse Document Frequency (TF-IDF) and constructed a bag of words model (i.e., sparse vector model) to cluster the reviews around similar subjects. The model enabled us to identify similar reviews to any specific review. We also used Latent Dirichlet Allocation (LDA) as a topic modeling technique to produce topics according to the word frequency of the reviews. LDA generated the most frequent topics (mixture of words). We used the model to find the similarity of any given review to any mined topic and define the mix of the topics related to each review. We presented the modeling of the reviews via Doc2Vec (a variant of Word2Vec) with genism. This model also identifies similar reviews. The presented models facilitate decision-making through efficiently identifying related reviews or finding reviews containing a particular topic.

# Opinion Leader Detection Using Deep Learning

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Abstracts

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***Dr. Yang Li<sup>1</sup>, Dr. Yanni Ping<sup>2</sup>, Dr. Abdullah Albizri<sup>1</sup>***

*1. Montclair State University, 2. St. John's University*

Opinion leaders, originally proposed by Lazarsfeld et al., are characterized by their ability to give influential comments and opinions, put forward guiding ideas, and guide the public to understand social problems. With the widespread adoption of social media, online communities such as Twitter, Facebook, and Instagram are becoming the primary source of information transmission and dissimulation. This study develops a novel opinion leader detection framework that identifies influential users on STEAM, the world's largest video game e-commerce and distribution platform. Different from previous studies that focus on topological network measures, we utilize the cutting-edge deep learning models to extract structural embeddings together with side information to identify opinion leaders. The proposed framework achieves high performance and is also scalable to large-scale networks. The findings would be helpful in designing online marketing campaigns.

# Re-examining Social Media Data: Reducing Bias and Disinformation in Natural Language Processing Systems

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Abstracts

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*Dr. Jin-A Choi<sup>1</sup>, Dr. Rajiv Kashyap<sup>1</sup>, Dr. Cyril Ku<sup>1</sup>, Dr. Jim Samuel<sup>2</sup>*

*1. William Paterson University of New Jersey, 2. Rutgers*

Scholars are witnessing unprecedented growth in the demand for Natural Language Processing (NLP) systems to interpret and assign meaning to large corpora, especially in the social sciences. Scholars are becoming increasingly concerned about biases arising from NLP systems to understand social media data and enable decisions in marketing, organizational behavior, etc. There is an urgent need to ensure that social science researchers and practitioners who use social media data understand NLP's limitations and develop robust and dependable strategies to understand and counter bias in NLP systems. Bias refers to systematic error and signifies a predisposition to collect, interpret, and present data to favor inaccurate results that are in line with individual prejudices. This results in two types of harms: 1) allocational harms, which includes prejudicial allocations of resources (e.g., credit) or opportunities (e.g., jobs) to different social groups, and 2) representational harms, which refers to unfair characterizations of social groups. Most NLP applications are ill equipped to detect and mitigate bias arising from the use of flawed algorithms or prejudices embedded in large corpora. Therefore, this article examines two types of algorithm level biases, (word embeddings bias and word choice labeling bias), in addition to two system level biases (sentiment bias and toxicity bias). Potential opportunities to detect and mitigate bias in NLP systems will be discussed in depth.



# Understanding and Analyzing the Strengths and Weaknesses of Corporate Social Actions

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Abstracts

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***Mrs. JIE LI<sup>1</sup>, Prof. Peter Tashman<sup>1</sup>, Dr. Joseph Gonzales<sup>2</sup>, Prof. Asil Oztekin<sup>3</sup>***

*1. Manning School of Business, University of Massachusetts Lowell, Massachusetts, USA, 2. Department of Psychology, University of Massachusetts Lowell, MA, USA, 3. Manning School of Business, University of Massachusetts Lowell, MA, USA*

With increasing public attention on corporate social responsibility, companies doing “harm” or “good” to society has eminently impacted the brand image, consumer perception, employee retainment, and investment decisions. This paper investigates the association between the strengths and weaknesses of the corporate social actions among publicly traded US companies, and how the association is moderated by firm’s corporate social responsibility (CSR)-related strategies, i.e., how does being accountable in one social area mitigate or counteract other firm-related social controversies in the future? We use Kinder Lydenberg Domini Ratings Data and company annual reports of Russell 3000 companies from 2008 to 2018. We identify and summarize the firm’s CSR-related strategy from the company annual reports using Natural Language Processing. Furthermore, we proposed an exploratory factor analysis for dimension reduction. And using structural equation modeling to investigate the lead-lag association between strengths and weaknesses the corporate social actions, and test whether detrimental performance ratings of environmental, social and governance (ESG) in one context leads to the exemplary performance of ESG rating in others.

# **Cyber Security, IT, and Emerging Technologies**

# A Research Study Proposed to Examine the Effect of Software Customization on Software Startup Projects.

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Abstracts

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***Dr. Sudhaman Parthasarathy*<sup>1</sup>, *Dr. Girish Subramanian*<sup>2</sup>**

*1. Thiagarajar College of Engineering, 2. Penn State Harrisburg*

Startups are newly created companies facing high volatility in technologies and markets. In software startups, requirements are mostly drawn out of the customer's experiences on their familiarity with the software product to be built and the market value it is likely to add to the customer's organization. Software startups are mostly engaged in developing products that reach out to a larger market than a product that would be used by a particular customer or organization. Some significant aspects of software development by startups include their practices of "made to stock" than "made to order" and extensively customizing the developed product to suit the targeted customers and validating the customized product often after the deployment, that is, fixing the issues during the post-implementation phase. Such customization practices of startups may lead to low customer satisfaction and errors during implementation. To learn the impact of software customization by startups, we will contact software startups and select projects labeled as "failure" based on well-established metrics such as over budget, poor customer satisfaction, beyond schedule, etc. We then intend to study the extent of customer customizations and how it contributes to these projects being labeled as "failure". Then, we intend to apply the quantitative method used in previously published research work to measure the degree of software customization and see the threshold percentage of customization and its relationship to software project failure. Finally, we report lessons learned from our research. We have identified research sites and startups willing to engage in our research project.

# Evaluation and Review of Cybersecurity Forensic Tools Available for the Raspberry Pi

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Abstracts

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***Prof. Stanley Mierzwa<sup>1</sup>, Mr. Benjamin Lorenc<sup>1</sup>***

*1. Kean University*

In the area of digital forensic evidence collection and analysis, a host of different tools and applications can be utilized. These tools will provide the most fundamental use cases for forensic investigators to employ. In some cases, these technology solutions may be purchased and part of an enterprise-level package. In other scenarios, the use of open-source and free tools can be approached. In this research effort, a landscape review and literature review will be done to focus on what open source and freely available tools can be integrated and used with the Raspberry Pi computing devices. The Raspberry Pi computers fall into the class of systems that are provided as single board units, with an incredibly small physical footprint, and priced very modestly. A genuine benefit of using single board unit computers will minimize the constraints of approaching digital forensic solutions, given the size and price, and with this, the expectation that more and more practitioners and students can begin to learn about important skills utilized to investigate cybercrimes. This research paper will outline the currently available digital forensic solutions available, what and how they function, and propose a toolbox or set of tools that can be utilized to start such a functional role in an organization.

# Hotel Technology Selection

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Abstracts

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***Dr. Jin Fang<sup>1</sup>, Dr. Fariborz Partovi<sup>2</sup>***

*1. Clark University, 2. Drexel University*

The hospitality industry has turned to technology as a strategic weapon to improve operational efficiency, support employees, enhance service quality, gain competitive advantages, and maintain customer relationships. Hence, this paper is about technology planning in the hotel industry. We propose a prescriptive model to strategically select technologies to invest in the hotel. By implementing Hyperlink Induced Topic Search (HITS) and PageRank algorithms, we construct a network connecting “hotel selection criteria,” “activities,” and “technologies.” The results present the ranking of the technologies based on the HITS or PageRank weights, utilizing a network analysis. Considering the technologies’ costs and the hotel’s budget, we formulate an optimization model using the Knapsack problem. We demonstrate how our model can be applied to plan technology investments in a hotel with a numerical example.

# IT Transformation at Smithfield Foods: From On-Premises Data Center to a Cloud-Based ERP System

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Abstracts

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***Dr. Dmitriy Shaltayev*<sup>1</sup>, *Dr. Robert Hasbrouck*<sup>1</sup>**

*1. Christopher Newport University*

This case examines the evolution and transition of Smithfield Foods, the world's largest pork processing company, ERP system that converted its architecture to the cloud starting in 2015 when Julia Anderson, was hired as the company's Global CIO. The case documents her journey to convert Smithfield's information systems to SAP HANA, the most recent version of the SAP ERP system. During her tenure at Smithfield, Julia not only helped the company adopt the SAP HANA system, but also led an effort to move it to a multi-cloud environment. The case illustrates how a large and geographically distributed company can leverage technology to reduce costs and improve operational efficiencies.

# **DSS, Machine Learning, and Artificial Intelligence**

# A Virtual Assistant for Moderators: Enforcing Social Norms in Online Communities

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Abstracts

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***Mr. Necdet Gurkan<sup>1</sup>, Prof. Jordan W. Suchow<sup>1</sup>***

*1. Stevens Institute of Technology*

Online (or internet) communities are groups of individuals with a shared interest or purpose who use the internet to communicate with each other. Online communities have their own guidelines, norms, and needs, such as moderation, engagement, and management. These communities must preserve and develop norms that benefit the group to become and remain successful. The preservation of social norms heavily depends on the behavior of moderators (Grimmelmann, 2015). Moderators have the ability to promote or conceal postings, and to recruit or prohibit users, to maintain social norms within the community. However, moderators tend to have cognitive biases and low competency when enforcing intersubjective norms, where members must align their subjective beliefs according to the shared beliefs. Here, we extend cultural consensus theory to develop a virtual assistant to support a moderator's decision making by inferring each moderator's competence along with their biases in support of providing more transparent mechanisms for promoting the health of online communities. Our model includes learning from experience, centralized moderation, and decentralized moderation to accurately estimate the consensus. We then apply our virtual assistant to an online community dedicated to preserving a norm related to facial aesthetics. Our virtual assistant is able to point out a moderator's cognitive bias and perceptual misalignment in recognizing the consensus of a moderated post. Our model is applicable as a virtual assistant for moderators in a broad array of intersubjective judging processes within finite scales.



# Clustering Uncertain Data with Fuzzy Kernel K-Medoids Algorithm

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Abstracts

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*Prof. Behnam Tavakkol<sup>1</sup>, Prof. Youngdoo Son<sup>2</sup>*

*1. Stockton University, 2. Dongguk University-Seoul*

Traditional data mining algorithms do not consider any uncertainty for data objects. On the other hand, uncertain data mining algorithms are designed to capture the inherent uncertainty in data objects. To model the uncertainty, algorithms use different approaches such as: representing each data object as a sample of points or a probability density function (pdf). Fuzzy methods have long been used for clustering traditional (certain) data objects. They are used to produce non-crisp cluster labels as opposed to regular clustering algorithms that produce crisp labels. For uncertain data, however, besides an uncertain fuzzy k-medoids algorithm, not many other fuzzy clustering methods have been developed. In this work, we develop a fuzzy kernel k-medoids algorithm for clustering uncertain data objects. Kernel methods use transformation of data objects from the original space to a higher dimensional space. Transformation of data can result in better separation of data clusters in the higher space. The developed fuzzy kernel k-medoids algorithm uses an extended version of a popular probabilistic distance measure known as the Bhattacharyya distance to capture the distance between uncertain objects in the higher space. We show through several examples that the developed fuzzy kernel k-medoids algorithm produces more reasonable results compared to existing fuzzy k-medoids algorithms in clustering data sets with non-linearly separable clusters.

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# Deep Modular Co-Attention Networks for Online Product Matching

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Abstracts

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*Ms. Yangyang Yu<sup>1</sup>, Ms. Ruijing Yang<sup>1</sup>, Dr. Jordan W. Suchow<sup>1</sup>, Dr. Rong Liu<sup>1</sup>*

*1. Stevens Institute of Technology*

Digital retail platforms such as Shopee and eBay require precise product matching, which is detecting multiple instances of the same product across multiple listings. Precise product matching not only improves users' experience but is beneficial to business management and development. Automated matching systems can use both product images uploaded by sellers and textual information such as product descriptions, Q&As, and reviews. Here, we adapt Deep Modular Co-Attention Networks (MCAN), a deep learning method created for Visual Question Answering (VQA), to the problem of product matching and demonstrate its superior performance. MCAN is a solution to multimodal learning for integrating visual and textual content. MCAN achieves high performance via its unique interactive attention mechanism between pretrained image (Faster R-CNN) and textual (300-dimensional GloVe + LSTM) representations. Co-attention enables each unimodal module of the encoder to effectively guide or supplement the other. We adapt the MCAN model structure such that, rather than the MCAN decoder outputting a multi-category classifier on the basis of binary cross-entropy, it instead calculates the distance between the two product multimodal representation pairs using the contrastive loss of a Siamese network or binary loss of logistic regression. We apply the model to the Shopee Price Match Guarantee dataset and compare the approach to several benchmark models, including traditional unimodal approaches, textual and image representation direct-concatenation approaches, and previous multimodal approaches. We discuss future uses of modified Deep Modular Co-Attention Networks for product matching and related business problems such as price matching.

# Ensemble Learning Framework to identify the key factors that leads to attrition in software professionals

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Abstracts

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***Mr. Aariz Faizan Javed*<sup>1</sup>, *Mr. Syed Abdullah Ashraf*<sup>1</sup>, *Dr. Pradip Kumar Bala*<sup>1</sup>, *Dr. Rashmi Jain*<sup>2</sup>**

*1. Indian Institute of Management Ranchi, 2. Montclair State University*

The human resource has always been the most important part of any organization. Employee attrition has long been a source of concern for businesses. There is a significant cost associated with finding a new employee and replacing those who are leaving. This is due to the amount of time spent in. Interview procedures, sign-on bonuses, and a loss of productivity for several months while the new employee is on the job is being trained and acclimating to the new position and responsibilities A step toward comprehending why and how When employees are most likely to leave, it is possible to take corrective actions to improve employee retention. Here we talk about an ensemble learning framework to assess the attrition that takes place particularly with respect to the software engineers. These software professionals carry with them a wealth of expertise and when they leave, it leads to a loss to the organization.

# Ensemble Learning Framework to Identify the Key Factors that Leads to Attrition in Software Professionals

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Abstracts

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***Mr. Aariz Faizan Javed*<sup>1</sup>, *Mr. Syed Abdullah Ashraf*<sup>1</sup>, *Dr. Pradip Kumar Bala*<sup>1</sup>, *Dr. Rashmi Jain*<sup>2</sup>**

*1. Indian Institute of Management Ranchi, 2. Montclair State University*

The human resource has always been the most important part of any organization. Employee attrition has long been a source of concern for businesses. There is a significant cost associated with finding a new employee and replacing those who are leaving. This is due to the amount of time spent in. Interview procedures, sign-on bonuses, and a loss of productivity for several months while the new employee is on the job is being trained and acclimating to the new position and responsibilities A step toward comprehending why and how When employees are most likely to leave, it is possible to take corrective actions to improve employee retention. Here we talk about an ensemble learning framework to assess the attrition that takes place particularly with respect to the software engineers. These software professionals carry with them a wealth of expertise and when they leave, it leads to a loss to the organization.

# Exploring the Perceptions of Chinese Business Professionals Towards AI Technology

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Abstracts

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***Dr. Sung Shim***<sup>1</sup>

*1. Seton Hall University*

This paper examines the perceptions of Chinese business professionals towards AI technology and applications. It uses data collected from a survey of Chinese business professionals who also enrolled in a part-time MBA Program in China. AI has come to occupy an important role in China's 'Made in China 2025' blueprint, and China wants to become a global leader in the field by 2030. It seems that China has made significant progress in the past decade or so in terms of academic papers, patents, and both cross-border and global AI funding. Given the increasing interests and developments in the AI field in China, it is important to understand how Chinese business professionals perceive AI technology and applications for their businesses. The results of this paper are expected to provide timely and valuable insights into the current states, potential benefits as well as problems, and prospects of AI technology and applications in China.

# Forecasting Electronic Waste Using Improved Multi-Variate Grey Models with Residual Modification

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Abstracts

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***Dr. Gazi Duman*<sup>1</sup>, *Dr. Elif Kongar*<sup>2</sup>, *Dr. Surendra Gupta*<sup>3</sup>**

*1. University of New Haven, 2. Fairfield University, 3. Northeastern University*

Fueled by a variety of factors, including the advent of digitalization, increasing population and urbanization, and rapid technological advancements, Electronic Waste (e-waste) or Waste from Electrical and Electronic Equipment (WEEE) has been the fastest growing waste stream in the world. Efficient management of e-waste organically aligns with the environmental, social and governance (ESG) frameworks. The literature offers various methodologies focusing on prediction of e-waste generation. Among these, Grey Modeling (GM) approach has drawn attention due to its ability to provide meaningful results with utilizing relatively small-sized data. In order to improve the overall success rate of the approach, several GM-based models have been developed. The performance of these models, however, heavily rely on the parameters used with no established consensus regarding the criteria that would improve accuracy. The purpose of this study is to present a novel forecasting technique for e-waste predictions with multiple inputs in the presence of limited historical data. The proposed non-linear grey Bernoulli model with convolution integral NBGMC(1,n) improved by Particle Swarm Optimization (PSO) demonstrates superior accuracy over alternative forecasting models. Furthermore, Fourier residual modification method is applied to increase the precision of the forecast. A case study utilizing Washington State e-waste data is provided for comparative analysis.

**Keywords:** Electronic Waste, Improved Grey Modeling, Particle Swarm Optimization, ESG, Fourier Series, Forecasting, Reverse Logistics.

# Leaf Classification using FGIC Tasks via Transfer Learning

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Abstracts

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*Dr. Hien Nguyen<sup>1</sup>, Mr. Dev Juneja<sup>1</sup>*

*1. Penn State Harrisburg*

Deep convolutional networks have achieved state-of-the-art performance in the difficult task of fine-grained image classification (FGIC) in recent years. With the dataset of importance as input and categorical predictions as output, the majority of models conduct end-to-end classification. Custom deep convolutional networks, on the other hand, are expensive to train and complex to construct. In this paper, we look at how recent advances in transfer learning may be applied to the Leafsnap dataset's FGIC challenge. We evaluate performance of end-to-end CNN approaches with deep pretrained networks as feature extractors for input into basic machine learning models.

# Learning Low-Dimensional Representations of Marketing Data with Quantum Machine Learning

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Abstracts

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***Dr. Pablo Rivas**<sup>1</sup>, **Dr. Liang Zhao**<sup>2</sup>*

*1. Baylor University, 2. St. Ambrose University*

Representation learning is a research area that has significantly benefited from machine learning recent advances. Quantum machine learning advances, in particular, have opened new opportunities for learning data representations. Our research studies a hybrid quantum machine learning approach to learning low-dimensional data representations using a quantum variational circuit. The quantum circuit is uniquely wired into a neural network architecture based on a classic dense autoencoder. The proposed methodology can successfully perform unsupervised dimensionality reduction of data by learning the parameters of the quantum circuit with traditional gradient descent techniques.

We use publicly available marketing data to showcase the learning potential of our model. Specifically, we study the effectiveness of different marketing promotional channels. Our preliminary results suggest that the model can find latent spaces and learning representations with high discriminative potential. Data from marketing shows that our model is comparable to a classic approach and better than PCA in finding data clusters. The hybrid quantum variational autoencoder can be beneficial to generate low-dimensional representations of big data to facilitate feature extraction analysis. Many important marketing research issues would be aided by using our hybrid quantum variational autoencoder, and there are ample opportunities for new interdisciplinary research in the future.



# Performance of Machine Learning under Noise

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Abstracts

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***Prof. Amit Das***<sup>1</sup>

*1. IFMR Graduate School of Business, Krea University*

We examine how the performance of machine learning (ML) algorithms responds to the presence of noise in the training data. Using a publicly available dataset, we train a variety of ML algorithms on the task of bankruptcy prediction while progressively adding increasing levels of Gaussian white noise to the data. Our inquiry seeks to identify ML algorithms that are less sensitive to the presence of attribute noise in the training data, and those that display graceful degradation in the face of increasing noise.

Bankruptcy prediction is a canonical task in machine learning, and we make the requisite refinements in our classifiers to account for data imbalance: few companies go bankrupt, most do not, and the unequal cost of misclassification: false negatives are more expensive than false positives. We use a variety of performance measures including the area under the ROC curve, and the F1 score: the harmonic mean of precision and recall.

Initial results indicate good performance under noise from gradient boosted ensembles of decision trees, random forests, and linear discriminant analysis. We hope to generate recommendations of which classifiers to use at different levels of noise, and also gain an understanding of why some classifiers perform better than others.

# Shared-Mobility Recommendation Through Reducing Repetitions in Traffic Networks

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Abstracts

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***Mr. Mohammad Bakhsh<sup>1</sup>, Prof. Josephine Namayanja<sup>1</sup>***

*1. University of Massachusetts Boston*

This study explores how to reduce traffic congestion by expanding the concept of shared-mobility into all exiting users including taxis, ride-hailing, food delivery, package delivery, and grocery delivery in which individual trips can be reduced and replaced by substitute shared modes of mobility. This study combines graph theory and spatial-temporal analysis to extract roads and traffic networks from traffic routes, and determine similarities between trajectories that results in locating the highest connected values for reducing congestion. Through similar trip trajectories, one is able to identify where and when trip redundancies occur. This is in turn can be leveraged to optimize trips by offering shared-mobility recommendations in critical geo-locations and time periods. This study poses benefits in various mobility-related application areas where shared-mobility can be leveraged.

# Shifts in Religious and Social Attitudes and Behaviors in Response to COVID-19: Understanding the Change in Work Orientation Dynamics within the American Workforce in Response to the Pandemic

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Abstracts

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***Mr. Mojtaba Talaei-Khoei*<sup>1</sup>, *Dr. Joseph Gonzales*<sup>2</sup>, *Prof. Asil Oztekin*<sup>1</sup>, *Prof. Kimberly Merriman*<sup>1</sup>**

*1. Manning School of Business, University of Massachusetts Lowell, MA, USA, 2. Department of Psychology, University of Massachusetts Lowell, MA, USA*

We used path analysis to investigate how religious attitudes and behavior, socializing with personal contacts, and computer and internet usage are associated with subjective well-being, economic well-being, health, and work as the central life interest in the 2018 and 2021 General Social Survey (GSS) of adults residing in the United States. We hypothesize that when people experience increased morality salience (i.e., in 2021 during Covid-19) their value orientation shifts and/or is amplified. Specifically, we predict a positive shift in the relationship between intrinsic behaviors (socializing and religion) and subjective well-being and health, a negative shift in the relationship between computer/internet usage and subjective well-being and health, and a negative shift in the relationship between intrinsic behaviors and work orientation (drawing from new research on job embeddedness). We also model various socio-economic variables as potential controls or moderators, in consideration of the “Mathew Effect” that suggests different effects among the ‘poor’ versus the ‘rich’. By evaluating shifts in these relationships before and after Covid (2018 vs. 2021) we provide insights into a potential change in the attitude of the American workforce to explain why some American workers left their jobs to stay at home with their families in response to the pandemic.

# The Role of AI Ethical Guidelines in Regulating Human Behavior

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Abstracts

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***Dr. Uma Gupta***<sup>1</sup>

*1. University of South Carolina Upstate*

Our understanding of the economic power of AI commercialization and its related ethical implications on human welfare and well-being continues to evolve and align, albeit in ad hoc and arbitrary ways. Balancing our highest ethical standards with rapid technological advances are a challenge because we are limited in our ability and capacity to plan, scope, manage, regulate, and predict human behavior. Therefore, meaningful and rigorous AI ethical guidelines assume new importance.

This paper studies the core values and principles embedded in AI ethical guidelines and raises the fundamental question: Are guidelines sufficient and impactful to address the ethical challenges that AI poses for humanity? Do guidelines truly moderate and guide responsible discoveries, inventions, and the commercialization of AI theories and principles? Are AI guidelines sufficient to control, monitor, respond, and regulate unobserved human behavior? Can guidelines prevent catastrophes and guarantee the comprehensive assessment of AI products before their market commercialization? Are guidelines today an afterthought crafted to meet the specifications of the product rather than the other way around?

This paper identifies the limitations of existing ethical guidelines to assess the impact of AI products and services on the human race. Using a universal ethical framework that is relevant to all scientific communities as a means to share ethical principles with the global scientific community, the paper highlights the relevance of micro ethics and the importance of embedding political and legal prowess into ethical guidelines.

# **Education, Curriculum, and Cases**

# Best Practices for Online Live Asynchronous Interaction in Online Courses

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Abstracts

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***Dr. Bhupinder S. Sran<sup>1</sup>, Dr. John W. Weber<sup>1</sup>***

*1. DeVry University*

The Coronavirus pandemic caused universities to move their classes to online delivery. It was quite a challenge for faculty as they were not familiar with this delivery modality. As time has gone on and faculty have adjusted to this new way of teaching, they have developed techniques to provide students opportunities for live online synchronous interaction.

Many faculty are also beginning to implement such techniques in online courses. As online students see the value of this synchronous interaction, they are starting to expect it.

In this presentation, we will discuss the challenges faced by faculty providing opportunities for live synchronous interaction with students, especially in online courses. We will also examine various models used by the faculty, such as live office hours and live lectures. Finally, we will present best practices identified by faculty teaching in various disciplines, both technical and non-technical.

## Bringing Industry into the Classroom: Supply Chain Mapping Project in Global Supply Chain Management Courses

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Abstracts

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***Mr. Muhammad Hasan Ashraf<sup>1</sup>, Dr. Koray Ozpolat<sup>1</sup>, Dr. Mehmet Yalcin<sup>1</sup>***

*1. University of Rhode Island, College of Business*

The recent COVID-19 outbreak, and numerous unsustainable sourcing scandals have proven that the corporate firms lack visibility into their often-deep tier supply chains. Even though majority of the large firms' executives acknowledge the significance of the supply chain mapping, not much effort is made in this regard. Amid these critical times, firms are relying on the business schools to prepare undergraduate students for the professional world by exposing them to the contemporary real-world problems and equipping them with relevant skillset and knowledge, and more importantly making them aware of the challenges and rigor involved in carrying out complex tasks. Responding to this, based on the Project Based Learning approach, we present a Supply Chain Mapping project (SCMp) as part of a course deliverable in global supply chain management (SCM). Students are required to design a three-tier supply chain map for a Patagonia product while keeping Patagonia's sustainability mission in mind. Students are exposed to a commercially used mapping software to aid them in designing an effective supply chain map. The aim of the project is to expose the students to the contemporary real-world issues of supply disruption and sustainability, while experiencing the rigor and challenges involved to address them. Analysis of survey data shows that student satisfaction with the SCMp is high, and they enjoyed working on the project as it helped them bridge the academia industry gap. Insights on the benefits and challenges students experienced from completing the SCMp highlight the utility of this project.

# Developing a Marketing Elective to Incorporate Personal Branding Concepts with Career Service Resources

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Abstracts

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***Dr. Kathleen Ferris-Costa***<sup>1</sup>

*1. Bridgewater State University*

Despite the extensive career services programs offered at secondary education institutions across the United States, students continue to underutilize the programs offered for career preparedness. Research was conducted to investigate what skills students were interested in learning more about related to the job search process and how they preferred to receive such information (Ferris-Costa and Guyon, 2020). The findings were consistent with previous research and showed Career Service resources were greatly underutilized by students. However, students were interested in learning more about these resources and the best way to provide them would be to offer a credited course.

In response to this research, a 3-credit marketing elective courses was created for undergraduate students. With a prerequisite of marketing principles, this course focuses on students' personal brands and the job market. The curriculum incorporates the use of marketing concepts with career service resources and demonstrates how students can use their marketing knowledge to review, revise, and accurately represent their personal brands to prepare them for the job market.

During the semester, students define their personal brands and incorporate a consistent narrative into their job seeking resources such as their resume, LinkedIn profile, networking skills, interviewing skills, writing skills, digital footprint, etc. Students utilize their marketing knowledge to create the tools necessary to enter the job market, with the assurance they are accurately presenting their personal brands to potential employers.



# Engagement Fellows: Partnerships to Improve Learning and Support in Quantitative Courses

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Abstracts

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***Dr. Julia Fullick-Jagiela<sup>1</sup>, Dr. Nitish Patidar<sup>1</sup>, Dr. Yan Jin<sup>1</sup>***

*1. Quinnipiac University*

Gibbs and Wood (2021) emphasized the need to create curriculum partnerships with students. We present a program that trains student engagement fellows to improve learning outcomes and to address student engagement challenges in modalities employed during the pandemic (i.e., hyflex- with virtual and in-person students - and asynchronous online). Fellows provided support to both students and faculty to improve belonging, which is critical for engagement (Gillen-O'Neel, 2021). This presentation will discuss program structure and illustrate implementation suggestions from a case study in two quantitative undergraduate courses. This research used five measures from student evaluation data (three related to the instructor and two for students) to find that the courses assisted with the engagement fellow had either higher or equal evaluations in both courses, compared to the courses without the engagement fellow (with the same instructor). Comments for the course and the engagement fellow also indicated that the students were more satisfied with both courses (e.g., great course load for operations management, helpful content, great ability to present the materials), found engagement fellows easily approachable (e.g., review quantitative concepts and problems in the class) and had higher engagement (e.g., helpful, friendly, adequate answers to the project). For one course, the shared efforts lead to higher one-on-one interaction in class.

# Entrepreneurship Education with Societal Significance: Protocols for Aiming Higher

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Abstracts

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***Dr. Cesar Bandera*<sup>1</sup>, *Dr. Regina Collins*<sup>1</sup>**

*1. New Jersey Institute of Technology*

Successful entrepreneurs exploit their tacit knowledge, based on prior experience, during opportunity discovery and business model validation. However, few students have tacit knowledge on the major crises affecting society, such as healthcare disparity and clean energy how to address. How can post-secondary education prepare students to be entrepreneurs that make societal impact, or even convince them that this can be a viable future endeavor? We present an entrepreneurship curriculum that, building on three pillars, teaches undergraduate students to pursue societally significant opportunities. The first pillar is the distinction between tacit and codified knowledge as drivers of entrepreneurship. The second pillar is metacognition to reinforce students' self-efficacy. The third pillar is the protocol of the federal Small Business Innovation Research program ("America's Seed Fund"). The curriculum emphasizes the multidisciplinary collaboration required by societally significant solutions. The course also exercises skills required to achieve such solutions, including forming strategic partnerships, navigating funding protocols, and grantsmanship. These skills are of value not only to future entrepreneurship, but also to societally significant careers in the corporate, academic, and public service settings.

## Exemplars: Show me, then I'll show you

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Abstracts

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***Dr. Carolyn LaMacchia***<sup>1</sup>

*1. Bloomsburg University of Pennsylvania*

Educations are challenged to develop multiple skills in students as well as discipline knowledge. Course assignments are an avenue for students to develop communication, information literacy, and discipline knowledge. Well-constructed assignments include details instructions and grading rubric. An exemplar may also be provided in addition to the instructions and rubric. An exemplar is an example of an excellent model of the assignment. Research shows that providing an exemplar can lead to an improvement in student performance. Additionally, an exemplar can help make complex grading criteria more understandable to students. This research reports guidelines for the addition of an exemplar in an upper-level technology class assignment. The assignment required students to complete a literature review on a topic then critique a collection of presentations from a well-known summit. In addition to developing discipline knowledge, the assignment goal was to demonstrate information literacy and presentation skills. A document describing the approach to researching the topic was discussed along with information literacy, library searches, APA formatting, vendor information versus referred information, and professional preparation and delivery. The exemplar was well-received by the class. This technique can be very beneficial to technology programs.

# Exploring the Role of Emotional Intelligence in Online Learning

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Abstracts

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***Dr. Mohammed Raja*<sup>1</sup>, *Dr. Ravi Narayanaswamy*<sup>2</sup>**

*1. York College of Pennsylvania, 2. University of South Carolina - Aiken*

The COVID-19 pandemic has transformed the societal norms of conducting daily activities in recent years. It is prominent among academic learning institutions. A unique challenge is that the clientele served by these institutions are primarily young adults whose behavioral traits are still nurturing. In addition, success in online learning environment is mainly self-driven. This study uses a theoretically-driven emotional intelligence (EI) construct, which comprises of an array of personal, and social skills that influence the ability to cope with environmental demands and pressures. EI is multidimensional in nature, this study employs four dimensions - self-awareness, self-management, social awareness, and relationship skills to capture it. Another critical component that affects students learning is instructor support, i.e., the strategies employed by the instructor to encourage student learning.

The primary objective is to determine the relationship between EI, instructor support, student learning satisfaction and student performance. The data is collected using a survey-based approach from undergraduate students who have taken at least one online course during COVID-19. All constructs are measured using established instruments. Two hundred and fifty-six valid responses were obtained and the initial measurement analysis were significant. At present, the modeling is in progress. Some of the potential implications will include strategies for universities to evaluate the behavioral traits and design support structures for students taking online courses. Second, for instructors, this study aims to provide a possible explanation for understanding student performance in an online course.

# Exploring the UTAUT Model for Learning Management System Use with Business Analytics Education

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Abstracts

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*Dr. Ellen Belitzky<sup>1</sup>, Dr. Gazi Duman<sup>1</sup>*

*1. University of New Haven*

The COVID-19 pandemic has sparked a public interest in data and added interest in business analytics education programs. There may be expectation that with analytics credentials, job seekers will have promising employer prospects in industry. This demand-side view can be contrasted with supply-side shortage of qualified traditional higher education instructors in business analytics subjects. Professors who are subject matter experts in computer programming, statistics, and business functions do not necessarily have the skills for online teaching. Moreover, if these skills can be taught in remote modes, there is still a gap in teaching the communication skills required for sought after jobs and long-term career success. Thus, a pandemic intervention for leveraging an increased dependence on learning management systems (LMS) and platforms could be an enabler to close the supply chain gap in business analytics for the higher education sector. This study will explore the application of the UTAUT model to use of LMS in higher education business analytics programs. The UTAUT model is widely used in academic literature to demonstrate that when enabling variables lead to intent to use a system there will be resulting behavior to use the system. Variables for this study may include academic aptitude, willingness to apply skills, an academic support system, and the pandemic environment. The study has potential impact for the supply chain of business analysts with credentials in the job market who would fill industry demand for qualified employees.

Keywords: Business Analytics, Learning Management Systems, UTAUT Model, Post-Pandemic Education, Disruptive Technology Platforms

# Implementing a Mobile Technology in an Online Healthcare IT Course: A Case Study

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Abstracts

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***Dr. Colleen Carraher Wolverton***<sup>1</sup>

*1. University of Louisiana at Lafayette*

Studies indicate that students would like to utilize their cell phones in their course work (Stachowski et al 2020; Fernandez 2018; Van De Bogart 2011). Furthermore, researchers have called for designing future learning environments that incorporate cell phones (Fernandez 2018; Thomas and O'Bannon 2013; Van De Bogart 2011). This study seeks to respond to that call by incorporating a technology into a course to send reminders about homework assignments to student's cell phones in order to potentially mitigate cognitive overload (Liao et al 2019).

We implemented the Remind app as an optional choice in an online MBA course at a university in the southeastern United States. The Remind app is a communication platform that enables educators to send reminders about assignments to students in their course. As this course represents one where students have weekly assignments, and students regularly miss the deadline to submit an assignment and therefore receive a zero on the assignment, it represents an excellent option for this case study.

Our findings indicate that students who registered for the Remind app differ significantly in their ethnicity, age, and years of professional work experience. We will discuss the implications of these findings and recommendations for how to effectively implement these types of mobile technologies in online courses.

# Increasing Student Engagement and Interaction in the Online Classroom: An Intensive Diverse High Impact Multi-Strategy Mini-Teaching Approach

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Abstracts

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***Dr. Ikehukwu Ndu***<sup>1</sup>

*1. University of Southern Maine*

The Covid-19 pandemic dramatically transformed how and where students were taught. Universities had to suddenly switch to online learning with little or no preparation. Students, teachers and the university administration lacked experience and expertise in online learning. This sudden change generated a high degree of uncertainty and a tangible fear in the decline in the perceived quality of higher education as a result of the absence of face-to-face contact and physical interaction.

In this context, this study explains how the accounting instructor navigated the crisis by adopting a diverse high impact multi-strategy mini-teaching approach. Initial results of the quantitative analyses of online student feedback surveys revealed that this diverse high impact multi-strategy mini-teaching approach was successful in constantly sustaining students' interaction and interest levels high throughout the accounting courses taught by the researcher during the Covid-19 pandemic period from August 2020 to May 2021.

It is expected that the findings of this study will assist academics as the strategy can be exportable to other courses and provide practical guidelines for instructors who are interested in achieving high level student engagement and satisfaction in the online classroom teaching using digital learning platforms in the future.

# Introducing Causal Inference Using Bayesian Networks and do-Calculus

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Abstracts

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***Dr. Tim Lu***<sup>1</sup>

*1. University of Maine*

We present an instructional approach to teaching causal inference using Bayesian networks and *do*-Calculus, which requires less prerequisite knowledge of statistics than the existing approaches and can be consistently implemented in courses at different levels from beginning to advanced. Moreover, this approach is aimed directly at addressing the central question in causal inference with the emphasis on probabilistic logic and causal assumption, and with the purpose of revealing the relevance and difference between causal inference and classical statistical inference. Using a freeware tool, we demonstrate our approach with five examples that instructors can use to introduce students at different levels to the conception of causality, motivate them to learn more concepts for causal inference, and demonstrate practical applications of causal inference. We also provide detailed suggestions on using the five examples in the classroom.



# Marketing the Olympic Games and the Winter Olympics: What's Changed Over Time?

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Abstracts

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***Dr. Elizabeth Elam*<sup>1</sup>, *Mr. Curt Hamakawa*<sup>1</sup>**

*1. Western New England University*

The variety of funding sources for the International Olympic Committee (IOC) over the past 40 years is examined. Differences in the type of event (summer Olympic Games or Winter Olympics), number of sponsors, size of audience etc. have changed over the years, and the COVID-19 pandemic even affected when some events have been held. This exploratory paper paints the overview of recent trends in marketing these Games.

# PESTLE Analysis and Organizational Strategy: Coal in WY

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## Abstracts

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***Dr. Heidi Hughes***<sup>1</sup>

*1. Central Connecticut State University*

Several Management courses teach students to consider how the internal and external environment influences and impacts organizational strategies. The SWOT (Strength, Weakness, Opportunity, Threats) analysis is one of the more common approaches in the US. This case study utilizes the PESTLE (Political, Economic, Social, Technology, Legal, and Environmental) approach which is more common in Europe and UK universities. The PESTLE analysis is more detailed and helps students more thoroughly examine a multitude of external factors that impact organizations. This case study will use the coal industry in WY. A recent report on National Public Radio highlighted many of the different external factors that are impacting coal in WY (Siegler, February 2, 2022: A White House push to help WY town go nuclear is cautiously embraced). The PESTLE analysis uncovers many threats to organizations and their stakeholders and also identifies opportunities for new organizations.

The case study is written for three different levels:

- Introduction to Management
- Undergraduate Capstone Strategy
- MBA Strategy.

Brief PESTLE analysis of Coal in WY:

- Political: Incumbent Presidential views
  - Interlink with Legal and Social
- Economic: Boom of WY when coal moved from WV. Decline of WY towns when coal is phased out
  - Interlinked with political policies and social
- Social: Societies views on environment and energy consumption
  - Interlinked with Political and Economics
- Technology: Advances in technology for solar, wind, nuclear options
- Legal: Clean Air Act
  - Interlink with Political
- Environment: Harvesting coal (mining) / Using coal (greenhouse gases)

## Simi Bot: A Text Data Mining Teaching Tool

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Abstracts

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***Dr. Andres Fortino**<sup>1</sup>, **Mr. Wukun Chen**<sup>1</sup>*

*1. NYU*

We developed an application to efficiently perform TF-IDF text similarity scoring to teach text data mining analysis. A web-based application, Simi Bot, was produced in the R language with a Shiny app user interface. Besides similarity scoring of texts, it also features topic clustering and keyword extraction. The application allows users to provide content locally or upload it as a text file pasting it into a text box in the web page customizing the unsupervised machine learning hyperparameters, and previewing the text mining results. As a teaching and learning tool, this program provides students in data analytics and other related disciplines with an easy-to-use tool to perform TF-IDF text similarity scoring analysis on any web-enabled device. Some applications include matching resumes to occupations or jobs, matching a syllabus to occupations or jobs, matching prospective faculty resumes to program course descriptions to assign faculty to courses, and recommending courses to students based on gaps found in their resumes.

# Teamwork and Collaboration Tools for the Virtual Classroom

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## Abstracts

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***Dr. Kellyann Kowalski<sup>1</sup>, Dr. swanson, jennifer<sup>2</sup>***

*1. University of Massachusetts Dartmouth, 2. Stonehill College*

Research has shown that teamwork and collaboration not only help students learn material, but also improve their interpersonal skills. Many of us have effectively used teamwork and other collaborative learning techniques in our in-person classrooms for years. During the pandemic we found ourselves teaching in asynchronous virtual classrooms trying to figure out how to keep student teamwork and collaboration as an integral part of the learning process. Although Zoom breakout rooms are useful for student teamwork and collaboration, it is difficult to monitor student work. In an in-person classroom we can simply walk around the class and quietly observe each team as they work. With Zoom breakout rooms, visiting each breakout room takes a long time and is disruptive to the students as they work.

Most of us are back teaching in-person, but virtual classrooms are here to stay post-pandemic. Therefore, it is important to find ways to promote and manage student teamwork and collaboration in the asynchronous virtual classroom. We will present a few tools that can be used to do so, including Google Drive and Padlet. Using such tools, students can work together in real time and instructors can easily monitor their progress. We will discuss these tools in terms of how they can be used and provide examples of student activities that can be done using them.

# Technology Readiness: Does it Matter in Online Learning Environments?

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Abstracts

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***Dr. Mohammed Raja*<sup>1</sup>, *Dr. Ravi Narayanaswamy*<sup>2</sup>**

*1. York, 2. University of South Carolina - Aiken*

The recent COVID-19 pandemic has transformed the learning environment worldwide. Specifically, it has pushed most higher learning institutions to offer online courses. The critical aspect is that not all academic institutions were prepared for this transition. The main challenges include acquiring the technology infrastructure, ensuring the faculty utilize the technology, and confirming student access and willingness to apply technology. This study uses theoretically grounded constructs of Technology Readiness (TR) and Instruction Technology Competence (ITC). TR is a personality trait-like variable that captures users' general attitudes toward accepting new technologies. It determines a person's predisposition to use new technologies based on one's mental enablers and inhibitors. TR is a multi-dimensional construct, and it is captured using – optimism, innovativeness, discomfort, and insecurity. ITC refers to instructors using digital resources to foster student learning. Furthermore, students must be motivated to learn. This is assessed using a motivation construct. This research argues that student learning satisfaction and course performance will be influenced by TR, ITC, and student motivation. The data for this study was a part of a large survey collected from undergraduate students who have taken at least one online course during the COVID-19 pandemic. The initial psychometric analysis revealed significant loadings and correlations. The modeling and analysis are in progress. The potential contributions will include implications for universities regarding strategies to enhance perceived usefulness and ease of use of adopted technology amongst students and instructors.

# The Lived Experiences of Adult Learners in an Individualized Program: Empowerment, Responsibility, Tensions, and Anxiety

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Abstracts

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*Prof. Daniel Woldeab<sup>1</sup>, Prof. gemma punti<sup>1</sup>, Prof. Richard Bohannon<sup>1</sup>*

*1. Metropolitan State University*

## **Abstract**

This study explores the lived experiences of individualized and interdisciplinary students enrolled in a four-year public university in the Upper Midwest region of the United States. Those enrolled in this individualized degree program are working adults with significant family, work, and life obligations. As Brookfield (2006), Knowles (1980), and Dewey (1903) indicated, adult learners want to be in charge of their education and find meaning in coursework that relates to their professional or out of school experiences. While this seems to be a common discourse for most of our learners, some also struggle with the complexity and uncertainty of directing one's own degree. This study, based on focus groups conducted as part of classroom activities, reveal how working adults find their individualized degrees to be student-centered yet constrained by university policies, experience the process as liberating and empowering while also anxiety provoking, and worry about the perception of an 'easy' degree while striving for a rigorous and passion-driven one.

# **Healthcare Analytics and Services Management**

# Clustering Hospitals to Analyze the Feasibility of Community Paramedicine Interventions

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Abstracts

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***Dr. Mehmet Kilinc***<sup>1</sup>

*1. Le Moyne College*

Community paramedics providing follow-up home visits, including patient assessments and evidence-based treatments, reduce hospital readmissions for discharged patients with heart failure (HF). Although community paramedicine (CP) program successes have been reported, the economic feasibility of CP programs for HF patients is less well known. This study aims to develop a cost-benefit analysis model that considers the implementation costs of CP intervention and the financial benefits through the Hospital Readmission Reduction Program (HRRP). Using secondary datasets and the outcomes reported in pilot studies, we utilize a Monte Carlo simulation model to determine the expected net present value (NPV) of CP intervention. Due to the variations in service area size, the annual number of HF discharges, and average Medicare payment per HF discharge among hospitals, we define different groups of similar hospitals via clustering algorithms and calculate the economic feasibility for each group. The results of this study provide economic insights for the successful widespread implementation of CP intervention. Hence, hospitals considering implementing CP intervention can benefit from the study findings.



# Competition and Coordination Between Traditional Hospital and Internet Hospital

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Abstracts

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*Dr. Aichih Chang<sup>1</sup>, Dr. Zhongping Li<sup>2</sup>*

*1. New Jersey Institute of Technology, 2. Anhui University*

Motivated by rapid growth of online healthcare platforms, this paper investigates its impacts on the healthcare ecosystem with considerations of heterogeneous patients, homogeneous service providers and profit-driven hospitals. A game-theoretical model with a queueing framework is developed and two healthcare systems are considered, including a monopoly system with either a traditional, offline hospital, or an online, internet hospital, and a duopoly system with both hospitals. Our study finds that in both systems a large population of patients always increases supply and demand and hospital utilization, which leads to an improvement of hospital profitability, and welfare of both patients and service providers. When considering a monopoly system and comparing the performance of a monopolistic internet hospital with a monopolistic traditional hospital, our study suggests that the former outperform the latter in hospital utilization only when the wait cost is not high (i.e., patients are less sensitive to wait time), especially when the wait cost is medium and patient population is small or population of service providers is large. When considering a duopoly system, this study concludes that the decisions of patients, service providers and hospital managers are interrelated; a large population of service providers increase its hospital's supply, demand, and wage rate, while decreasing its wait times. When comparing between monopoly and duopoly systems, the advent of the internet hospital is beneficial only when the competition between two hospitals is relatively weak; that is, either the number of service providers is sufficiently large or the patient population is relatively small.

# Digitalization of the Medical Field and the Use of Healthcare Information Systems

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Abstracts

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***Dr. Edward Chen***<sup>1</sup>

*1. University of Massachusetts Lowell*

This research looks at the need for digitization in the medical and healthcare fields and the advantages or disadvantages of adopting IT. The reasons for the rise in the use of Health Information Systems (HIS), also known as Electronic Health Records (EHR), and their current applications. Understanding the impact of the technology on both the patient and health care provider experience was a core tenant of the project. Additionally, current and future applications of HIS both within and outside of the patient care experience were pursued to understand the full application of the technology for the benefit of patients on both an individual and population level. Wide-spread adoption of HIS in the United States is still in its relative infancy, with a disconnected network of several record providers available. The impact on the patient's experience both within and outside of the hospital is continuing to evolve. The ability to organize and categorize health information gleaned from health records has improved dramatically with EHRs with the direct effect on health research of all kinds. It is recommended that the promotion of digitalization in medical organizations requires support from the government in the aspects of institutional reform and funding.

# Economics of Introducing a Mobile Clinic as an Added or Exclusive Modality for Dialysis Service

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Abstracts

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***Dr. Mona Jabbari*<sup>1</sup>, *Prof. Nagesh Murthy*<sup>2</sup>, *Dr. Eren Cil*<sup>2</sup>**

*1. Providence College, 2. University of Oregon*

Medicare covers costs for dialysis treatments and any associated hospitalization for patients with End-Stage Renal Disease. We analyze the strategic interaction between Medicare and a dialysis service provider, and show that mobile clinic as an added or exclusive service modality can be a win-win-win for Medicare, service provider, and patients.

# Improving Data Transparency in Clinical Trials Using Blockchain Technology

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Abstracts

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***Prof. Afrooz Moatari-Kazerouni<sup>1</sup>, Prof. Amin Keramati<sup>1</sup>***

*1. Assistant Professor, Widener University*

The unpredictable nature of the clinical trial process is a major driver of high costs for pharmaceutical drugs. To justify the costs of drug development, most pharmaceutical companies aim to develop 2-3 new drugs per year, but the success rate and long development timelines with clinical trials diminish the chances of a successful product. Such uncertainty brings out higher prices for stockholders throughout the supply chain, from investigator to the end consumer. Blockchain technology presents an opportunity to address some of these threats to the integrity of collected data. Its distributed network platform enables databases to store time stamped transaction records. These stored data are essentially impossible to hack or steal, because the ledger is not kept on a single repository, but is spread throughout multiple databases in replicate copies. Blockchain is a secure platform for storing and processing all types of valuable information, from clinical trial analysis results to business workflow documents to patients' medical data and blueprints of genetic information.

This study explores the role of blockchain in supporting clinical trials data management by developing a proof-of-concept of a patient-facing as well as the researcher-facing systems. The results propose a solution that enables the interaction of patients and researchers engaged in clinical research throughout the supply chain of pharmaceutical drugs development. The outcomes are intended to benefit patients by empowering them to have better controlled access to their data, and for researchers to maintain adherence to reporting requirements.

# Improving Outpatient Appointment Scheduling in Multi-Domain Clinics by Machine Learning Techniques

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Abstracts

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***Prof. Davood Golmohammadi<sup>1</sup>, Prof. David Dreyfus<sup>2</sup>, Mr. Lingyu Zhao<sup>1</sup>***

*1. University of Massachusetts Boston, 2. Rutgers Business School*

Outpatient scheduling remains a primary concern for operations managers. Outpatient clinics continue to struggle with patient scheduling so that patients and physicians are not kept waiting. Typically, standard block scheduling rules are applied for all patients. However, as is found in many service settings, each patient actually utilizes varying amounts of time. Accurately predicting the amount of service time needed for a specific patient should allow outpatient clinics to schedule more effectively. A decision-making model can be a very helpful tool for a scheduler. We use Machine Learning algorithms to predict service time for outpatient clinics servicing patients with a variety of characteristics. This study supports the understanding of factors that impact service time. Data from a clinic is obtained and used in the analyses. Four dominant data mining models are developed to predict service time and their performances compared. They are neural networks (NN), general linear model, linear regression, and support vector regression. The NN models performed the best. The reason for visiting the doctor and patient type are identified as the top characteristics to aid in predicting patient service time. Our contribution to the literature includes the following three items. First, we obtained a large dataset and extract quality data to test the prediction accuracy of multiple models to determine which one improves scheduling the best. Second, patient characteristics were identified through machine learning modeling and sensitivity analysis to understand which ones are most important for service time prediction accuracy. Clinical policy implications and recommendations are provided.

# Is it Time for the Healthcare Providers to Rethink Their Service Delivery Strategy? A Regression Analysis Using PA Hospitals

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Abstracts

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***Dr. Chamila Kalpani Dissanayake<sup>1</sup>, Dr. Dinesh R. Pai<sup>2</sup>***

*1. Penn State University at Brandywine, 2. Pennsylvania State University at Harrisburg*

The declining trend in inpatient admissions is an indicator of severe financial threat to the US hospitals while it could also mean delayed care by the patients. It is important to explore factors associated with the declining inpatient admissions to know how to improve their service delivery strategies to overcome these problems. This research used regression analysis models on PA hospital data collected during 2013-2018 and found that the inpatient admissions to hospitals were significantly and positively correlated to beds setup and staffed, occupancy rate, readmission rate, and outpatient admissions. Further, higher average length of stays was found to be negatively associated with inpatient admissions. Comparison of desired versus actual impact led to the conclusions that the positive readmission index indicates substandard service quality in PA hospitals, while the positive relationship of outpatient admissions indicates poor health levels of patients. Authors also found an increasing trend in outpatient admissions, thus suggest examining the potential benefits of reallocating unproductive inpatient service resources towards further expansion of the outpatient services. Also, both private and public healthcare providers should work collaboratively to find a systematic solution to provide more quality, efficient, and effective care at an affordable cost to all Americans.

# Machine Learning Models for Prediction of COVID-19 Cases and Deaths: Hyperparameter Optimization and Performance Evaluation

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Abstracts

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*Mr. Mojtaba Talaei-Khoei<sup>1</sup>, Mr. James Rolleri<sup>1</sup>, Prof. Asil Oztekin<sup>1</sup>*

*1. Manning School of Business, University of Massachusetts Lowell, MA, USA*

**Objective:** COVID-19 is the pandemic of our time and unprecedented public health crisis. Machine learning (ML) models were used in predicting the incidence and mortality of various illnesses. We aimed to build tuned ML models on classification of COVID-19 cases and deaths.

**Materials and Methods:** The ML algorithms of the decision tree,  $k$ -nearest neighbors, random forest, gradient boosting, kernelized support vector, and multi-layer perceptron neural network were used in the classification of COVID-19 cases and deaths among counties of the United States. Hyperparameter tuning through GridSearchCV was adopted to find the best parameters to optimize the performance of the models. Accuracy, precision, recall, specificity, F1 score, operating-receiver characteristic curve, and precision-recall curve of each model were presented. The best-tuned model was selected based on the F1 score.

**Results:** In predicting counties with high and low COVID-19 cases, the gradient boosting classifier performed the best with an F1 score of 0.703 on the testing split. Also, the random forest classifier performed very well (F1 score of 0.700). Gradient boosting and random forest classifiers also showed robust performance in classifying low and high COVID-19 deaths among U.S. counties with F1 score performance of 0.790 and 0.780, respectively.

**Conclusions:** We examined various tuned ML models in predicting the low and high levels of COVID-19 cases and deaths at the county level. This work furnishes an insight into how machine learning approaches can be beneficial in addressing the need for rapid and accurate models to assist in tackling the COVID-19 pandemic.

# Monitoring Length of Stay and Readmissions of Chronic Obstructive Pulmonary Disease (COPD) Patients: A Control Chart-Based Time Series Analysis

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Abstracts

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***Prof. Fatma Pakdil<sup>1</sup>, Prof. Nasibeh Azadeh Fard<sup>2</sup>, Prof. Steve Muchiri<sup>1</sup>***

*1. Eastern Connecticut State University, 2. Rochester Institute of Technology*

Hospital length of stay (LOS) and readmission rate are commonly considered major patient outcomes for measuring quality and cost of healthcare services. This paper examines the relationship between readmission rate and LOS of COPD patients using a nationwide database, the Healthcare Cost and Utilization Project (HCUP) database between 2010-2018. The primary goal of this study is to analyze the trends of the LOS and readmission of COPD patients using control charts and investigate whether the changes in LOS have affected the 30-day readmission rates of COPD patients. Obtaining a further understanding of the relationships between LOS and readmission rates of COPD patients may provide insightful knowledge for policy and decision-makers.



# Monte Carlo Simulation for Power Analysis Designing Longitudinal Studies

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Abstracts

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***Dr. Simcha Pollack***<sup>1</sup>

*1. St. John's University*

Complex experimental designs require Monte Carlo simulation to determine an adequate sample size. The existing programs for calculating power apply to situation where the research design and statistical analysis is relatively standard. However, with more complex designs, it is difficult or impossible to do a power analysis with the available tools.

Complex designs that have no packaged solution include longitudinal studies with non-linear trajectories and missing data. The correlation between time points, if it is a longitudinal design, greatly affects the findings and must be addressed. The existence of missing data, often occurring in experiments on humans, complicates the statistical analysis and the power analysis. No analytical formula exists to project the proper sample size under these conditions.

Using SAS (Statistical Analysis System) code, we can calculate power for this situation and easily modify the program to handle a wide range of models.

# Predicting and Explaining Quality in Home Healthcare Agencies: A Machine Learning Approach

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Abstracts

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***Dr. Mehmet Kilinc<sup>1</sup>, Dr. Furkan Oztanriseven<sup>1</sup>***

*1. Le Moyne College*

Home healthcare agencies provide a wide variety of services to patients outside of the hospital to help with their recovery or chronic conditions. The Home Health Compare database provides the performance data of agencies on a variety of quality measures. One of the most important quality measures is “Discharge to Community” which measures the percentage of episodes in which patients were discharged to home/self-care without an unplanned hospitalization for 30 days. In this study, we employ supervised machine learning algorithms to predict an agency’s discharge to the community level in a multiclass classification modeling setting. In addition, we attempt to discover the most important predictors in the best model. The results offer insight into home healthcare agency performance to improve the quality of care in the sector.

# Using DEA to Determine Hospital Performance in Reducing HAI Prevalence

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Abstracts

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***Prof. Herbert Lewis<sup>1</sup>, Prof. Christine Pitocco<sup>1</sup>, Ms. Veda Sripada<sup>2</sup>***

*1. College of Business, Stony Brook University, 2. Department of Applied Mathematics and Statistics, Stony Brook University*

In this study, we use data envelopment analysis (DEA) to measure, for each hospital, the degree to which it can reduce hospital acquired infections (HAIs.) Our focus is on five major HAI categories: Clostridium difficile infections (CDI), surgical site infections (SSI), central line-associated bloodstream infections (CLABSI), carbapenem-resistant Enterobacterales (CRE) considering both body (CRE-Body) and bloodstream (CRE-Blood) origins.

The results of this study provide insight to hospital administrators and state health officials indicating how each hospital is performing over time with respect to HAIs. In addition, a hospital may compare their results to other hospitals within a given year and over time. The goal of this study is to identify areas where HAIs may be reduced thus improving the overall quality of care.

# **Innovation and Creativity**

# Leveraging IDEAs for Individual and Organizational Development

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Abstracts

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*Dr. Eric W. Stein<sup>1</sup>, Dr. Denise Potosky<sup>1</sup>*

*1. Penn State*

Measuring creativity in context is challenging. Efforts to measure generalized creativity produces indications of overall creative horse-power, whether it gets expressed in the context of work or not. Other measures assess creativity as skills or activities; i.e., things individuals have done in the past like playing a musical instrument or having written a book or a symphony.

To address these limitations, the authors developed and validated an instrument that measures creative strengths that apply to individual expression especially in the context of work. Our analysis suggests four key dimensions of creativity: Improvisation (I), Design (D), Experimentation (E), and Aesthetic engagement (A). The IDEA Creative Strengths Inventory (CSI) offers a new, web-enabled, self-report measure of the creative strengths.

In this presentation, we discuss the development and validation of the instrument as well as the under-lying model that emerges from confirmatory factor analysis. We also discuss the application of the instrument for career management, leadership development and organizational development.

# **Legal, Ethical, and Social Issues**

## Elderly Fraud: Profiling the Crime using Data

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Abstracts

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***Dr. Ahmet Ozkul<sup>1</sup>, Ms. Francesca Tujak-Weiss<sup>1</sup>***

*1. University of New Haven*

The elderly population has always been one of the most vulnerable. This population is more susceptible to online scams, financial exploitations, and many other crimes which are called “elderly fraud”. To understand the elderly fraud, we used data analytics and visualization techniques based on 77 cases of elder fraud throughout the United States in the last 20 years. Our initial findings suggest that densely populated cities are targeted by domestic and international scammers, and most American perpetrators are using investment schemes against elderly populations.

# Investigating the Influence of Learning Robotic Process Automation on Artificial Intelligence Anxiety

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Abstracts

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***Dr. Alsius David***<sup>1</sup>

*1. SUNY Oneonta*

Robotic Process Automation (RPA) is becoming an essential skill that managers desire employees to possess in today's workplace. Simultaneously, the expression of anxiety towards artificial intelligence (AI) is emerging in today's society. This study uses the theory of integrated fear acquisition to examine the influence of the learning of RPA skills on anxiety towards AI.



# Meta-Analysis on the Antecedents of Social Entrepreneurial Intention: Comparison between Developed and Developing Countries

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Abstracts

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***Dr. EunSu Lee***<sup>1</sup>

*1. Kean University*

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. Although there are many studies on the antecedents of Social Entrepreneurial Intention (SEI), there have been few studies to compare the antecedents between developed and developing countries. Contributing to the research on the antecedents of SEI, we performed a meta-analysis of 40 studies (k=21, N=11,577) that include samples from 3 developed and 17 developing countries to examine any differences in SEI antecedents between the two groups. 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. We elaborated implications, limitations, and future research based on the results.

# Social Entrepreneurship Development: From the Perspective of Michael Porter's Diamond Model

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Abstracts

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***Dr. EunSu Lee***<sup>1</sup>

*1. Kean University*

Porter suggested a model that helps explain why some nations are more competitive and why some industries within the nation are more competitive than others are. Porter's Diamond model discusses that factor condition, related industry support, government policy, and customer demand play a critical role in determining the development of competitiveness of certain industries in each country.

The current study attempts to apply Porter's Diamond Model to explain the development of social entrepreneurship in each nation. There have been few studies to show how the national level environment influences the success of social entrepreneurship in a certain sector of social problems. Applying Porter's Diamond model into the context of social entrepreneurship, the current study discusses government regulation/support for social entrepreneurship, the prevalence of social problems (customer demands), donors, volunteers, education institutions (factor conditions), nonprofit organizations, regular entrepreneurship (support from related industries) will influence the facilitation of social entrepreneurship in certain social problem domains. The current study discusses implications for practitioners, future research issues, and limitations.

# Triple-Effect of Corporate Governance, Managerial Ability, and Corporate Social Responsibility on Firm Performance: a Longitudinal Study

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Abstracts

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*Prof. Qing (Ray) Cao*<sup>1</sup>, *Prof. Vicky Gu*<sup>2</sup>

*1. University of Houston-Downtown, 2. University of Houston-Clear Lake*

We present research exploring the relationship between corporate governance (CG), managerial ability, and corporate social responsibility (CSR) rating on business performance. Drawing upon both agency theory and managerial ability literature, we investigate relationships among the CG mechanisms, CSR performance, and managerial ability and ultimately the influencing rule of business performance. We analyze the secondary data collected from various databases (e.g., WDRS, Eikon, Compustat, etc.) using both data envelopment analysis (DEA) and panel data analysis.

# **Operations Management / Operations Research**

# A New Formulation for Multi-Mode Resource-Constrained Project Scheduling Problem

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Abstracts

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***Prof. Amin Keramati*<sup>1</sup>, *Prof. Afrooz Moatari-Kazerouni*<sup>2</sup>, *Prof. Joseph Szmerekovsky*<sup>3</sup>**

*1. Assistant Professor, Widener University, 2. Assistant Professor, 3. Professor, North Dakota State University*

This study presents an exact model for the multi-mode resource-constrained project scheduling problem with generalized precedence relations that maximizes the net present value and minimizes the costs of overtime of activities by the project's completion time. Three different payment models were considered for positive cash flow and bonus-penalty structure. Project scheduling of this type occurs in many fields, for instance, construction industries. The proposed model has been inspired by the rectangle packing problems and MRCPSP. Although conventional MRCPSP-related models need a feasible solution to start, the new model has no such requirement. To evaluate the proposed model, a small size numerical example is solved, and its computational results are depicted in terms of schedules. In addition, computational results with 72 test problems in various sizes are reported and the results analyzed.

# A Real Options Approach to Evaluating Ergonomics Projects to Reduce Musculoskeletal Disorders in the Workplace

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Abstracts

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*Dr. Cheickna Sylla*<sup>1</sup>

*1. MTSM, NJIT*

## **A Real Options Approach to Evaluating Ergonomics Projects to Reduce Musculoskeletal Disorders in the Workplace**

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### **Abstract:**

Musculoskeletal disorders (MSDs) are a Health and Safety workplace problem that costs companies millions of dollars annually. However, OSHA Ergonomics Program Standard to reduce and eventually eliminate such problems was repealed by Presidential Order in 2003. Since such time, unions and professional staff associations have been fighting to reinstitute the standards. Fortunately, many companies are voluntarily adhering to some standards to prevent injuries and minimize safety costs. Yet, despite the human and organizational costs and widely available ergonomic solutions, many other companies are still resistant to investing in ergonomics programs. A Cost/Benefit justification framework is needed to help managers appreciate the full benefits of well-designed ergonomics programs. This research study proposes a Real Options approach for valuing ergonomics projects that is superior to the traditional Net Present Value (NPV) model to help managers appreciate the benefits of MSD programs. Using three types of embedded options - accelerate, expand, and contract, this study demonstrates that the value of ergonomics project can be more accurately evaluated; it also shows that the value of the original project increased when a Real Options approach is used.

# Developing Scheduling Methods to Meet Quantities and Due Dates of Orders

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Abstracts

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***Prof. sangoh shim***<sup>1</sup>

*1. Hanbat National University*

This paper presents scheduling methods for a semiconductor wafer fabrication to meet daily quantities of orders with multiple product types and different due dates. Since each order has a due date, a quantity to be produced and a product type, a production planning is made to satisfy meeting due date and quantity of order. By a production planning, the daily output quantities (to be transported to wafer probe facilities) and input quantities for all product types are determined and lots associated with orders are released to a fabrication. Although production planning is obtained, it is not easy for operators and manufacturing managers to observe production planning since the unexpected incidents, such as machine breakdown, operators' mistakes and preventive maintenance, occur frequently. Therefore, it happens frequently that actual daily output quantities of orders are different with the planed ones. In this paper, to satisfy production plans in real fabrication, efficient dispatching rules that can be used in scheduling and dispatching in manufacturing execution system for a semiconductor fabrication are developed.

# Forecasting for Datasets with Seasonality: Is it necessary to de-seasonalize the data first?

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Abstracts

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***Dr. Mustafa Canbolat***<sup>1</sup>

*1. SUNY Brockport*

To forecast time series that show trend and seasonality components, it is a common practice to de-seasonalize the data first and then apply the forecasting method in mind. The claim is that using the data as it is without de-seasonalizing first will result in less accurate forecasts. In this study we use randomly generated datasets and datasets from the literature to empirically show that there is no significant benefit of de-seasonalizing data on the accuracy of forecasts.



# **Strategy and Organizational Behavior**

# Collaborative Management Strategies: An Analysis of Success Factors to Achieve Organizational Success

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Abstracts

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***Dr. Haleh Karimi***<sup>1</sup>

*1. Bellarmine University*

## **Abstract**

Organizations achieve success by having a competent workforce. Soft skills competencies have a significant role in graduate employability and career success. There is a global endemic soft skills gap, especially among entry-level college graduates entering the workforce. The importance of soft skills competencies became more apparent during the COVID-19 pandemic when businesses began to work in a virtual world. As emerging technologies intertwined in companies post-COVID-19, their consumerization demanded a workforce exhibiting a large-scale proficiency in soft and technical skills. Investing in a culture that promotes the development of highly in-demand technical skills with relevant soft skills competencies is an ideal strategic move in the future. This study interviewed healthcare employers to illuminate the reasons for the soft skills misalignment and hear their voices on addressing the gap to build a robust foundation to achieve success. The findings identified major influencers: holding students accountable for mastery, informing academia about the skill gap and future skill demand, offering curriculums contingent on current environments, and collaborating to reduce the skills gap. Businesses that pursued these strategies cultivated better experiences with higher employee retention, engagement, and employee satisfaction, leading to a better work environment. Innovational ideas increased, advancing organizational success. Furthermore, they experienced a steady pipeline of competent and talented college graduates. The research added to the strategic implications of collaboration to build soft skills competencies and the consequences of executing these strategies to produce a better outcome to achieve organizational success.

Keywords: Strategy, management, organizational success

## Gen Z: Our Future

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### Abstracts

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***Mr. Jonathan Adrien<sup>1</sup>, Dr. Minyoung Cheong<sup>2</sup>***

*1. Penn State University - Great Valley, 2. PSU at Great Valley*

We present perspectives regarding current trends, and analysis of Generation Z. This work provides our audience a look into Gen Z and the predicted global conditions when this generation takes the helm as world leaders and influential participants in our greater global society and economy. We will observe environmental conditions such as climate change, citing findings by scientists on changes occurring in the world due to human activities. The effects and implications of economic crises that Gen Z has lived through is also taken into consideration. While looking at the present, we also take a look into the past and speculate as to whether current trends are mirroring past events. We take a dive into what makes Gen Z unique and different from its predecessors. Various topics are discussed such as the increasing threats of Cybersecurity, the growing presence of the Metaverse, increasing digitization of daily life and its impact on mental health of Gen Z, political and environmental climates, educational system, and most importantly what our future will look like if current trends continue as they are.

More detailed information on each field and the relevant information will be discussed.

KEYWORDS: Gen Z, climate change, Cybersecurity, Metaverse, pandemic, crisis.

# Generation Z and Workplace Expectations and Attitudes

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Abstracts

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***Dr. Heidi Hughes<sup>1</sup>, Dr. Joo Eng Lee-Partridge<sup>1</sup>***

*1. Central Connecticut State University*

Much has been written about Generation Y, or Millennials, regarding workplace attitudes (for example Aydogums, 2019; Josiam, Reynolds, Thorzhur, Crtsinger, et al., 2008; Torsello, 2019; Winter & Jackson, 2016). However, the oldest of Generation Z, born 1997-2012, are just beginning to enter the workplace and we have little information regarding their attitudes, behaviors, goals and desires regarding work. Research regarding career identity and workplace relationships in regard to younger generations is important. Recent research into Generation Z has indicated that they embrace the protean career mindset (Hall, 2002) where their focus is more about how work will fit into their lives, not how their lives will revolve around work (Robert Half, 2019). The literature suggests that Gen Z is likely to embrace a Protean Career attitude than other generations. The Protean Career is an attitude driven by internal values of the individual (Briscoe et al, 2006). Some of the core values of the protean career attitude is freedom, growth, high levels of mobility, work satisfaction, personal respect of their own self, and work-related flexibility (Hall, 2002).

Following IRB approval data was collected Spring 2021 and Fall 2021. A total of 302 complete and usable responses were collected.

Generation Z students who participated in this study are drawn to Traditional careers and do not demonstrate a Protean Career mindset. The study further looks at the attitudes these students have towards organizational commitment, supervisor support and how engaged they do and do not want to be with their future professional careers.

# Narcissism, Leadership, Societal Culture and Firm Performance: A Cross-National Study of American, Chinese and Polish Firms

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Abstracts

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*Dr. Mark Somers*<sup>1</sup>, *Dr. Jose Casal*<sup>1</sup>, *Dr. Yuchao Ma*<sup>2</sup>, *Dr. Tsutomu Ito*<sup>3</sup>, *Dr. Takao Ito*<sup>4</sup>, *Dr. Jolanta Mazur*<sup>5</sup>, *Dr. Rajiv Mehta*<sup>1</sup>

*1. New Jersey Institute of Technology, 2. Wuhan University of Textiles, 3. Ube National College of Technology, 4. University of Hiroshima, 5. Warsaw School of Economics*

## **Abstract**

The relationship among narcissistic leaders and firm performance was studied across societal cultures with a sample of American, Chinese and Polish firms. Narcissism and societal culture were unrelated to firm sales, but societal culture was related to length of relationships with key strategic partners in international alliances. Further, societal culture interacted with narcissism such that highly narcissistic leaders in American firms had significantly longer strategic partnerships than did their less narcissistic counterparts. Implications of these findings were discussed with respect to directions for future research.

# The Role of CEO Compensation in Explaining R&D Investment and Corporate Political Strategy

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Abstracts

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***Dr. Mine Ozer***<sup>1</sup>

*1. SUNY Oneonta*

This study examines the influence of research and development (R&D) investment on corporate political strategy (CPS) and the moderating effect of CEO compensation on the R&D investment and CPS relationship from the corporate governance perspective. There is a substantial research on the relationship between R&D investment and corporate governance; however research on the interplay of R&D investment, corporate governance, and CPS is lacking. There is a need for a better understanding of R&D investment and CPS decisions in the context of corporate governance mechanisms. In this study, I contend that R&D intensive firms are more likely to engage in CPS. R&D intensive firms could influence public policy process through CPS and that could benefit their strategic objectives in the future. CPS could be vital for R&D intensive firms because CPS helps firms reduce uncertainties in their environment and provide more secure environment for them. By relying on the incentive alignment perspective of agency theory, I also propose that long term CEO compensation strengthens the positive relationship between R&D investment and CPS. Long term CEO compensation can align the interests of executives and shareholders to mitigate agency problems, which could be more prevalent in the R&D and CPS context as both R&D and CPS involve inherent risk and uncertainty.

# Who Matters, and How Does it Matter? Examining Differences in Stakeholder Influences and Environmental CSR Actions

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Abstracts

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***Prof. Shobha Das***<sup>1</sup>

*1. IFMR Graduate School of Business, Krea University*

Firms in extractive industries, while contributing to economic growth, also have significant, and often negative, impact on environmental sustainability. Stakeholders] try to influence these firms regarding sustainability. We examine if there is a difference in the importance of stakeholders when comparing firms in extractive industries with those that are not. We also study whether there is a difference in the the environmental CSR actions undertaken by firms in extractive and non-extractive industries. Primary data collected from firms in Qatar, a country that is reliant on oil and gas, an extractive industry, is statistically analyzed. We find that the government is an important stakeholder for firms in both types of industries, while the importance of customers and suppliers is significantly different. There is also a difference in the nature of environmental CSR actions undertaken by firms in extractive and non-extractive industries.

# **Supply Chain Management and Logistics**



# Analytics Driven Decisions for Supply Chain Strategy in an Era of Change

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Abstracts

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***Dr. Ashok Viswanathan***<sup>1</sup>

*1. Best Buy*

It is widely purported that companies now compete not only on products and services but also on their supply chain capabilities. Constantly increasing customer expectations, changing macro-economic conditions, protracted demand volatility, disruptions from technological advancements, and focus on sustainability has compelled supply chains to accelerate their evolution. Typically, the strategy team is entrusted with the mandate of charting the long-term decisions to position the supply chain for future growth. However, the rate of change in market drivers has shrunk the decision timeline to innovate and transform. Additionally, the need for agility, resilience, and reliability has assumed paramount importance.

This presentation details the adaptation the strategy teams have undertaken to thrive in this environment. Additionally, the impact of the changes on the 4 pillars of transformation, namely – people, process, technology, and data are illustrated. Importantly, the increased role of analytics in enabling data driven decisions is charted amidst the trifecta of challenges in data quality / maturity, delivery speed, and talent shortage.

Specifically, the staggering transformation of the practice of supply chain network optimization is addressed comprehensively across the domains of supplier management, transportation, warehousing, fulfillment, and reverse. The challenges in building and maintaining a digital twin, program development to manage stakeholder expectations, and data governance to ensure adherence to operational and DataOps processes are discussed in detail.

# Analyzing the Impact of Vessel Size and Investment into a Port

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Abstracts

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***Dr. EunSu Lee***<sup>1</sup>

*1. New Jersey City University*

The enlargement of container vessels leads to an investment to have a port where large ships can be called. Nearby ports in hub ports also start calling larger ships than before with additional investment into its infrastructure and equipment and scale. In the process, the cascade effect that shift vessels from a port the other ports and the spillover effect that flows into the nearby ports due to limited capacity of the hub port. This study conducts empirical research based on data on these phenomena.

# Barriers to Blockchain Implementation within Supply Chain: Analysis in Manufacturing, Transportation and Retailing Sectors

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Abstracts

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*Ms. Soode Vaezinejad<sup>1</sup>, Prof. Douglas Hales<sup>1</sup>*

*1. university of rhode island*

Blockchain technology can improve supply chain transparency, traceability, verifiability, security, etc. which makes it so appealing for managers to adopt it. Despite this growing interest, there are limited blockchain implementation projects in different industries. Lack of managers' knowledge on the related blockchain adoption and implementation barriers to their fields can be considered as an important reason. Different adoption and implementation barriers have been identified in the literature but to the best of our knowledge, there is no article that focuses on the interrelationships among barriers in different sectors within the supply chain separately. Therefore, in this study, we focus on manufacturing, transportation, and retailing sectors within the supply chain individually and address: First, what are the levels of importance of implementation blockchain technology barriers in manufacturing, transportation, and retailing sectors in the supply chain? Second, what are the cause and effect relationship between barriers in each sector? And third, what barriers are the most important ones comparing manufacturing, transportation, and retailing with each other? The goal of this study is to boost managers' knowledge on the most related adoption and implementation barriers to their specific sectors. In this study, we use the Decision-Making Trial and Evaluation Laboratory (DEMATEL) tool to analyze the barriers.

# Did We Go too Far with JIT Inventory Planning and Control?

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Abstracts

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***Dr. Pedro M. Reyes*<sup>1</sup>, *Dr. Patrick Jaska*<sup>2</sup>, *Dr. John Visich*<sup>3</sup>**

*1. Baylor University, 2. University of Mary Hardin-Baylor, 3. Bryant University*

Inspired by the current global supply chain crisis, it gives rise to the question did we go too far with JIT inventory planning and control? While lean inventories are the byproduct of Lean Six Sigma methodologies for continuous improvement, we believe that the JIT lean inventories were stretched too far across global supply chains. Hence, our research seeks to evaluate the factors that led to this crisis and offer potential solutions in today's Industry 4.0 era and the transformation to the digitalization era. From a global supply chain strategic design, we seek to identify the implementation challenges and expected benefits of potential solutions for the global supply chain crisis within the lens of Industry 4.0 technologies.

# Human Related Factors and Supply Chain Integration in Non-profit Organizations

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Abstracts

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***Dr. Cigdem Ataseven***<sup>1</sup>

*1. Cleveland State University*

This research investigates the relationship between human related factors and supply chain integration in humanitarian/non-profit supply chains. In this empirical study, survey data collected from food bank managers is utilized to test the hypotheses. Human capital and top management support are studied to understand their impact on supply, demand and internal integration, and the relationship between supply chain integration and performance is analyzed. Model results are presented, and managerial as well as theoretical implications are discussed.

# Logistics Digitization and the firm performance: The moderating role of Paradoxical Leader Behavior

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Abstracts

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***Mr. Muhammad Hasan Ashraf<sup>1</sup>, Dr. Anis Triki<sup>1</sup>, Dr. Mehmet Yalcin<sup>1</sup>***

*1. University of Rhode Island, College of Business*

21st century shopping and shipping mania has made it unavoidable for the Third-Party Logistics (3PL) firms to invest in Industry 4.0 technologies that guarantee customer satisfaction and subsequently, ensure a competitive advantage in the industry. While prior literature has largely relied on Resource Based View (RBV) to explain the implications of such initiatives, this paper proposes Paradox Theory in conjunction with RBV to fully understand the consequences of Industry 4.0 for the 3PLs. We present a 2x2 experimental design composed of a scenario/sorting-game to explore the moderating role of Paradoxical Leader Behavior (PLB) between Logistics Digitization (LD) and 3PL performance. Our experiment is grounded in the hub sorting operations context. By employing Paradox theory in conjunction with RBV, this research aims to explore the role of PLB in achieving maximum benefits out of Industry 4.0 related investments made by the 3PLs. In doing so this study will answer the call for theory-driven research explaining the relation between 3PLs and Industry 4.0 technologies. Moreover, this research also introduce a Package Sorting Game that can be used as a valuable tool by the logistics researchers to operationalize performance.

# Managerial Capital in the Supply Chain: An Antecedent to a Superior Firm Performance

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Abstracts

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*Dr. Yan Jin<sup>1</sup>, Dr. Julia Fullick-Jagiela<sup>1</sup>*

*1. Quinnipiac University*

The intensified global competition and the increasing unprecedented events (e.g., Covid-19 pandemic) accelerate the pace of change in the current business world. To be competitive in such an environment, a manufacturing firm needs to have the proper human capital to ensure the firm's flexibility in response to the uncertainties and to maintain sustainable competitive advantages. Human resource management literature has identified the importance of both human capital and leadership capital (managerial capital in economics research) in achieving superior firm performance. However, this strategic human resource needs to expand to the firm's suppliers as the firm specializes in its core competence and further depends on its suppliers (Cao & Zhang, 2011; Schoenherr, 2018). Our research contributes to the human resource management field by investigating the managerial capital in both the manufacturing firm and suppliers in the same research model.

Grounded on the extended resource-based theory, the results of a large-scale survey and Structural Equation Modeling indicate that the manufacturer's managerial capital and suppliers' managerial capital positively correlate with each other. Furthermore, the coexistent managerial capital positively relates to the manufacturing firm's flexibility, which eventually helps the firm to achieve competitive advantages. Interestingly, the manufacturer's managerial capital directly relates to its competitive advantages, and that effect is partially mediated by the firm's flexibility, while suppliers' managerial capital has no direct impact on the manufacturer's competitive advantages but indirectly influences them through the manufacturer's flexibility.

# Renewable hybrid energy supply chain network: A dynamic optimization model for a cleaner energy mix

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Abstracts

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***Dr. Raza Rafique*<sup>1</sup>, *Dr. Mohsin Jat*<sup>2</sup>, *Dr. Hakeem-Ur-Rehman*<sup>3</sup>, *Dr. Muhammad Adnan Zahid Chudhery*<sup>4</sup>**

*1. Kean University, School of Management and Marketing, Union, 07083, NJ, 2. Edwards School of Business, University of Saskatchewan, Saskatoon, Canada, 3. University of the Punjab, Lahore, Pakistan, 4. International Institute of Finance, School of Management, University of Science and Technology of China, Hefei, 230026, Anhui, China*

This study addresses the strategic development of renewable hybrid energy infrastructure for a cleaner energy mix. The optimization model with a cost minimization objective designs a renewable hybrid supply chain network with solar and bio facilities. The dynamic elements of the model capture the interplay between energy demand and energy consumption considering the constrained economic conditions. A salient feature is the development of hybrid energy mix infrastructure based on the economics and availability of certain types of energy reserves and the energy demand in localized regions. The model analyses the cost for the optimum development of a hybrid renewable (solar, bio) energy system that can significantly vary over the planning horizon. The optimal setup starts as a highly centralized system and evolves into a largely decentralized system. The powerplants address local energy demands first and then contribute to the central grid with the minimum yield loss.



# Responsible Sourcing and Supply Chain Traceability

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Abstracts

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***Dr. Jen-Yi Chen***<sup>1</sup>

*1. Cleveland State University*

This paper explores a buyer's tracing and its supplier's own sourcing decisions in a multi-tier supply chain. We explore what different stakeholders can do to achieve a more transparent and responsible supply chain. We establish that under rather general conditions, the two firms will adopt mixed strategies in equilibrium, a focal case of our analysis. The mixed-strategy results explain why in practice, one firm is uncertain about the other's action and why different fractions of the buyers/suppliers play different pure strategies. We then show that more responsible sourcing can be induced by lowering the buyer's tracing cost but not by reducing the supplier's own responsible sourcing cost. We also find that more transparency does not always imply more responsible sourcing. For the external stakeholders, more responsible sourcing may be obtained through lowering tracing costs, improving tracing or public discovery of violations, and imposing more significant reputational damage or penalties only on the buyer. For the two internal stakeholders, the buyer and its supplier, a cost-sharing contract can coordinate the supply chain, and it may also result in more responsible sourcing when the potential reputational damage to the buyer is high.

# Revisiting Supply Chain Flows: A Road Map Through Paradox Lens

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Abstracts

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***Mr. Muhammad Hasan Ashraf<sup>1</sup>, Dr. Mehmet Yalcin<sup>1</sup>***

*1. University of Rhode Island, College of Business*

While there have been several supply chain flows (SCF) review articles published recently, they appear to either address several of the four most acknowledged flows (i.e., material, service, information and financial flows), or are narrowly based along specific functional areas (i.e., logistics, procurement etc.). Recent major supply chain disruption, i.e., COVID-19, have posed new threats to supply chain models, triggering interactions among SCF that may possibly have resulted in certain flows to become more influential in managing supply chain operations. Meanwhile, the impact on SCF have brought in unprecedented levels of complexity and ambiguity to supply chains. In these situations, business as usual is often not an option since managers are constantly encountering incompatibilities and dilemmas, hence experiencing tensions that became salient amid the pandemic. Utilizing paradox lens, and based on extant literature review on SCF and Paradox theory, we conducted preliminary interviews with professionals belonging to various industry sectors. This study provides a literature review on the evolution of SCF and aims to identify the impacts on SCF in various industry sectors amid COVID-19. In doing so, we also propose how tensions that emerge due to the impact on these flows can be conceptualized. This study will address the needs of investigating paradoxes in the SCM domain that can aid practitioners in how to efficiently manage the tensions they encounter when SCF are disrupted. In addition, by suggesting emerging research topics driven by the SCF, we aim to provide a road-map for the future SCM and paradox researchers.

# Sourcing for Critical Supplies in the Healthcare Supply Chain

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Abstracts

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***Dr. Amelia Carr***<sup>1</sup>

*1. Bowling Green State University*

The Pandemic of 2019-2022 impacted the ability of healthcare systems to obtain the necessary supplies to operate. This study presents case examples of healthcare systems and their efforts to source and maintain adequate supplies. The focus is on the healthcare supply chain. Background of the global supply problem is provided as it relates to healthcare organizations. Each healthcare organization is discussed to include the unique challenges they faced in their ability to source supplies during the pandemic. The organizational structure and the supply chain is examined for each of the healthcare systems included in the study. A summary of the lessons learned through innovation, collaboration, and the creative supply management strategies are discussed along with recommendations for the future.

# Supply Chain Agility for Competitive Advantage in Apparel Industry: The Role of SCM Practice and Partnership Quality

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Abstracts

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***Dr. Mohammed Jahed**<sup>1</sup>*

*1. St. Bonaventure University*

Given increasingly unpredictable business environments, supply chain agility (SCA) has been pursued as a high-value capability by both supply chain scholars and practitioners. This research examines supply chain management (SCM) practices in a specific, fast fashion apparel (FFA) industry, where SCA is important. The relationships among SCM practice, SCA, supply chain partnership quality (PQ), and competitive advantage (CA) are investigated, driven by new theoretical perspectives like resource advantage (R-A) theory in addition to resource-based view (RBV) and dynamic capability theories. A mixed-method approach was adopted, combining a qualitative, grounded theory approach followed by quantitative, survey-based analysis. Partial least squares structural equation modeling (PLS-SEM) and PROCESS macro were utilized for statistical analysis. The results indicate that SCM practice is critical to enhancing SCA, PQ, and CA. PQ is seen to partially mediate SCM practice à SCA relationship, while SCA is seen to have a close-to-full mediation effect on SCM practice à CA relationship. This study also indicates the relative impacts of SCM practice on partnership quality, agile capability, and sustainable competitive advantage in the FFA industry. **Keywords:** Supply chain agility, SCM practice, Supply chain partnership quality, Competitive advantage, Apparel supply chain, Resource-based View, Dynamic capabilities, Resource advantage theory, PLS-SEM.

# The Effects of Gray Swan Phenomena on Operational Performance

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Abstracts

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*Dr. Tony Lynch<sup>1</sup>, Dr. Joo Jung<sup>2</sup>*

*1. Pen, 2. University of Texas Rio Grande Valley*

The current pandemic has [re]focused companies' attention on the various risks to they are exposed in the global supply chain. Managers' perceptions of risks tend to be guided by their attitudes toward risk. Some have referred to the pandemic as a black swan – an unpredictable event. This paper investigates the relationship between the occurrence of a Gray Swan (a low probability-high negative impact event) and the resulting effect on a firm's operational performance. Firms face significant challenges to their operational efficiency including maintaining quality, reducing lead times, reducing cost, and improving flexibility (Prajogo et al. 2012; Hong et al. 2019). We employ an integrated theoretical framework using Transaction Cost Economics and Contingency Theory to answer the following research questions:

R1. Does the occurrence of a Gray Swan negatively impact firm operational performance?

R2. Is the relationship between Gray Swans and firm operational performance mediated by the firm's buyer-supplier relationship?

R3. Does the firm's risk management system moderate the effects of a Gray Swan on operational performance?

We found that there is a direct negative relationship between the occurrence of a Gray Swan and firm operational performance. We also found an indirect effect between of a Gray Swan of firm operational performance which is mediated by the type of buyer-supplier relationship. The effect was larger for firms with a transactional buyer-supplier relationship. We also found an interaction effect between the firm's risk management framework and the type of buyer-supplier relationship on firm operational performance.

# The Evolution of Supply Chain Network Structures of Major Global Brands

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Abstracts

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***Dr. James Minas*<sup>1</sup>, *Dr. Natalie Simpson*<sup>2</sup>**

*1. St. John's University, 2. University at Buffalo*

We study complex networks resulting from supply chain relationships of 34 global brands from different industries over a 20-year horizon. This data set encompasses annual networks which ultimately connect 2,376 additional firms through major supply relationships. We apply competing definitions of complexity from the network science literature to detect what structural changes to these supply networks have occurred over the years. We also consider which of these network complexity measures are most relevant in the context of authentic supply chain structures.

# The US Port Congestion, the Value Destroyer for the Supply Chain Competitiveness

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Abstracts

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***Mr. Anish Surya*<sup>1</sup>, *Prof. Douglas Hales*<sup>2</sup>**

*1. University of Rhode Island, College of Business, 2. university of rhode island*

A critical hub which connects all modes of transportation, port (or seaport) is regarded as a significant player in global logistics and supply chains since it handles over 90%, in terms of volume, of cargoes transported over the globe (UNCTAD 2014). The competitiveness of the port becomes a topic of increasing relevance, given the importance of the port both as a source of value creation for firms involved in a supply chain and, more in general, for the impact of port activities on the social, environmental and economic development of the region in which the port is located. Indeed, ports are of major economic and strategic importance for countries as they facilitate imports and exports by having connected geographical location, subsequently fostering the local, national and regional economy and boosting firm's competitiveness along the entire global supply chain. Considering the significance of the port in the country's economy directly or indirectly any disruption in port not only adversely impact the whole supply chain flow but also will majorly impact the businesses and economy at large.

As supply-chain woes have wreaked havoc on the global economy due to pandemic covid-19, one chokepoint in particular has stood out: America's woefully is ports congestion. Ships idling off the coast, waiting to offload goods, have become an icon of paralysis. Such delays impose serious costs: Retailers face shortages, manufacturers have slowed production due to delay in incoming raw materials or semi-finished goods, goods have spoiled, and exporters have lost customers.

# **Marketing and Consumer Behavior**



# Event-Related-Potential (ERP) as a Scale Validation Tool: Understanding Individual Neuropsychological Differences based on the Style of Processing (SOP) Scale

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Abstracts

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***Dr. William Jones*<sup>1</sup>, *Dr. Meng Hsien (Jenny) Lin*<sup>2</sup>**

*1. Ramapo College of New Jersey, 2. California State University Monterey Bay*

The Style of Processing scale has been widely used in contexts related to individual processing of information since it was developed by Childers et al. (1985). A series of research dialogs published in an issue of *Journal of Consumer Psychology* (JCP) in 2008 discusses the pitfalls of the scale (Bagozzi 2008) and how the scale is suggested to inform processing of specific stimuli with respect to words versus pictures. Instead of counterarguing these viewpoints, Childers and Jiang (2008) provide an alternative approach to study SOP through the lenses of neuroscience by examining brain circuits to provide insight on individual differences in information processing. Childers and Jiang proposed that using the framework of differences in response time in tasks undergoing automatic or controlled processing, individual differences in these processes can be verified by neuroscience data.

A decade later, we took these propositions and conducted an event-related potential (ERP) study that aims to (a) dissect these processes in the context of processing pictures and (b) validate the SOP scale neurally, which provides future researchers a tool for scale development and scale validation. We test the original propositions outlined in Childers and Jiang (2008), which is based on the notion that the brain is wired and trained to process information in a certain sequence and route from repeated learning, which is reflected in preferences verbal vs. visual preference. We also test an alternative set of hypotheses that is based on effectiveness in suppressing learned processes that are reflected in automatic responses.

# Impact of Covid-19 on Consumer Preference for an App-Based vs. Street-Hailed Taxi Ride: An Empirical Analysis of New York City Taxi Industry

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Abstracts

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***Dr. Prashanth Ravula***<sup>1</sup>

*1. New Jersey City University*

The Covid-19 pandemic and social distancing mandates have significantly impacted consumer behavior in several industries. For example, consumers have started using more e-commerce websites for shopping because they believed brick-and-mortar stores were more of a health risk. Against this backdrop, we hypothesize that consumers in the taxi industry may prefer more app-based taxi rides (e.g., Uber, Lyft) than street-hailed rides (e.g., Yellow-, Green-taxi). Further, we posit that this shift in consumer preference may be more remarkable in very dense markets like Manhattan, New York City (NYC). Because consumers may feel Uber or Lyft cars are a more private space and less risky than street-hailed Yellow or Green taxis. Since Manhattan is denser than the outer boroughs of NYC, consumers in Manhattan may prefer app-based rides vs. street-hailed rides more than consumers in outer boroughs of NYC. Analysis of the NYC taxi industry between February 2019 and July 2021 explores these issues by comparing consumer preference for an app-based ride (Uber, Lyft, Juno, Via) vs. street-hailed ride (Yellow-, Green- taxi) during the pandemic with that before. The study complements the ride data provided by the NYC Taxi & Limousine Commission with weather data and Covid-19 hospitalization data provided by the NYC Department of Health and Mental Hygiene. Specifically, the study uses a segmented regression approach to estimate market-share models (aggregate and market level). Study findings will provide implications for app-based and street-hailed ride service providers.

# Impact of Various Marketing Theories and Software Applications on Small Colleges

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Abstracts

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***Dr. Melissa Ford***<sup>1</sup>

*1. County College of Morris*

The purpose of this qualitative study was to examine the impact of marketing options on college selection, and of Customer Relationship Management (CRM) tools on marketing efficiency. Five theories of marketing options and efficiency, including Customer Relationship Management, undergird this study. Small colleges must determine ways to market themselves, optimize use of technology, and increase enrollment to compete with other post-high school options. Using selected theories of marketing options and efficiency as theoretical framework. This study was conducted utilizing qualitative methodology; information-gathering tools used were interviews and questionnaires. Data interpretation was accomplished through thematic analysis influenced by elements of transcendental phenomenology. The participants were 10 current and former administrators/faculty from small colleges in the Mid-Atlantic region, and 286 students enrolled in two such schools. The administrators were interviewed; the students answered questionnaires. All inquiries were drawn from two research questions that reflected the problem, purpose and theoretical framework of this study—marketing options and CRM usage. The results confirmed that internet marketing of the website type (not social media) is most influential among college bound students. Surprisingly, personal contact and word of mouth were deemed more effective than social media, implying they deserve increased attention. Customer Relationship Management (CRM) was confirmed as being very useful in college admissions. Results are presented with recommendations to take advantage of such findings by small colleges. Recommendations were to concentrate on internet marketing focused on nearby students, to emphasize personal contact during recruitment, and to use CRM tools to enhance marketing efficiency.

# Impact of Various Marketing Theories and Software Applications on Small Colleges

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# The Case for Intuitive Advertising

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Abstracts

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***Dr. Francisco Quevedo*<sup>1</sup>, *Dr. Pradeep Gopalakrishna*<sup>2</sup>**

*1. Rutgers University, 2. Pace University*

We demonstrated that brand preference is highly intuitive, showing a Path Analysis Beta of .71 for intuition even for a high-end automobile choice. Rationalization came into play when we manipulated the price variable, raising the rational Beta to .54 when such an intuitive choice had to be justified. We had previously proven that the more time and money consumers have, the more likely they are to decide intuitively or emotionally. Also, through extensive gaps-in-the-literature research, we showed that the combined effect of rationality, intuition, the senses, and emotions on consumer preferences had not been properly studied. Worse, although research had shown attention to be intuitively selective, marketers continue to plow billions into price-based promotions and attribute-based advertising, trying to rationalize with a consumer that could not care less about their arguments. We present here at NEDSI 2022 the case for intuitive advertising and marketing. Advertising messages should trigger attention by appealing to the audience's intuition upfront and support these stimuli with rational criteria, if at all, only to help customers justify their intuitive preferences, instead of the other way around, as 20<sup>th</sup> Century consumer decisions models dictated. Marketing should anchor brand experiences not on reason but on emotions and sensations which feed intuition. Successful marketing must appeal to human nature. Our proposal is, therefore "persuasion without argumentation", "fewer words, more imagery" as leading brands do; let the audience arrive at their own conclusions from what they see, and customers form their opinions based on what they feel. Rationality is overrated...

# The Limits of Artificial Intelligence in Customer Relationship Management: An Implicit Mindset Perspective

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Abstracts

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*Mr. Uttam Paudel<sup>1</sup>, Dr. Ozge Aybat<sup>1</sup>*

*1. Penn State Harrisburg*

Marketing managers have been quick to adopt the advancements in artificial intelligence (AI) to improve efficiency, data management, and brand image. AI-driven marketing has also been touted for improving existing customer experiences and for creating newer, more enjoyable ones. Amidst this backdrop, this research investigates the use of AI in customer relationship management, its reception by customers, and the factors that determine its success. Firm-specific factors such as availability of internal resources (Libai et al., 2020; Chi et al., 2020), industry sensitivity (Mogaji et al., 2020), as well as demographic factors such as age, education level, employment status (Pticek & Dobrinic, 2019) have been found to influence users' perception of AI; however, the research on customer-centric factors has been limited. The current work shows that consumers' implicit mindsets (Dweck et al., 1995)-; that is, their beliefs in changeability or fixedness, is an important factor to consider. We suggest that consumers with growth mindsets, who believe in improvement and change over time, respond more positively to AI when compared to consumers with a fixed mindset, who believe that things are fixed and unchangeable. Data we collected from 191 online survey participants shows that growth mindsets are more likely to be supportive and optimistic about AI, compared to fixed mindsets. They are also more likely to be favorably predisposed to anthropogenic AI such as Siri and Alexa. This study advances the work on AI and implicit theory and offers important managerial implications to improve AI success in marketing.

# Using Regression Analysis to Estimate the Impact of Human Trafficking Interventions in the U.S.

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Abstracts

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*Dr. Vernon Murray<sup>1</sup>, Ms. Ashlyn Smith<sup>1</sup>*

*1. Marist College*

We coded 180 UN human trafficking cases in the U.S., between 2005 and 2015. Each victim/case was then categorized according to the level of trafficker “egregiousness” in the Murray et al. (2015) “Victim Intervention Marketing” (VIM) framework. Victims who were minors or coerced adults were “Enslaved.” Victims who were hindered (e.g. passport taken) but not prevented from leaving the situation were “Nearly Enslaved.” Finally, “Unenslaved” victims merely accepted employment so egregious as to be illegal. Ideally, all other things equal, the percentages of the most egregious forms of human trafficking should decrease over time, while the percentages of the less egregious forms would increase. To determine if this was the case for the U.S., we ran Regression Analysis using the three categories (above) as independent variables. “Year of Prosecution” (2005 -2015) was the dependent variable. We found positive slopes (i.e. betas) for the two most egregious forms, and a negative slope for the least egregious form (i.e. “Unenslaved”). The R-square (.34) suggested this model could be useful in identifying the betas. Pearson Correlations were positive for the two most egregious forms of trafficking, but negative for the least egregious form (however  $p > .05$ ). One interpretation is that trafficker egregiousness has been increasing. Another is that the U.S. more aggressively prosecuted the *least* egregious human trafficking cases, thus increasing the percentages of the *most* egregious cases. Since the VIM framework prescribes social marketing interventions (e.g. “Radical Confrontation”), efforts targeting the more egregious forms of trafficking should be increased in the U.S.

# Authors Index

Adrien, J.	647	Dag, A.	578
Affisco, J.	356	Das, A.	597
Aggarwal, A.	78	Das, S.	651
Albizri, A.	579	David, A.	636
Almeida, M.	95	Desnoye, N.	304
Amoah, E.	315	Ding, X.	181
Anoruo, E.	565	Dissanayake, C.	626
Ashraf, M.	603, 658, 662	Dreyfus, D.	625
Ashraf, S.	293, 558, 591, 592	Duman, G.	594, 609
Ashrafimoghari, V.	518	Dwivedi, R.	95
Ataseven, C.	657	El-Rayes, N.	371
Aybat, O.	674	Elam, E.	613
Bakhsh, M.	598	Fang, J. (Clark University)	585
Bala, P.	293, 558, 591, 592	Fang, J. (Kean University)	571
Bandera, C.	606	Fard, N.	628
Belitzky, E.	609	Ferris-Costa, K.	604
Berman, B.	33	Ford, M.	671, 672
Bohannon, R.	618	Fortino, A.	228, 615
Brennan - Tonetta, M.	190	Fossatti, P.	418, 437
Bugallo, E.	418, 437	Friedman, H.	3, 335, 398
Canbolat, M.	644	Fullick-Jagiela, J.	605, 659
Cao, Q.	639	Gantz, C.	247
Carr, A.	663	Gefen, D.	247, 530
Casal, J.	649	Ghashami, F.	247
Catania, J.	550	Golmohammadi, D.	625
Chang, A.	621	Gonzales, J.	581, 599
Chen, E.	622	Gopalakrishna, P.	673
Chen, J. (Cleveland State University)	661	Gu, V.	639
Chen, J. (Stevens Institute of Technology)	568	Gupta, S.	502, 594
Chen, W.	615	Gupta, U.	600
Cheong, M.	647	Gurkan, N.	588
Choi, J.	580	Habig, S.	458
Chudhery, M.	660	Hales, D.	655, 667
Chukwuogor, C.	565	Hamakawa, C.	613
Cil, E.	623	Hasbrouck, R.	586
Collins, R.	606	Hellström, R.	220
Corlu, C.	265		



Hertz, S.	398	Liu, H.	114
Hong, J.	511	Liu, R.	590
Hughes, H.	614, 648	Liu, X.	220
Inabinet, M.	315	Lorenc, B.	584
Ito, T. (Ube National College of Technology)	649	Lu, T.	612
Ito, T. (University of Hiroshima)	649	Luz, C.	437
Jabbari, M.	623	Lynch, J.	335
Jacobsen, S.	220	Lynch, T.	665
Jacobson, A.	209	Ma, Y.	649
Jahed, M.	664	Mai, F.	568
Jain, R.	293, 558, 591, 592	Maleyeff, J.	181
Jaska, P.	656	Mazur, J.	649
Jat, M.	660	McGarvey, K.	530
Javed, A.	293, 558, 591, 592	Mehta, R.	649
Jayaraman, J.	570	Merriman, K.	599
jennifer, s.	616	Mierzwa, S.	584
Jin, Y.	605, 659	Minas, J.	666
Jones, W.	669	Mintz, C.	3
Joseph, R.	81	Moatari-Kazerouni, A.	624, 641
Juneja, D.	595	Monticelli, J.	418
Jung, J.	665	Muchiri, S.	628
Karimi, H.	646	Murillo, J.	315
Kashyap, R.	190, 580	Murray, V.	675
Keramati, A.	624, 641	Murthy, N.	623
Kilinc, M.	620, 630	Namayanja, J.	598
Klanwari, P.	265	Narayanaswamy, R.	608, 617
Kleiner, D.	335	Nasri, F.	356
Kongar, E.	594	Ndu, I.	565, 611
Kowalski, K.	616	Neil, N.	550
Kronrod, A.	578	Ngene, G.	575
Ku, C.	580	Nguyen, H.	595
LaMacchia, C.	607	Nitting, A.	52
Lee, B.	315	Ozer, M.	650
Lee, C.	315	Ozkul, A.	635
Lee, E.	637, 638, 654	Ozpolat, K.	603
Lee-Partridge, J.	648	Oztanriseven, F.	630
Lewis, H.	138, 631	Oztekin, A.	578, 581, 599, 627
LI, J.	581	Pai, D.	626
Li, Y.	579	Pakdil, F.	628
Li, Z.	621	Paknejad, J.	356
Liebowitz, J.	52	Pan, J.	265
Lin, M.	669	Parthasarathy, S.	583

---

Partovi, F.	585	Sripada, V.	631
Patidar, N.	605	Stagliano, A.	567
Paudel, U.	674	Stein, E.	633
Pelaez, A.	190, 209	Subramanian, G.	583
Peng, R.	181	Suchow, J.	518, 588, 590
Ping, Y.	579	Sui, J.	568
Pitocco, C.	138, 275, 631	Sundaresan, S.	574
Pollack, S.	629	Surya, A.	667
Potosky, D.	633	Sylla, C.	642
punti, g.	618	Szmerekovsky, J.	641
Qin, L.	81	Talaei-Khoei, M.	578, 599, 627
Quevedo, F.	673	Tashman, P.	581
Quirvan, C.	566, 572	Tavakkol, B.	589
Rafique, R.	660	Triki, A.	658
Raja, M.	608, 617	Tsanacas, D.	569
Ramaswamy, M.	122	Tujak-Weiss, F.	635
Ravula, P.	670	Vaezinejad, S.	655
Rehman, H.	660	Vakil, A.	33
Reyes, P.	656	vazzana, v.	199
Rivas, P.	596	Visich, J.	656
Rolleri, J.	627	Viswanathan, A.	653
Samuel, J. (Rutgers University)	190	Wang, C.	575
Samuel, J. (Rutgers)	580	Wang, J.	577
Samuel, Y.	190	Weber, J.	602
Sanchez-Persampieri, E.	199	Weidman, D.	265
Schroeder, K.	199	Welch, K.	315
SEXTON, T.	138, 275	Winston, E.	209
Shaltayev, D.	586	Woldeab, D.	618
Shi, J.	371	Wolverton, C.	610
Shi, Y.	575	Xia, Y.	480
Shim, S.	593	Yalcin, M.	603, 658, 662
shim, s.	643	Yang, R.	590
Shin, H.	315	Yao, P.	502
Silva, L.	437	Yoshikuni, A.	95
Simpson, N.	666	You, Y.	228
Singer, A.	480	Yu, Y.	590
Slavin, N.	571	Zamanova, T.	9
Smith, A.	675	Zhang, Z.	574
Somers, M.	649	Zhao, L. (St. Ambrose University)	596
Son, Y.	589	Zhao, L. (University of Massachusetts Boston)	625
Song, Y.	181		
Sran, B.	602		

---

Zhao, S.	114	ZHOU, S.	576
Zheng, C.	458		





# ***Risk, Resilience and Recovery in Turbulent Business Environments***

**52<sup>nd</sup> NEDSI Annual Conference  
Washington, DC, March 30- April 1, 2023**

## **CONFERENCE ANNOUNCEMENT**

[NEDSI](#), the northeast regional division of the [Decision Sciences Institute](#), will be holding its 52<sup>nd</sup> annual conference in Washington, DC, from March 30 – April 1, 2023. 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**

[School of Business and Public Administration](#)  
[University of the District of Columbia](#)

## **CALL FOR PAPERS**

Full papers, abstracts, and workshops are invited for, but not limited to, the topic areas listed. Undergraduate and Master level 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 31, 2023** through the conference website at [nedsi2023.exordo.com](https://nedsi2023.exordo.com). If you have proposals for panels, roundtable discussions, sessions, and workshops, please email them to the program chair. For additional information <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**

To be communicated soon.

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