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Abstracts

A Comparison of Student Preferences Regarding Class Offerings and Learning Styles between a Public and Private Institution of Higher Learning

Oral

Dr. Mike Shurden¹, Dr. Susan Shurden¹, Dr. Timothy DuPont²

1. Lander University, 2. Newberry College

Colleges and universities have implemented more non-traditional classes such as hybrid and online offerings over the past years. This shift is especially true since the Covid 19 outbreak that forced schools to convert to online offerings during spring 2020 semester. Questions that are now to be considered are: Do most students prefer the traditional, face-to-face classroom environment, or do the majority of students prefer online offerings? Are hybrid classes a good compromise that students prefer? In addition, with what type of learning style do students associate? These questions were answered in a previous study, which involved only a public university; however, now the research has been extended to include a small private college. Surveys were administered at two small institutions of higher education located within the Southeastern region of the United States. One institution was a small public university while the other was a small private college. This paper will examine the data using statistical analysis to determine if significant differences exist between the two institutions with regard to student preferences toward class offerings and learning styles.

A Design Science Approach to Machine Learning Applications of Physical Fitness

Oral

Dr. Caleb Bradberry¹, Dr. Hui Wang¹, Mr. Devin Dent²

1. Radford University, 2. Virginia Tech

Machine learning has provided the technological foundation to shift recommender and expert systems into the day to day use for decision makers. From traffic flow optimizations to deep neural networks for artistic style transfers, machine learning can be found. This research examines the potential of designing a system with which an individual with a limited knowledge of physical fitness can begin to develop smarter and more informed workout routines. The scope of this system is extended to provide better informed decisions for personal trainers, exercise physiologists, and explores the potential as a medical recommender system for physical therapists with a limited range of ailments.

A PAIRED SAMPLES ANALYSES: EXAMINING PSYCHOMETRIC OUTCOMES FOR A COHORT OF HEALTH SCIENCES AND TECHNOLOGY ACADEMY (HSTA) PARTICIPANTS

Oral

Dr. Sherron McKendall¹, Dr. Alan McKendall¹

1. West Virginia University

This proposed study will examine psychometric scales known in the literature to predict academic and life success. Examining a cohort of HSTA participants (N=99) from their entrance (i.e., baseline data) through exiting (i.e., graduation data) the program we will determine if there is a mean difference in academic intentions, community engagement, engaging differences, social support, etc. from pre to post intervention stage. ^[1-15]

A Survey of Healthcare Management Students Learning Preferences Prior and during Coronavirus (COVID-19).

Oral

Dr. TaQuesa McLeod¹, Dr. Lisa Wills Keister²

1. Lander University, 2. Prince William Community College

This follow-up survey seeks to provide a comparative analysis of student learning preferences of healthcare management students pre- and during-COVID 19 pandemic. Students were assessed one year prior to COVID and two years after the emergence of COVID, 2019 and 2021 respectively. This paper reports on the demographic, psychometric properties, discipline, and academic factors at a Southern Regional university. Changes in professional, administrative, and student academic goals have precipitated the need to assess student modality preference and educational trends. This data will be used to develop a conceptual framework of student learning preferences and academic evaluation.

A THREE-TIERED APPROACH TO “SEIZE THE DEI”! PRACTICING WHAT WE PREACH (AND TEACH)

Oral

Dr. C. Douglas Johnson¹

1. Georgia Gwinnett College

Carpe diem is translated as “seize the day” and is viewed as sage advice from the Roman poet, Horace, who expressed the idea that one should enjoy life while one can. Intentionally using a play on words, the “Seize the DEI” (pronounced “day”; meaning “Diversity, Equity, and Inclusion”) mantra has particular relevance to organizations and individuals who seek to fully engage in and contribute in a meaningful way to organizational life. This paper outlines 15 lessons professors and/or practitioners can use as modules or a series of sessions to assist current and aspiring organizational leaders in understanding, embracing, and executing these concepts to enhance organizational effectiveness, as well as employee engagement and satisfaction (or fulfillment). The “Seize the DEI” series begin with six lessons at the macro (organizational) perspective and concludes with six lessons at the micro (individual), with the three meso (interactional) lessons in between to emphasize the interplay between the two.

ACHIEVING SUPPLY CHAIN RESILIENCE IN THE TELECOMMUNICATIONS INDUSTRY: AN ANALYTIC HIERARCHY PROCESS (AHP) MODEL APPROACH

Oral

Dr. Laquanda Leaven Johnson¹

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Telecommunications companies have become abundantly aware of the inherent risk that competition between like-type service providers present. Although many risks threaten to disrupt a supply chain, losing customers and market share directly affects a company's bottom line and causes alarm across all business sectors. In response, the telecommunications companies are working harder to retain their existing customers as it costs more money to attract new customers. Consequently, determining what customers require in their mobile service provider means collecting various data and analyzing such data, which can become quite complex. Turning this data into valuable insights that influence crucial business decisions requires an equally robust system that can manage the various data sets. This paper aims to review how mobile service providers within the telecommunications industry utilize AHP models to analyze customer preferences to ensure customer retention and supply chain resiliency.

An Examination of Nostalgia and Voluntary Simplicity

Oral

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While many factors come into play, emotions have a large role in the consumption process. An emotion of great interest is the feeling of Nostalgia. Although considered to be a positive emotion in modern theory, depending on the valence and occasion nostalgia can also be considered as a negative emotion with feelings of discontent and dissatisfaction triggered by discontinuity between past and present. Analysis of general conceptions about nostalgia indicate that this emotion involves fondness, self-focused, and social recollections characterized by positive (happy) appraisals, and to a lesser extent by negative (sadness) appraisals. Nostalgic narratives typically depict momentous events from one's life, such as the individual overcoming a challenge. One such challenge may be one's engagement in voluntary simplicity, which is a deliberate choice to reduce one's materialism for a variety of reasons. For some, it is a way to reduce one's environmental footprint. Reducing the number of products purchased will have an impact, although very small, on the number of resources used to produce that product in the future. This paper will examine the relationship between nostalgia and voluntary simplicity.

An Examination of the Business Curriculum Core: What's Important and What's Not

Oral

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ABSTRACT

Curriculum is the domain of the faculty at institutions of higher education. Faculty seek to impart the general and specific knowledge necessary for students to succeed in the careers. Business majors are in a broad category of disciplines which include Accounting, Marketing, Management, Economics, Management Information Systems, Human Resources, Project Management, and Entrepreneurship. The Business Core, those classes required for every major, is integral for students to gain a holistic understanding of Business disciplines as it provides a breadth of knowledge, context and the necessary skills which will allow students to enter and successfully navigate through their career. But what are the classes which constitute the Business Core and are they appropriate for the 21st century?

Matt Gavin, in a 2019 article for the Harvard Business School online, listed the ten important business skills. These skills included: An Understanding of Economics, Data Analysis Skills, Financial Accounting Skills, Negotiation Skills, Business Management Skills, Leadership Skills, Effective Communication, Emotional Intelligence, Decision-Making Skills, and Networking. While these skills do not perfectly match-up with specific classes, one can see how a curriculum which includes these skills would benefit students.

The researchers at a public, mid-Atlantic Masters II University desired to see if there was a disconnect between what they and their students found important and what the Alumni and Employers found important.

The host institution has been criticized for having such a large core as the perceived excess number of classes may make it more difficult for students to complete the program. If a student transfers from another institution or changes their major the onerous core requirement may make it difficult for the student to graduate with just the 120 required hours to earn a Bachelor's degree.

The first part of this study examined the curricular offerings of the Business college's peers. These programs were selected due to their size and geographic location to the host institution. In addition, six noted institutions were cited as aspirational which could provide guidance in the host institution evaluating their curriculum. The business core of 17 institutions was analyzed to find commonalities and differences (see Table 1).

Business Law was utilized at all seventeen institutions. Financial Accounting, Intro to Marketing, Business Policy and Managerial Accounting were used by over 82% of the institutions compared.

Interestingly, less than 30% of the peer institutions utilized the lowest eight classes. Perhaps the most notable issue with the Applied Mathematics for Business which no other institution used. This limits the student's ability to take the class at another institution or to transfer the class in and receive credit for it.

Table 1: Host institution Business Core and the % of institutions which included these classes

Legal Environment of Business – 100%

Financial Accounting – 88%

Principles of Marketing – 88%

Business Policy and Strategy – 88%

Managerial Accounting – 82%

Principles of Economics (Macro) – 76%
Principles of Economics (Micro) – 71%
Management of Organizations – 65%
Operations Management – 59%
Calculus I – 53%
Elements of Applied Probability and Statistics – 41%
Software Applications for Business – 35%
Career and Professional Development I – 29%
Business Ethics and Social Responsibility – 29%
Public Speaking – 18%
Calculus for Applications I – 18%
Leadership and Human Behavior – 12%
Corporate Finance – 12%
Career and Professional Development II – 0%
Applied Mathematics for Business – 0%

The next step was to examine classes used at other institutions which were not present at the host institution. Management Information Systems was the most offered class not in our curriculum. The host institution offers this class as an elective. Financial Management was second and is offered as an elective as well.

Over a third of the institutions had a class in business statistics while the host institution utilized a class in the institution's Mathematics department to not duplicate offerings. International Business and Organizational Behavior were both used by 29%. The host institution offers International Business as an elective. Leadership in the host institution was used instead of Organizational Behavior. Perhaps these classes should be considered by the host institution (see Table 2).

Table 2: Classes in the Business Core NOT in Host Institution's Curriculum

Management Information Systems – 59%
Financial Management – 41%
Business Statistics – 35%
International Business – 29%
Organizational Behavior – 29%

A survey was developed and sent to current students, alumni, employers, and Chamber of Commerce members from the host county and two neighboring counties to ascertain the answer to this question.

An electronic, anonymous survey link was sent to ensure the anonymity of the respondents. For each class, a Likert rating of Not Important, Slightly Unimportant, Neutral, Slightly Important, and Critically Important was selected. The means for the responses were determined and compared by group. The findings are critical since they affirm or refute the practicality of each of the classes. In addition, there were free responses where the employers' listed classes and skills they felt were valuable to students entering the professional workplace. A total of 224 usable responses were analyzed.

The results of this survey will help the host institution with its curricular development as well as provide a template for other institutions to use as well.

Keywords: Curriculum, Business Classes, Undergraduate skills, Business Core

An Exploration of Business Anthropology and Ethnography Research Techniques to Provide a Rich Explanation of Clients, Employees, and Stakeholders' Behaviors

Oral

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This undergraduate research study aims to explore the usage of business anthropology techniques within the modern business schema. This study will detail the pros and cons of using anthropological research techniques (e.g., ethnography) to examine the behavior of clients, employees, and stakeholders within the business atmosphere. People who employ business anthropology research techniques open themselves up to previously undiscoverable data and a rich explanation of the driving forces behind human behavior. However, the ethical standpoint of such research methodologies has often come into question and needs to be examined to provide future researchers with an ethically aware study. Through the definition and cultivation of what business anthropology is and examining its pros and cons, this research study aims to educate and reframe constrictions within the research world.

Keywords: business anthropology, ethnography, human behavior

An Exploratory Analysis of Hunger Relief Agency Clients

Oral

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Although hunger in the United States has always been intertwined with poverty, it has been brought to the fore during the COVID-19 pandemic. There is now a heightened awareness that hunger is pervasive throughout many communities in the United States. This study surveys food pantry clients to gain an understanding of who is subject to food insecurity in a large southeastern U.S. community. Demographic data is collected, along with questions that help define the extent of clients' food insecurity. Results suggest clients are primarily U.S. minorities (African American and Hispanic), they are just as likely to be employed as unemployed and they do not receive food assistance of any kind by a two to one margin.

APPLICATION OF COGNITIVE LOAD THEORY TO IT DISASTER RESPONSE SITUATIONS: IMPLICATIONS FOR INDUSTRY AND ACADEMIA

Oral

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Disaster response and recovery of information technology (IT) systems is a critical time for organizations. This paper examines the process of IT disaster response through the lens of cognitive load theory (CLT). CLT is traditionally applied in a pedagogical context to understand the effect of assignment instructions on cognitive load in learning. In this study, CLT concepts will be adapted in practice to understand information processing in three IT disaster response situations in a medical office. Results will provide a better understanding of disaster response information processing and should impact how IT disaster response problem solving is taught in academia and industry.

APPROACHING THE UNAPPROACHABLE: DO NEW STAFF AUDITORS HAVE RISKY RESPONSES TO AN UNAPPROACHABLE IN-CHARGE AUDITOR?

Oral

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Increased expectations of new staff auditors with little experience often necessitates seeking assistance to complete more complex tasks. These auditors can seek assistance from many sources including prior year workpapers, peer team members, the in-charge auditor, or a client contact. While prior literature finds that new staff auditors are likely to avoid older, more experienced, and more knowledgeable client contacts (Bennett and Hatfield, 2013), it has not investigated new staff auditors' reactions to sources of assistance from within the audit team. Given the importance of the work performed by staff auditors, this experiment will assess their responses to an unapproachable in-charge auditor. Accounting students, proxying for new staff auditors, will be randomly assigned to experimental conditions in which they encounter either an approachable in-charge auditor or an unapproachable in-charge auditor and either an approachable client contact or an unapproachable client contact. The sources of assistance are necessary contacts when completing the given accounts receivable confirmation task that requires that they seek assistance to complete successfully because the prior year workpapers and peer team members lack the necessary information. First, the social identity theory predicts that new staff auditors will identify with their team members (i.e., the in-charge auditor) more than the client contact because they are more similar to them and will therefore want to act according to traits they perceive as typical of their in-group (i.e., the audit team) (Tajfel and Turner, 1979). As such, we predict that new staff auditors will seek assistance from an in-charge auditor who is less or equally as unapproachable as a client contact. Second, the "no-win" situation that staff auditors encounter when they have an unapproachable in-charge auditor and a client contact who is seen as out-of-group, results in some level of fear in selecting any of the available sources of assistance, which is associated with reduced investigation, or audit effort (Guénin-Paracini et al., 2014). As a result, we next predict that new staff auditors will gather less evidence when they have an unapproachable in-charge auditor. Third, new staff auditors interact daily with team members. If these interactions with team members are fearsome, because of an unapproachable in-charge auditor, then the interactions have the potential to increase new staff auditors' stress due to fear and/or poor organizational culture, which can result in increased turnover intentions firms (Hiltebeitel and Leaub, 2001; Reinstein, Sinason, and Fogarty, 2012). Our final prediction is that new staff auditors will display higher turnover intentions with an unapproachable in-charge auditor. The results of this study will provide insights into a potential risk introduced to the audit engagement through an unapproachable team member upon whom new staff auditors are highly reliant. This study will develop a richer understanding of choices that new staff auditors must make when they are completing tasks, which has an overall effect on audit quality.

Assessing the Impact of COVID-19 pandemic on Education: Insights from Teachers and Students in India and the United States– A Study

Oral

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The COVID-19 pandemic impacted daily and business life worldwide, and education has been no exception. As a result of the lockdown, students and instructors had to quickly move from the traditional face-to-face teaching method to virtual learning. On the one hand, the COVID-19 pandemic exposed the unpreparedness, inadequacies, inequities, and inadequate supportive environments to deliver education online or virtual; on the other hand, it significantly impacted students and instructors for their learning and teaching. Most students and teachers were not prepared for online learning mode and had to adapt quickly to new pedagogical concepts and methods of delivery of teaching and learning. Also, the marginalized groups who did not have access to high tech reliable, supportive environments were further marginalized. This study aims to investigate the impact of COVID-19 on education in students and instructors for their learning and teaching. The data will be collected from two different countries: the United States and India. A Five-point Likert-scale questionnaire targeting students and instructors separately is designed to collect data on their experiences. The questionnaires are divided into five categories: virtual classrooms, course learning outcomes, an alternative method of assessment, the impact of online teaching, and satisfaction.

Assessing the Impact of Social Media on COVID-19 Pandemic – A Study

Oral

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Social media played a significant role during the COVID 19 pandemic period. The various studies indicate that social media had a positive impact on managing crises and sharing information and resources in response to stressful events. However, at the same time, several researchers concluded that the spread of misinformation, amplified on social media and other digital platforms had a significant negative impact resulting in mental health issues. It also jeopardized measures to control the pandemic that is a threat to global health. This study aims to collect data through a quantitative survey with persons eighteen years of age and above, as well as review the most recent studies conducted on the role of social media. The study searched the electronic databases available at PsycINFO, PubMed, and LISTA. The findings' generalizability may contribute to the scientific literature and offer insights into using social media effectively as a strategy for better crisis management. The results might also lead to future empirical studies investigating the role of social and digital media in identifying several constructs.

CONCEPTUALIZING “THE LEADRIGHT VALUE(S) PROPOSITION FRAMEWORK” FOR TEACHING LEADERSHIP

Oral

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In an effort to facilitate active learning in the classroom (or leadership development workshop) and engage students in critical thinking that enhances personal and professional development, a new framework to introduce critical leadership themes. The proposed framework is two-tiered with superordinate and subordinate themes. The proposed session highlights the superordinate themes (character, integrity, respect, influence and achievement), as well as the experiential experiences engaged in the class associated with the framework to address the subordinate themes. The session will also describe the origins of the framework and an explanation of the value(s) proposition. The proposed session will be a simulation of the experiential experience itself where the attendees engage in an acrostic approach with the superordinate themes to address the associated values of leadership. There is also an opportunity for the participants to complete the activity, ask questions of the presenter, and share feedback.

COPING WITH SUPPLY UNCERTAINTY IN A MATERIAL REPLENISHMENT SYSTEM

Oral

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Stock replenishment decisions in uncertain operating environments often require accounting for various sources of uncertainty in order to enhance the desirability of the outcomes. To that end, supply uncertainties and ensuing disruptions in the replenishment process are commonly regarded as major contributors to increasing the complexity of such decisions. We present a stochastic model of a material replenishment system operating under uncertainties in demand, lead time and supplier availability. The model leads to an exact closed form formulation of the expected cost function based on the adopted ordering policy. Numerical results derived from the model help with understanding the confluence of such uncertainties on the system performance and exploring possible means of coping with an inherently unreliable supply process.

Crisis Averted? The Moderating Role of Firm Prominence Amid a Product Harm Crisis

Oral

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Companies take great care in researching new products to prevent issues from arising. Although many resources are used to prevent them, product harm crises are very common. Prevention steps are very important to minimize the likelihood of these occurrences, but it would be seemingly rare for companies to completely avoid them, especially companies with an expansive number of products. In other words, all companies will likely encounter a product harm crisis at some point in their lifetime. Product harm crises are known to have negative impacts on both brand preference and advertising effectiveness. Given this, these companies must have steps in place to minimize the impact of these situations. This research will look at aspects of the company that may aid in protecting the company from negative impacts amid a product harm crisis. Aspects being analyzed include strategic alliances, new product introductions, and competition.

Cybersecurity Education: Enhancing Student Engagement and Broadening Participation: Can culturally Relevant Practices Help?

Oral

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The 2021 Colonial Pipeline cyber-attack, which led to shutting down the largest energy pipeline in the U.S. resulting in massive oil and gas shortages, is a glaring wakeup call about the immediate need to better protect our communication and information systems. This attack was detrimental to our economy, resulting in massive costs, consumer frustration, and ultimately lost business. One aspect of cyber protection involves increasing the numbers of individuals entering the cybersecurity field as well as the need to increase diverse perspectives. As cyber attacks become more varied and frequent there is a need to ensure diverse perspectives are represented in design, development, conceptualization, creation and implementation of cybersecurity technologies and practices.

Cybersecurity crosses multiple industries and disciplines. A diverse team with varied skills and backgrounds can provide richer, broader perspectives, answers, and solutions. Diversity in the workplace is beneficial; it enhances the variety of applied knowledge, perspectives and solutions (NAS, NAE, and IOM 2011). Diversity improves the engagement and performance of professionals and enhances innovation and research efforts (Cohen et al., 2002; U.S. Glass Ceiling Commission 1995).

The number of cyberattacks are steadily increasing, but the number of professionals entering the field are not keeping pace with the need. Those with lived experiences that produce knowledge of how to minimize bias or disparate impacts are virtually absent. There is a huge shortage of underrepresented minorities in the cybersecurity field (Chai et al., 2006).

There is an estimated cybersecurity job shortage of over 3.5 million by 2021 according to Cybersecurity Ventures (Forbes, 2018). Jobs in the cybersecurity areas are numerous and one of the fastest growing sectors for new jobs (Morgan, 2019; Forbes, 2018). NIST and ISACA are organizations with certifications in cybersecurity ranging from CompTIA Network+ at the entry level to the CISSP at the managerial level.

The purpose of this research proposal is to address the lack of diversity, skills, and knowledge in the cybersecurity field by developing and evaluating an inclusive, culturally relevant course/framework around curriculum, materials and practices toward increasing knowledge, interest, engagement and adoption in the cybersecurity discipline by under-represented minorities including women.

Ultimately, this effort is designed to address the large shortage of underrepresented minorities in cybersecurity fields by sparking their interest and understanding of the value of cybersecurity. The research question focuses on whether using culturally relevant approaches to teaching cybersecurity courses will positively engage students to adopt cybersecurity or other STEM fields.

The use of culturally relevant approaches to teaching has been shown to have positive outcomes in academic achievement (Ladson-Billings, 2014). I plan to use inclusive and culturally responsive pedagogy to develop the course and curriculum and teach the course based upon ecological theory and previous culturally relevant concepts for teaching (Gay, 2018; Ladson-Billings, 2014; Bronfenbrenner, 1994). The goal is to use a culturally relevant approach to engage students (the students consist of a majority population of underrepresented minority students in the cybersecurity field) to pursue cybersecurity courses, degrees, and certificates. This proposed research is unique in its culturally relevant and inclusive approach to cybersecurity education, which can be used as a framework for

other STEM related programs. In this research, the

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focus is on using a culturally relevant approach to educate, engage, and motivate underrepresented minorities to adopt cybersecurity education and careers. This proposed research will be a two phased approach involving qualitative and quantitative methods. The first phase will include focus groups and a survey instrument to help in developing a culturally relevant-based course. The information from the first phase will be used to develop the course for phase two. The second phase will include the development of a culturally relevant course which also includes a pre- and post- test. The course will be based on culturally relevant materials, content, and curriculum. The curriculum is based on ecological theory associated with culture.

Data Mining Cosmetologists Social Media Posts to Discover Latent Occupational Health Risk Factors

Oral

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Cosmetologists providing skin, hair, and nail services are exposed to potentially harmful chemicals in the workplace on a daily basis. Workers also endure long working hours, repetitive body movements, constrained body positions, and prolonged periods of standing. This largely female dominated profession has been reported to be associated with a variety of health concerns, including dermatitis, musculoskeletal disorders, back and joint pain, respiratory issues, reproductive complications, and certain cancers. Limited research exists on the association of such ailments with beauty industry professionals. This study aims to contribute to the body of research assessing the occupational health risks of salon work. Specifically, it investigates the perceived prevalence of disease among this population using content analysis. A better understanding of the health implications for cosmetologists will play a vital role in disease prevention, product regulation, and the implementation of safety procedures and risk-reduction strategies in the salon.

DAY OF THE WEEK EFFECT IN US EQUITY MARKET DURING WEEKS WITH PARTIAL TRADING DAYS

Oral

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Many studies have examined the day of the week effect in the equity markets all around the world. However, there has not been any close scrutiny of financial data to capture the day of the week anomalies during weeks with incomplete trading days. In this study, we have probed beneath the surface and investigated the differences in US equity market daily returns during the weeks with incomplete trading days for the period of 2001-2020. The results of this research mainly reveal that Mondays are most pleasing to the general equity investors, as the average daily return on stocks as represented by S&P 500 was the highest. Additionally, the standard deviation of daily returns was also the highest on Mondays. Fridays, on the other hands, were the least favorable day of the week on the grounds of the highest daily return, while Thursdays claimed the prize for the day with lowest level of volatility.

DID INCOME RELATIVE TO THE PUA BENEFITS DETERMINE THE SEVERITY AND DURATION OF UNEMPLOYMENT DURING THE PANDEMIC? EVIDENCE FROM 159 GEORGIA COUNTIES.

Oral

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1. Middle Georgia State University

In March 2020, congress passed the Pandemic Unemployment Assistance Program (PUA) which provided \$600 per week to individuals dislocated from their jobs by the pandemic. Eligible Georgians also received up to \$365 in state benefits. For Georgians, this amounted to \$50,180 annually, not including additional stimulus checks, and other benefit programs provided in the CARES Act. The state of Georgia has 159 counties that in 2019, varied in per capita income from \$20,755 and \$71,604 and from \$25,712 to \$112,834 in median household income. We explore the relationship between income relative to PUA benefits and its impact on the severity and duration of unemployment across all counties in Georgia during the pandemic. Contrary to conventional wisdom, we find a positive relationship between income and the severity and duration of unemployment.

DIGITAL MARKETING CURRICULA IN VIRGINIA'S REGIONALLY ACCREDITED COLLEGE'S AND UNIVERSITIES

Oral

Dr. Alice Obenchain-Leeson¹

1. Roanoke College

Scholars in marketing education are working tirelessly to unearth, explain and respond to the opportunities and forces for change facing marketing curricula in the 21st. Citing digital disruption as a dominant force for change, scholars are addressing guiding frameworks [5] pedagogical approaches to teaching social media [6], and large scale systematic 'state of' studies in digital marketing curricula [7]. Alongside these important academic developments in digital marketing education, the world of work in digital marketing faces a skills gap. O'Brien [9] reported that securing workers with the right skill set is the number one challenge facing the digital marketing industry. While there are likely many reasons for this skills gap, a salient study on AACSB schools with undergraduate marketing programs reported that only 15% of marketing programs require a digital marketing course as part of the program's core marketing degree requirements [6]. With regard to digital marketing curriculum, perhaps Crittenden [3] summarizes it best when she suggests that marketing education is playing catch-up. In addition to playing catch-up, Langan, Cowley and Nguyen [6] demonstrated an evolving pattern of digital marketing curricula adoption among AACSB marketing programs.

Some schools are responding by updating legacy courses, while others are creating wholly new specializations in digital marketing areas. Regardless of approach, marketing educators are having to make room for digitally relevant content, which still feels new to many. Embracing new ways of thinking about and teaching marketing are common among us. While forces for change in marketing curricula are not uncommon, the multi-disciplinary nature, and multi-faceted scope of digital marketing seem to foster a heightened sense of newness for the most seasoned marketing educator. To this author, marketing educators are in a familiar space of both innovation adoption (product and process, incremental and disruptive) and innovation creation. While many organizational and individual factors may impact organizational innovation, organizational culture values for adhocracy were found to be related to higher frequencies of program innovation in colleges and universities. [8] As the adoption and production of curricula occur, initially, at the school/department/college level, a missing piece in benchmark studies on digital marketing curricula adoption is understanding the impact of departmental-level organizational variables, departmental innovativeness, culture, etc.

Scope and Research Question(s): This abstract represents a work in progress in the truest sense in that it: 1) introduces a long-term, systematic study of digital marketing curricula in regionally accredited marketing programs in the United States that extends the work of Langan, Cowley and Nguyen, and builds upon it, and 2) documents a related recent exploratory research on digital marketing curricula undergraduate marketing programs in Virginia, the results of which will be used to improve the long-term study.

While the work of Langan, Cowley and Nguyen [6] provided a benchmark into digital marketing offerings at 497 AACSB schools, there are more than 1500 undergraduate marketing programs in the United States. Many marketing programs were not accounted for in the study. At completion, the long-term study will contribute to the field of marketing education in three ways. One, as an extension of Langan, Cowley and Nguyen's [6] work, it will be a helpful comparative supplement to the 'state of digital marketing curricula' reports needed by marketing educators. Two, at completion, the nationwide study will provide a more representative view of digital marketing in undergraduate marketing education in the United States. Three, the final study will examine the adoption of digital marketing

curricula from an organizational innovation perspective by examining business school/department/college characteristics (i.e., size, structure, professional accreditation), capabilities (i.e., culture, innovativeness, mission statement outcome measures) and their impact on the commitment to digital marketing curricula.

This remainder of this abstract addresses the exploratory research on digital marketing curricula in undergraduate marketing programs in Virginia. The guiding research questions are:

1. To what extent are marketing programs in Virginia's regionally accredited business schools/departments/colleges adopting digital marketing in their curricula offerings?
2. To what extent are business schools/departments/college's mission statements helpful in understanding the evolving pattern [6] of digital marketing curricula adoption?

Definitions: This exploratory phase adopts several definitions from Langan, Cowley and Nguyen [6] as follows:

Digital marketing: is conceptualized as broadly covering various elements to include technologies, devices, platforms, media, data, and the transformation of it [6, p. 33]. By extension, this study also adopts the same broad view [3, p. 33] of digital marketing, which includes areas such as social media, mobile marketing, analytics, e-commerce, e-mail marketing, marketing software, and customer data mining as topics to integrate into marketing curricula.

Marketing program: any business school that provides the option to specialize in marketing with at least one required marketing course as part of an undergraduate business degree. [6, p. 34]. Options to specialize were identified by labels such as: marketing major, marketing emphasis, marketing concentration, marketing specialization, and marketing track

Commitment to Digital Marketing Curricula: is a continuum of stages [6] for classifying schools along a continuum of evolving adoption stages such as: "legacy infusers" (i.e., infusing digital marketing content into legacy courses in marketing), "adopters" (i.e., offering one or more digital electives), "specializers" (i.e., offering a major, minor, certification, specialization, track or emphasis in a digital marketing area), "requirers" (i.e., requiring a digital marketing course in the marketing program), or "exemplars" (i.e., requiring a digital marketing course for marketing programs + offering a digital marketing specialization)

Sample: The National Center for Educational Statistics (NCES) College Navigator was the sampling frame for this exploratory study. Twenty-eight (n=28) Virginia schools met the definition of "marketing program" for inclusion.

Methods: Secondary data were gathered from the NCES College Navigator website, college/university websites and college/university catalogs. Demographic data (i.e., school name, address, type, highest degree awarded) and program-level data (i.e., name of marketing program, type of marketing program, name of degree, name of digital marketing specializations) from the schools were downloaded from NCES into Excel. Using the institutional websites and catalogs, the course names and numbers for all marketing programs and digital marketing specializations, the school/department/college mission, and accreditation status were added to the Excel file. From this data, 13 non-metric variables were created. In addition, four metric variables were created to include: "Digital Marketing Course Required", "Number of Digital Marketing Courses Offered", "Number of Digital Marketing Specializations". Descriptive analysis, using SPSS were performed on the metric variables. Results will be discussed.

School/Department/College mission statements were grouped and combined into a corpus according to their stage in the *commitment to digital marketing curricula*. The corpus was submitted to a line-by-line interpretive text analysis in accordance with mission-statement analysis methods. [1],[2],[4].

Abbreviated Results Overview: This portion of the abstract presents a summary of the results for the two research questions of this current study. Regarding the first research question, the abbreviated results of this abstract address digital marketing courses as a requirement in marketing programs. Among the 28 business schools in the sample, all offer a marketing program. 21% (n=6) require a digital marketing course.

Among the 6 schools who require digital marketing in their marketing programs, there is variance in the number (1-4) and topical focus of them. Among the 6 schools who required digital marketing courses in their marketing programs, there were 13 unique titles across 15 required courses. For example, there were 2 courses titled “Social Media”, and 3 others that included the same phrase with additional variants to include “Social Media Marketing”, “Social Media Research”, “Social Media Strategies”. The course “Marketing Analytics” is required by two schools, while a similar variant, “Audience Analytics” appeared at a third school. Design courses (n=3) were offered in 3 variants to include – “Web Design”, “Media Design”, “Computer Graphics”. Courses in Interactive Marketing (n=2) occurred in two variants – “Introduction to Interactive Marketing” and “Interactive Marketing Strategies”. Courses required in e-Commerce (n=2) included the variants of “e-Commerce and CRM” and “e-Commerce and MIS”.

Outside the requirement for digital marketing in marketing programs, most schools offer digital marketing courses. Specifically, 96.4% (n=27) of the business schools offer some type of digital marketing course. Seventy-four different course names were identified with notable variance in them. Courses are offered as electives and are also configured among digital marketing-related majors, minors, concentrations, cognates, tracks, emphases, and specializations. Further details will be discussed.

Among the 28 schools in the sample, they differ in their commitment to digital marketing education. While 21% (n=6) business schools require a digital marketing course in their marketing program, others demonstrate commitment to digital marketing education at different levels. Using a continuum of stages [6], 67.8% (n=19) of business schools in Virginia are either “adopters” (i.e., offering one or more digital electives) or “specializers” (i.e., offering a major, minor, certification, specialization, track or emphasis in a digital marketing area). The remaining 32.1% (n=9) business schools demonstrate more extreme commitment to digital marketing education. For example, 1 school offers no digital marketing courses (nor coverage of digital marketing topics) and 2 schools infuse digital marketing content into existing legacy marketing courses. At the other extreme, 7.1% (n=2) are considered “exemplars” (i.e., requiring a digital marketing course for marketing programs + offering a digital marketing specialization).

Regarding the second research question, mission statements are regarded as a fundamental building block of an organization. Mission statements capture an organization’s unique purpose and practices [1], and guiding principles and operating values [2]. Mission statement scholars study the components [1] [4], characteristics and how mission content varies across organizations. Mission statements have been established as important for behavioral benefits [1] with mixed results for impact on organizational outcomes [4].

The corpus of mission statements from “Legacy Infusers-Adopters” expressed their purpose as “preparing” or “educating” students to become “successful leaders or professionals” with one reference to “preparing students for graduate school”. Two unique expressions of purpose were expressed as “to cultivate a learning environment that inspires people” and “to create learning opportunities that change lives”. Most schools described what students learn in general terms such as “technical and non-technical skills”, “business knowledge” and “business competencies”. Several schools named their programs. Regarding practices, there was little coverage. References to practices were minimal, focused on the learning environment, and very expressive, such as “relevant discovery, transformative experiences, and engaged partnerships”. The tone of the corpus was informational. There was no mention of digital relevancy.

The corpus of mission statements from Specializers-Marketing Program Requirers-Exemplars” were similar to the “Legacy Infusers-Adopters” above. For example, this corpus targeted their purpose on preparing students for careers and graduate school, but an equally common emphasis was “developing the whole student – intellectually, professionally, personally”. Also, several schools acknowledged multiple stakeholders – students and communities. Unlike the corpus above, descriptions of student learning utilized language of “grounded in” (i.e., liberal arts, multi-disciplinary study, broad based core) and frequent descriptors of “challenging”, “focused”, “rigorous”, and “specialized skills/powerful skills”. The naming of programs was demonstrated less than the corpus above. Similar to the

corpus above, references to practices were minimal. There were numerous references to innovation (i.e., preparing innovative leaders, inspiring students, stakeholders and communities, and creative/ entrepreneurial learning). The tone of the corpus was forward thinking and descriptive. There was no mention of digital relevancy.

Limitations: There are numerous limitations in this exploratory study. One, as the exploratory phase to a larger study, the sample in this current study is non-random and small ($n < 30$); generalizability beyond the sample is not warranted. Two, access to “real-time” data was limited, which limits the usability of a “state of”-type report. Unlike the AACSB study [6], the author did not have access to internal departmental data (i.e., curricula that had been approved, but not on the website nor in the catalog, or other resource data) that could have changed or illuminated the facts presented. Three, the definition of digital marketing in this study lacks concreteness. While it seems to represent a good way to inclusively talk about digital marketing and the actions of marketing programs in 2022, it can be unwieldy from a research perspective.

Implications, conclusions and directions for future study will be discussed in the oral presentation.

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Does Time Matter – Does Course Pedagogy impact learning outcomes.

Oral

Dr. TaQuesa McLeod¹

1. Lander University

This pilot study seeks to determine whether differences in pedagogical approaches of accelerated (8-week) versus full-term courses impact student mastery of the subject matter, learning outcomes, and skills. Informed consent was obtained from both student cohorts, Spring 2021, and Spring 2022 of an intermediate multidisciplinary public health course. The data collected during this study will assess specific course outcomes through two varying assignment deliverables and instructor-led training (ILT) methods. The data will be analyzed using a vetted educational rubric assessment tool. The results will be used to assess assurance of learning, progress assessment, and discipline course modality evaluation at the academic unit level.

Drop or Average? – Optimizing Grading Policies for Student Learning

Oral

Dr. Dan Simundza¹

1. Virginia Tech

This paper studies the incentive effects and impact on learning outcomes of exam grading policies – in particular, does a more forgiving grading policy lead to better learning outcomes? To answer this question, I exploit a change in midterm grading policy in a large introductory business statistics course at Virginia Tech. Both grading policies allow students two attempts on each midterm exam, but for those who take the exam a second time, a ‘skin in the game’ policy uses the average of the two scores while a ‘forgiving’ policy drops the low grade, keeping only the higher score. The two policies provide different incentives for studying, with the skin in the game policy incentivizing more studying up front and the forgiving policy enabling a potentially counter-productive look-and-see strategy. However, I find that the forgiving policy: 1) produces roughly similar distributions of first-attempt scores; 2) greater utilization of second attempts, especially in the upper half of the first-score distribution; 3) a better distribution of second-attempt scores, and; 4) most crucially, better results on the final exam, on which students are allowed just one attempt. Given these results, I argue that a forgiving exam grading policy enhances student learning, provided the instructor can reasonably produce different exams for each attempt.

Edpuzzle for E-learning: A Study of Advantages and Limitations

Oral

***Dr. Carmen Alvarez-Alvarez*¹, *Dr. Leann Mischel*²**

1. Universidad de Cantabria, 2. Coastal Carolina University

The need for online educational tools has increased significantly since the COVID-19 pandemic forced many students to embrace distance learning as a classroom alternative. While many instructors have used Edpuzzle to enhance distance learning, there has been little research that assesses and compares the views of teachers and students on the tool's advantages and disadvantages. To examine the perceived advantages and disadvantages of using Edpuzzle for classroom learning, we surveyed a sample of 152 teachers and students on their experience with the tool. The results reveal numerous advantages, including that Edpuzzle is a motivating, dynamic, and novel self-learning tool for students. Likewise, teachers point out that it is easy to use, focuses the attention of students, and is versatile. Both teachers and students point out few limitations. Based on this evaluation, it was concluded that Edpuzzle allows teachers to interact with students who are learning alone, providing added value to graphic material to be used. Likewise, the preference of students for graphic and visual material to complement other learning tools and help students to better understand the knowledge to be acquired was also verified. Disadvantages of the tool mostly had to do with technological challenges and potential boredom. When weighing the advantages and disadvantages posed by teachers and students, it was found that the unique combination of interactive teaching that Edpuzzle provides is promising for the future.

Effects of organizational communication on employee job satisfaction, job performance, and turnover intentions of accounting professionals moderated by COVID-19

Oral

Dr. Dena Breece¹, Dr. Stephen Moore¹

1. University of North Carolina at Pembroke

With so many changes occurring due to COVID-19, what changes have transpired within organizations? Have employee attitudes and behaviors been positively or negatively impacted? This research seeks to expand upon prior literature effects of organizational communication on employee outcomes. While extensive organizational communication and employee research exists, minimal research has been conducted regarding the organizational communication influence on accounting employees especially during and post-pandemic. The primary research question asks how have components of organizational communication impacted accounting employee attitudes and behaviors during and after COVID-19? Based on the more recent communication constitutes organizing (CCO) approach at the center of organizational communication, the six premises of CCO scholarship are used as a foundation to examine organizational communication within a professional accounting environment. CCO is best known for its belief that the organization emerges in and is maintained and transformed by communication. As such, CCO scholarship takes into consideration the inclusiveness of organizational communication through the study of communication events, the breadth of the definition of organizational communication, acknowledgment of the character of communication, human and non-human communication, and the primary aspect of communication while studying CCO scholarship, as well as the CCO's belief of the equal consideration of the organization itself and its organizing within the organization. The methodology consists of a mixed methods approach where qualitative and quantitative data are gathered and evaluated. A focus group of approximately seven to ten certified public accountants (CPAs) practicing in firms and industries within the state of North Carolina are interviewed to develop a valid, reliable survey instrument. CPAs working in North Carolina public accounting firms and industries are solicited to complete the survey. Based on a sample population of over 12,000 North Carolina Association of CPA members, large respondent size data pertaining to the components of organizational communication effects on employee satisfaction, performance, and turnover intentions with the moderating effects during COVID-19 and post COVID-19 are gathered. Employee demographics, correlations, and statistical analysis are performed. The research and its findings add to academic and practitioner insight necessary to further understand and develop organizational communication and its relation to positive employee outcomes.

Evaluating the Great Resignation in the Field of Accounting

Oral

Ms. Charlotte Moore¹

1. Student Roanoke College

Tentative Abstract

I have researched through my own internship experience and publicized studies on the great resignation to determine to what extent the great resignation has permeated the boundaries of the very stable field of accounting.

Experiential Learning: A Pathway to Teach Post-COVID Complexity

Oral

Dr. Uma Gupta¹

1. University of South Carolina Upstate

Experiential learning has been an integral component of business education for decades. COVID-19 impacted the nature, scope, and location of experiential projects. Many schools were forced to shift from face-to-face experiential learning that involved close contact with clients to virtual environments. Teamwork was challenging for students as they navigated a virtual world. Communication methods and approaches changed with key stakeholders. Students struggled, and continue to struggle, with anxiety, loneliness, isolation, and a sense of disengagement.

As faculty, we are called upon to revise our pedagogy to meet the holistic needs of our students. This includes not only discipline-specific knowledge and workforce readiness, but it also includes teaching our students resilience, teamwork, embracing failures, and working efficiently in virtual worlds.

This workshop lays out a systematic roadmap and a set of meaningful guidelines for faculty, both new and experienced in experiential learning, to design, modify, and deliver an outstanding experience in experiential learning for business students. Based on findings from the research literature on experiential learning and the emerging research on COVID and its impact on student learning, this workshop addresses the following questions:

Introduction:

1. How has COVID changed and impacted the way our students learn?
2. What is the added value and impact of experiential learning on the Assurance of Learning outcomes?

Selecting an Experiential Learning Project

1. What are the fundamental metrics to identify an effective EL project?
2. What are effective communication strategies to reach out to potential sponsors?
3. How does one embed learning outcomes within project goals?
4. What are some effective project management strategies for experiential learning projects?

Roadblocks to Learning: Challenges Students Face Post- | COVID

1. A national pandemic of loneliness, isolation, and anxiety
2. A Degree focus versus a Learning Focus: Helping students take a long-term view
3. Cheating: Overcoming some of the Challenges that Faculty Face
4. Publicizing your work within the institution
5. Translating your insights into research

Exploring sustainability and resilience in supply chain practices from a managerial perspective

Oral

*Dr. Sergey Ponomarov*¹

1. The Citadel

The COVID-19 pandemic has exposed the vulnerabilities, increased risks, and uncertainty of interconnected and interdependent global supply chains. Under current conditions, risk management and sustainability become increasingly important phenomena in supply chain management research and practice. This research seeks to emphasize the importance of managerial opinions and individual perceptions of supply chain and logistics managers in the current challenging business environment. Exploring supply chain sustainability and risk management from the individual level can help to build a better understanding, as managers are often the ones that formulate and implement sustainable and resilient supply chain strategies and tactics.

FACULTY DIVERSITY INDEX: SHOULDN'T THAT BE MEASURED TOO?

Oral

Dr. C. Douglas Johnson¹

1. Georgia Gwinnett College

One of the metrics used by the *US News & World Report* to rank colleges and universities is a diversity index for students. The index measures how likely you are to interact with a student of a different race than you and the more diverse the student population, the higher the index. If one racioethnic group is particularly high, that does not translate into a high diversity index score. The diversity index has become increasingly important as globalization occurs and within the workplace employers seek those effective at interacting with individuals with backgrounds that differ from our own and employees with higher levels of cultural competence. If this is an important metric for students, shouldn't this extend to faculty diversity as well? At present, there is not a faculty diversity index; however, in this session a corollary measure is offered as an important tool to assess how classroom interactions are in terms of how diverse the faculty ranks are. In addition to computing a faculty diversity index, correlations should be evaluated to determine if there is alignment between the student and faculty diversity, as well as compare if differences exist by institution type or over time. As a pilot study, the current analyses will evaluate the student and faculty diversity indices at University System of Georgia institutions. In addition to sharing the results, discussions will be held regarding the potential theoretical and practical implications.

Grade Inflation and Student Performance

Oral

Dr. Elizabeth Cole¹, Dr. Jim Oconor¹, Prof. Brian Smith¹

1. University of South Carolina Upstate

We have been discussing grade inflation for decades. Generally researchers posit that grade inflation increases over time. There is conjecture that grade inflation is a result of faculty focus on teaching evaluations, rising consumerism in higher education and that it has increased over time (Tucker and Courts 2010). Grade inflation is accompanied by a number of issues. Bar et. al. 2009 suggest that grade inflation leads to a loss of the information conveyed by grades, or grade compression. When you experience grade compression the best students get the same grades as the next best students, which means that the information conveyed by grades to employers and graduate programs cannot efficiently evaluate student performance via grades (Tucker and Courts 2010). Additionally educators are concerned that grade inflation distorts a students perception of reality by allowing them to believe their work is exemplary even though it falls short of the mark (Friederichs 2012). Students report unevenness and a lack of clarity in grades when they vary between classes (Supiano 2020). Further it reduces effort students put in and their performance because the goal is set low (Tucker and Courts 2010). Scanlen and Dean (2004) suggest in their evaluation of grade inflation in Nursing that even more importantly grade inflation can damage the profession and place patients at risk.

In this study we are looking at how students perform on an external exit exam (the Major Field Test in Business or MFTB) in relation to their course grades, and the average grades in their course (grade inflation measure.) Furthermore we are looking at how course Student Opinion Polls impact their performance on the MFTB. Preliminary results indicate that as in earlier research SOP's are highly correlated with student grades. Furthermore, we find that both measures have a strong negative correlation with student performance on the MFTB.

Identifying the constructs for measuring the impact of Artificial Intelligence and AI-based automation tools for growing Inequalities at the firm, country, and consumer levels – A Study

Oral

***Dr. Shilpa Deo*¹, *Dr. Jeff Zhang*², *Dr. Sushil Sharma*³**

1. MIT-WPU University, 2. Ball State University, 3. Texas A&M University Texarkana

Recent advancements in robotics, artificial intelligence (AI), machine learning, sensors, and AI-facilitated automation tools have opened up new markets and new opportunities for higher productivity growth and progress. However, at the same time, it has created multiple negative impacts on economic inequality, raising fears of mass technological unemployment across the globe. It is estimated by World Economic Forum that blue-collar workers are vulnerable to losing employment and income and increased usage of AI due to the spread of the pandemic may cause “double disruption”. It may cause jobless growth in case there is a lack of reskilling opportunities. As a result of these inequalities, AI technologies may act as either a global unifier or divider. Concerns over AI-facilitated automation and artificial intelligence echo globally. AI-driven automation will continue to grow in the coming years and demand structural policy changes in the economy. The study attempts to identify the constructs/variables that could be used for examining the impact of AI-facilitated automation tools in increasing economic inequalities at the firm, country, and consumer levels. It will be immensely useful for the policymakers in devising policies to reduce inequalities along with the increasing usage of AI.

Improving Student Engagement through Undergraduate TAs

Oral

Dr. Barbara Fraticelli¹, Dr. Michelle Seref¹

1. Virginia Tech

In the spring semester of 2020, many universities struggled with student engagement when learning moved online due to the pandemic. In response, the Pamplin College of Business at Virginia Tech launched the Engage TA Program to support both faculty and students. While some faculty members had used undergraduate teaching assistants (TAs) in previous semesters, it had been on an ad-hoc basis. The Engage program centralized training, administration, and payment for TAs within the college. A hallmark of the program is the 16 hours of training workshops required for new TAs, as well as monthly check-in meetings for all TAs. Starting at 100 TAs in Fall 2020, the program expanded to 150 positions by Spring 2022 and is set to reach nearly 200 positions in Fall 2022. Engage TAs now assist faculty as they employ online, hybrid, or in-person teaching tools and techniques to increase student engagement and learning. Undergraduate TAs can incorporate students' perspectives in course development and delivery as well as facilitate effective communication in faculty-student and student-student collaboration. The Pamplin Engage TA Program benefits current course students by enhancing course engagement and communication, benefits faculty through additional course management support, and benefits the TA students in their training and mentoring experience. Recently, the Engage program was used as the template for a similar undergraduate TA program in Virginia Tech's College of Engineering, and the model can readily be implemented at other colleges and universities. This workshop will address the process of developing an undergraduate TA program, including determining which courses should be supported, recruiting/assigning TA applicants, providing training to TAs, and developing corporate sponsors. We will also discuss some best practices for using undergraduate TAs to support student learning and to promote student engagement.

Instant Access: Etext in the classroom

Oral

Dr. Abdul-Aziz Bahha¹, Dr. TaQuesa McLeod¹

1. Lander University

Digital or electronic text (etext) offers students and teachers an additional instruction tool to support or enhance the learning process. Using etext in the classroom is a new trending paradigm, especially in college courses or higher education. Various etexts options are available to suit students' knowledge, characteristics, abilities, and interests. This study describes the culture of etext to include the advantages, limitations, strategies, and framework for using it as a textbook in classrooms. Research studies show that etext provide interactive immersive instructional resources for students however this does not come with challenges for students and faculty. This presentation will also discuss the accessibility and methodology of using etexts in lieu of custom hardcopy textbooks of Business and Healthcare Management students.

Interactive Session: Addressing Challenges for Teaching Classes with Data Use, Computational Methods or Software

Oral

***Dr. Robert Andrews*¹, *Dr. Ping Wang*², *Ms. Fatemeh Valizadeh Gamchi*³, *Mrs. Wilma Andrews*⁴**

1. Virginia Commonwealth Univ, 2. James Madison University, 3. Virginia Commonwealth University, 4. Virginia Commonwealth University

This session intends to be interactive with those attending and with the session leaders who have a breadth of experience teaching classes that range from multiple levels of mathematics, statistics, digital literacy software, analytics, business intelligence and management science. In an attempt to make the session relevant to attendees, everyone in the session will be asked for what they find the most challenging for the classes they teach. The session discussion will attempt to address the presented challenges that can include student characteristics, selection of learning aids, providing needed support for students, or selection of evaluation methods.

Introducing Corporate Psychological Responsibility (CPR)

Oral

*Dr. Johanna Sweet*¹, *Ms. Sydney Wagner*²

1. Roanoke College, 2. Student Roanoke College

The World Health Organization, the American Psychological Association, OSH and The Society for Human Resource Management (SHRM) have all emphasized and defined the importance of health in organizations. Their definitions now include psychological health. With mental health becoming more of a common human resource topic with the most recent Covid-19 pandemic, organizations have become more conscious to create a physically safe and psychologically safe environment. Additionally, employees are advocating for employers to care for more than providing a physically safe place to work. They are expecting a safe place to work, and support for the mental health and well-being of employees and their families.

There is no one term in the literature to discuss this new trend. The term “Corporate Psychological Responsibility” is being introduced as new terminology to describe this concept. Corporate Psychological Responsibility (CPR) is the *responsibility of an organization to focus on the psychological components of its employees to create a competitive advantage for all stakeholders*. Like corporate social responsibility, CPR can create a competitive advantage. Employees will be more motivated, empowered, and productive, thus distinguishing the organization.

A model of CPR was developed using motivational theories. Psychological elements important to organizational success were identified and build on the ideal that the person and environment dictate behavior. Person and environmental factors that impact employees psychologically were identified in a comprehensive literature review. These factors are the pillars of the CPR model and include the following: health and safety, psychological capitals, positive relationships, personal growth, rewards, and organizational policies/practices. Thus, CPR as an equation is $CPR = (\text{Health \& Safety}) \times (\text{Psychological Capitals}) \times (\text{Positive Relationships}) \times (\text{Personal Growth}) \times (\text{Rewards}) \times (\text{Fair Practices})$.

CPR is important and will become increasingly important as employees demand their psychological health be considered. Scholars and practitioners should begin to use this term as more literature on healthy workplaces is explored, beyond mere illness and health. The model of CPR can be used as a diagnostic tool to assist practitioners in determining where they may need to adjust practices. CPR is significant as it is a new term being introduced into the organizational behavior conversation.

Organizations that invest in their employees’ psychological capitals, foster positive relationships, provide meaningful rewards and growth opportunities, and create a safe and fair environment will ultimately create a psychologically healthy environment, whereby creating more motivated employees. As a result, the organization will have a reputation of being a great place to work and productivity will increase. It is the responsibility of an organization to focus on the psychological health of its employees for both “doing the right thing” and for organizational success.

INVESTIGATION OF THE IMPACT OF CHANGE IN THE AACSB'S ACCREDITATION STANDARDS ON BUSINESS EDUCATION– A PILOT STUDY

Oral

***Dr. Adel Novin*¹, *Dr. Mohammad Abdolmohammadi*², *Dr. Javad Gorjidooz*³**

1. Clayton State University, 2. Bentley University, 3. Embry-Riddle Aeronautical University

Employers have long been critical of the degree of preparation of business graduates entering the workplace, claiming that they do not have all the skills required by the profession. Pursuant to this belief, over the past several decades, different initiatives have been undertaken by the business community to encourage the needed change in business education, but that has not ended the continued concerns of the employers. However, the 2013 and 2020 accreditation standards adopted by the Association to Advance Collegiate Schools of Business (AACSB) International, the leading and most prestigious accrediting body for business schools, have shown promise for having potentially more effective business education that may at last meet the employers' needs. Through its new accreditation standards, the AACSB has begun to make business education much more connected to practice in order to enhance the value, relevancy, and impact of business education. This paper after discussing the recent initiatives of the AACSB that have offered cautious optimism for potentially effective changes in the business education to meet practitioners' needs, reports on the findings of a pilot study investigate the changes resulted in the business education because of the AACSB's new standards and expectations.

Learning by doing, the relationship between High-Performance Computing (HPC) with Design Spine of higher education and enhancement of their learning: A Mixed Method Study.

Oral

Dr. Abdul-Aziz Bahha¹, Dr. Aref Hervani¹

1. Lander University

Abstract

The education and training in High-Performance Computing (HPC) and the Design Spine structure is the tool to provide instruction to students, faculty, and staff at university courses, online, material, and workshops. HPC (computer base) to integrate new data increase model resolution is now being used in academics to support the academic and administrative divisions. For Example, planning, curriculums, management related to enrollment, tuition prepared worksheets, schedules, files, customer care solution software, and hardware issue. By developing and revising curriculum and program such as syllabus, Student Learning Objective (SLO), and rubric. The Design Spine to design courses and create new and updated existing curricula is now being used to combine several academic disciplines or professional specializations to create a project with Design Spine to help students from experience in Business Administration, Information Technology (IT) Management in advanced level.

With the combined Design Spine and HPC, a Design Spine curriculum will lend itself to the HPC criteria since the industry's talents are the exact requirements in a Design Spine system. For Example: Working on a problem from start to finish using creativity, problem-solving, critical thinking, prioritizing social responsibility, utilizing communications, learning to organize and process project management skills. When the students learn with this method, their education and thoughts are much less disjointed. The subject is no longer separate in their mind but flows together easily to solve a problem from the top down. Integrate technology into the curricula with Learning Management System (LMS) and Improve students' learning processes and outcomes.

MANAGERIAL ATTRIBUTES OF SUCCESSFUL LEADERS IN STRATEGICALLY MANAGED ORGANIZATIONS

Oral

*Dr. Jon Musgrave*¹, *Dr. David Fowler*², *Dr. Jill Musgrave*³

1. Morehead State University, 2. Lander University, 3. Union College

Abstract

A qualitative phenomenological study was conducted to explore the attributes of successful leaders in strategically managed organizations. The population for this study was selected from a sample of leaders that had been instrumental in formulating and implementing their organization's strategic plan. These leaders represented organizations with 50 to 1000 employees and budgets that ranged from 2.5 million to one billion dollars.

The study was conducted after IRB approval was received, and each leader consented to be interviewed. The semi-structured interview process was used to explore the respondents' thoughts on strategic planning and the attributes needed to create, implement, and reinforce the process. Once the interviews were concluded, the transcripts, field notes, and observations were analyzed.

Two primary research questions guided the research. First, What attributes do leaders in strategically managed organizations possess? Second, how do they use these attributes to impact the organization's culture and implement their strategic plan?

Mean–Variance Portfolio Efficiency under Leverage Aversion and Trading Impact

Oral

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1. Radford University, 2. Rensselaer Polytechnic Institute

This paper addresses the optimal rebalancing problem of a long–short portfolio with high net asset value under trading impact losses. The fund manager may employ leveraging as a tool to increase portfolio returns. However, to mitigate potential leverage risks, frequent rebalancing may become necessary, which leads to significant slippage losses that dampen portfolio performance ex-post. We consider the problem in an integrated framework by incorporating trading impact and leverage restrictions ex-ante within a mean-variance framework, where leverage control is imposed using a chance constraint. The resulting mean-variance-leverage optimization model (MVL) is non-convex, and we develop an efficient scheme to obtain the optimal portfolio. We investigate how portfolio leverage modifies the MV efficient frontier in the presence of trading impact, and highlight the significant outperformance of the proposed model relative to the standard mean–variance model. Increased target means require less restrictions on leverage, which result in higher rates of slippage losses. Our analysis supports the notion that leverage restrictions contribute to choosing high beta assets, even in the presence of trading impact.

Mindfulness and Motivation: A study of Academic Coach in an Online Course Using Self-Determination Theory

Oral

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The literature suggests that mindfulness and motivation are highly related to each other. Especially, studies show that mindfulness is positively correlated with highly autonomous forms of motivation and prosocial motivation, but not for externally controlled or introjected (self-controlling) forms of motivation. The present research examines the relationships between mindfulness and various type of motivation of academic coaches in online courses using self-determination theory. Additionally, we investigate the potential moderating effects of different facets of mindfulness on the link between those motivations and their job behaviors (e.g., job satisfaction, job commitment, turnover intention, etc.) and performance. Academic coaches ($N = 204$) completed questionnaires assessing motivation, mindfulness, job behaviors, and performance. Mindfulness was assessed with FFMQ-15: 15-item Five-Facet Mindfulness Questionnaire. The result shows that autonomous motivation is positively related to non-reactivity items ($b = .20, p < .01$), and prosocial motivation is positively related to describe ($b = .16, p < .05$) and non-reactivity ($b = .16, p < .05$) items. The study also offers insights on practices in higher education and online education by enhancing understanding of the motivational processes underlying human behaviors.

Multi-Vehicle Type Emergency Service Station-Optimal Location and Allocation

Oral

Dr. Damitha Bandara¹

1. University of Tennessee at Chattanooga

The primary focus of Emergency Services such as Medical and Fire service systems is to minimize the effects of an emergency by providing proper and efficient support to the scene. The response time, the time between the emergency call, and the arrival of the first responder to the scene, plays a crucial role in minimizing the fatality of the event. Positioning Emergency services at optimal locations can provide prompt support to the scene. A significant amount of research is conducted to achieve this goal. In many cases, the fire department and ambulance systems are separated by location and some services. Many emergency vehicle dispatching studies have focused on either EMS or Fire systems individually. However, most firefighters also have training as EMTs or Paramedics so that medical care can be administered with performing their firefighter duties. Thus, the Fire-based Emergency Medical Service has recently become more popular in the USA to provide prompt care and reduce operational costs. In this study, a mixed-integer linear programming model is developed to determine the optimal location and allocation for Fire-based emergency medical services to provide prompt care to the scene. A case study based on historical data from Dougherty County, GA EMS system is performed to test the performance of the proposed model.

NATIONAL FOOTBALL LEAGUE (NFL) RUNNING BACKS: EXAMINING MARKET INEFFICIENCIES

Oral

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Player performance is the key determinant of both contract duration and compensation in the professional sport industry (Link & Yosifov, 2012). Stakeholders often perceive overpaying an athlete that does not perform well as a being an undesirable investment and one that is potentially harmful to the organization (Jewell, 2015). Owners of professional sport franchises, general managers, coaches, and team data analysts utilize statistical models to determine a player's worth (Coates, Frick & Jewell, 2016; Farrar & Bruggink, 2011; and Swartz, Arce & Parameswaran, 2013). Professional sport teams attempt to ensure they are compensating a player based on fair market value (Greer, Price & Berri, 2019; Grootuis & Hill, 2013). Additionally, leagues such as Major League Soccer (MLS), Major League Baseball (MLB), the National Basketball Association (NBA) and the National Hockey League (NHL) offer players guaranteed contracts (MLSPA, 2019; MLBPA, 2021; NBAPA, 2021; NHLPA, 2021). Therefore, if an MLS, MLB, NBA or NHL player displays poor performance, experiences a long-term injury or even sustains a career ending injury; their particular team is still contractually obligated to compensate them. The NFL employs a "hard" salary cap and teams do not provide athletes with completely guaranteed contracts. The hard cap, in theory, prohibits teams from overspending on players (Mondello & Maxcy, 2009; Mullholland & Jensen, 2016). Also, by only guaranteeing a portion of the players contract, in theory, NFL teams should experience reduced investment risk. Regardless, NFL teams benefit from analyzing and evaluating athletes and compensating them in an equitable and efficient manner. These analyses should enhance return on investment.

Market inefficiency theory asserts that asset prices are imperfect to some degree and as such their true value is not reflected (Hayes, 2020). These inaccuracies can result from forces such investor emotions, shifts in the economy, devaluing of currencies and misinformation about a company, among others. To this end, there exist inefficiencies in compensating professional athletes. Several prior studies suggest that financial compensation does not effectively predict athlete performance (Medcalfe & Smith, 2018; Walters, Allmen & Kruatmann, 2017; White & Sheldon, 2013). In these previous studies, factors such as length of contract and national origin of the athlete influenced compensation, rather than athletic performance. Conversely, there have been numerous studies that suggest professional athletes are effectively compensated relative to their performance (Link & Yosifov, 2012; Mondello & Maxcy, 2009; Chao, Chen & Li, 2013). The purpose of this study was to determine the level of salary efficiency for National Football League (NFL) athletes playing the offensive position of running back.

Data was gathered on both rushing statistics and salary for the top 64 running backs during the 2021 NFL season. A single multiple regression analysis was performed with three measures of NFL running back performance (rushing yards, rushing touchdowns, and carries) serving as independent variables and 2021 salary serving as the dependent variable. The results revealed that there was a statistically significant relationship between player salary and athletic performance amongst running backs ($p < .05$). However, none of the three independent variables were significantly predictive of salary by themselves. Thus, three separate Pearson correlations were conducted to better understand the impact of running back performance on salary. The results indicated that rushing attempts ($r = .37$, $p < .01$), rushing yards ($r = .34$, $p < .01$), and rushing touchdowns ($r = .29$, $p < .05$), were all significantly correlated with salary. Attempts per game was the only variable that was individually predictive of player salary ($p < .05$).

The results offer a variety of strategic implications for NFL franchises. First, coaches and front office-executives

understandably wish to put their higher-paid players on the field as much as possible. The findings appear to reflect this notion, as the strongest of the three correlations was between rushing attempts and salary. However, despite the regression analysis, as well as all three correlations being statistically significant, there are still signs of market inefficiency. For example, rushing yards and rushing touchdowns had a weaker correlation to salary than rushing attempts. If the NFL running back market was truly efficient, the inverse would be true (i.e. rushing yards and touchdowns would be more strongly correlated to salary than rushing attempts). Further, this finding could be a result of injury and fatigue amongst running backs, since players' probability of injury increases with time on the field. Thus, this study showed that overall, running backs appear to be appropriately compensated for their services. However, there are still indications that teams are not receiving sufficient returns on their investments.

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Nonfinancial Predictors of Fraud in Nonprofit Organizations

Oral

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Nonprofit organizations play a vital role in providing many benefits to society. Unfortunately, they are often more susceptible and may fall victim to acts of fraud. This is often due to their size, resources, and culture of trust which may lead to a lack of adequate internal controls, such as inadequate segregation of duties and approvals. Incidents of fraud in nonprofit organizations can be a public relations nightmare for the organization and negatively impact the nonprofit sector overall by damaging public trust and threatening future support. Red flags of fraud in nonprofit organizations may take longer to be detected due to the lack of internal controls and approvals, which leads to an increase in damages. Therefore, it is important to prevent fraud through the adoption of policies and setup of controls to help deter fraud. However, nonprofit organizations may not have the resources to implement everything at one time. The challenge is for management to determine where best to focus resources. The goal of this study is to provide information about which policies should be implemented at a board level and which relationships may increase the risk for fraud. This study examined the use of seven nonfinancial predictors for reported fraud in U.S. nonprofit organizations. The data utilized was retrieved from 2017 IRS Form 990 filings of 630 U.S. nonprofit organizations with a 501(c)(3) tax exempt status. The sample included all nonprofit organizations who indicated a significant diversion of assets on their Form 990 and a random selection of the remaining population. Binary logistic regression analysis was utilized to determine and evaluate any associations between the variables and the existence of reported fraud. Five of the variables, audit ($p < .001$), transfers to related org ($p = .003$), board independence ($p = .031$), conflict of interest policy ($p = .008$), and whistleblower policy ($p = .014$), were found to be statistically significant as individual predictors for reported fraud in the sample analyzed. The prediction model using seven nonfinancial variables (audit, transfers to related org, board independence, relationship between key personnel, conflict of interest policy, whistleblower policy, and CEO salary approval requirement) was found to be a significant prediction model ($p < .001$) for reported fraud in the sample analyzed. The model explained seven and a half percent (7.5%) of the variance in the likelihood of fraud and correctly classified 65.6% of the cases analyzed. Based on the results of this study, suggestions are provided for auditors, board members, management, donors, creditors, and other stakeholders of nonprofit organizations for evaluation of fraud risk, analysis, and development of effective internal controls to protect against fraud.

NOSTALGIC ADS – THEIR IMPACT ON CONSUMER SPENDING DURING THE HOLIDAYS

Oral

Dr. Cherie Rains¹

1. Lander University

In this time of hyper-technology usage, simple advertisements no longer grab the attention of most consumers. Companies have now begun to advertise on platforms such as Hulu and TikTok to generate views as a means of success since streaming services and social media play a vital role in advertising. With so much competition for consumer dollars, this is especially heightened during the holidays. Holiday ads must now be a production filled with images that evoke a memory and/or emotion that are relatable to consumers. A well-made holiday ad not only entices consumers into the stores, but also generates a personal connection to certain brands.

While branding is important throughout the year, the attention gained during the holiday season is crucial to companies and large budgets are usually designated for this time period. Holiday ads are advantageous to companies and brands because they usually evoke consumer emotions. But does evoking these feelings, especially nostalgia, lead to more consumer spending during the holidays?

The holiday season is a time where nostalgia runs high, and individuals often reminisce of past times and loved ones. This feeling of nostalgia helps consumers make an emotional connection with products and brands being advertised. It is not completely known if individuals become more nostalgic during the holidays, but it has become a popular emotion for advertisers to focus on during this time of year.

The main purpose of this study was to ascertain how nostalgia used in holiday ads impacted consumer spending. The methodology used in this study was a questionnaire comprising 14 questions. Findings discovered that many consumers feel more generous during the holidays and that when holiday ads highlight nostalgia, emotional connections are made with the brand in the ad. When emotional connections were formed, consumers increased the amount of spending on holiday gifts. The holiday ad that brought about the most nostalgia was an ad about a family; therefore, from this study it can be concluded that by highlighting nostalgia and connecting to the emotions of the viewers, marketing executives could increase consumer spending because of the ads during this time of year.

Paycheck Protection Program Through the Banking Lens A Case Study

Oral

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Abstract

Countybank is a community-oriented financial services provider headquartered in Greenwood, South Carolina. It was founded in 1933 by a group of community-minded Greenwood locals to ensure there would be a financial institution available in the aftermath of the Great Depression.

The strategic location of Greenwood allows an abundance of small businesses to service clients throughout the Upstate region which consists of ten counties in the most western part of South Carolina. The city also home to major manufacturing companies that include Greenwood Mills Inc., Eaton, Caterpillar, Colgate-Palmolive, Diana Pet Food, and Velux.

In early 2020, the bank had to adapt its business model in anticipation of the arrival of a global pandemic that was quickly spreading to the Upstate region. The potential impact of the pandemic created a tremendous amount of uncertainty on its future business operations, customers, and stakeholders within the community. The pandemic was caused by the emergence of a novel coronavirus that was discovered in Wuhan, China in December 2019. The virus first appeared in the United States in January 2020 and new cases continued to increase throughout the country in early 2020. By March 2020, the increase in cases in the United States forced state governments to take drastic action to combat the virus.

The federal government assisted this effort by signing the Coronavirus Aid, Relief, and Economic Security (CARES) Act into law, providing \$2 trillion in aid to state and local governments, hospitals, and small businesses. One of the most significant provisions of the CARES Act is the Paycheck Protection Program, which was designed to provide an incentive for small businesses to keep workers on their payroll. It provided small business with the full forgiveness loans they need to maintain their payroll costs, hire back laid off employees, and cover applicable overhead. The program was implemented by the Small Business Administration with support from the Department of Treasury. Funds were also authorized for use to pay interest on mortgages, rent, utilities, worker protection costs for COVID-19, and uninsured property damage costs caused by looting or vandalism. Eligible organizations included small businesses with under 500 employees, nonprofits, veteran's organizations, self-employed individuals, sole proprietorships, and independent contractors.

The program was facilitated by existing SBA lenders, commercial banks, and credit unions to individual small businesses. The loans were divided into two different draws. The First Draw allowed eligible applicants loan amounts up to \$10 million were available based on the amount of average net profit each small entity had for the 2019 tax year. The Second Draw had similar terms but only offered loans up to \$2 million to organizations with fewer than 300 employees, could demonstrate a 25% reduction in gross receipts between comparable quarters in 2019 and 2020.

Countybank was in a strong financial position that would ensure the bank's survival and the decision was made to develop a strategy for assisting local small businesses by participating in the PPP program. There was a lot of uncertainty about participating in the program because it has just been created by Congress and its execution is still unclear. Other unknowns included the estimated amount of small business that would request the funds, funding the loans could be an issue because of the uncertainty of how this potential economic downturn would

affect the decline of deposits, and if participation in the program would be profitable or any potential consequences to the business for not participating in the program. Countybank chose to consult with its business relationship managers who had strong working relationships with their small business clients about the potential demand for the PPP program. Through those consultations, it became apparent that there would be substantial demand for the PPP loans and the bank risked losing customers if the PPP program were not offered. The bank felt it best to begin planning to estimate the projections of entering the PPP program.

The bank's baseline projection for participating in the PPP program would increase the bank's current loan portfolio from \$260 million to range of \$310-\$325 million giving the bank a projected loan growth rate of 18 percent to 25 percent.

The uncertainty of how the economic activity will impact deposits also caused concern about funding the program. The SBA proposed terms of the loans required an initial fee plus 1% that had to be amortized over 2 years. If the bank chose to use the PPP lending fund it could reduce asset growth by the amount of the PPP for capital calculations, which would help with the ratios.

The bank also considered using existing deposits to fund the majority of the PPP loans but the dramatic increase in expected demand would require borrowing additional funds.[JMD1] This may increase liquidity and insolvency risk depending on the amount of deposit decline affected by the economic slowdown.

The purpose of this research is to study a community bank's response to the COVID-19 pandemic via Case Study Questions related to the bank's involvement in the Paycheck Protection Program.

This case study will allow researchers to access and use the case study in classrooms as a real-life application for community banking. Specifically, the case study will be used in Economics and Finance classes.

[JMD1]Where did they choose to borrow money from?

Peer-to-Peer Cash Apps: A Users Intent to Adopt

Oral

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Introduction

Adoption of technology has been studied in the IS literature for many years. This study examines the intent to adopt peer-to-peer (P2P) cash applications by consumers and the factors that influence that intention. Peer-to-peer (P2P) cash applications allow transfer of funds between consumers via mobile devices. Popular examples include Venmo, CashApp, and Zelle. We seek to examine the intent to adopt P2P cash apps through commonly used adoption constructs examined and verified in the IS literature. We aim to examine constructs that influence adoption including social influence, perceived usefulness, perceived ease of use, security orientation, perceived risk, and trust.

Mobile payments have grown and become pervasive in societies which largely operate in a cash-less environment (Garcia-Swartz, Hahn, & Layne-Farrar, 2006). They have also grown in popularity in consumer transactions replacing the use of traditional payment methods such as personal checks, debit, credit, and even cash.

Discussion of Proposed Hypotheses

We posit that social influence from the IS literature is a construct that will ultimately affect adoption of P2P cash apps as the more friends, colleagues and independent business people that use cash apps that are in a person's social influence the more likely that person is to use cash apps as well. The construct for social influence is adopted from the Unified Theory of Acceptance and Use of Technology (UTAUT) (V. Venkatesh, Morris, Davis, & Davis, 2003; Viswanath Venkatesh, Thong, & Xu, 2012).

We posit that the perceived usefulness and ease of use will also influence the intent to adopt and use cash apps. The more a person perceives the apps as useful and easy to use, the easier it will be to adopt such an app. We adopt the scale of perceived usefulness and perceived ease of use from the Technology Acceptance Model (TAM) (Davis, 1985, 1989).

Finally, we posit that a person's security orientation and beliefs will influence the intent to adopt a cash app as a person would be less likely to adopt a cash app that is tied to their bank account if they believe it to not be secure. We measure security orientation using the construct and scale adopted from (Ng, Kankanhalli, & Xu, 2009). We measure trust and perceived risk by adopting the construct and scale from (Aliyu, Wimmer, Powell, & Rebman Jr, 2020; Pavlou, 2003; Pavlou & Gefen, 2004).

Proposed Methodology

To determine the affect of these constructs on intention to adopt, we will propose a model and test it via a survey instrument. We will examine the affect of each construct using structural equation modeling. We will also examine the affect of age and gender on the intent to adopt as well as we believe these will both influence the intent to adopt P2P cash apps.

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Perceived Stress Survey in Graduate and Undergraduate Students in a Small Liberal Arts College

Oral

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1. Rollins College

Perceived Stress Survey in Graduate and Undergraduate Students in a Small Liberal Arts College

Recent student surveys (Carter, 2020) indicate the following statistics:

- Nearly 90% of students have reported experiencing stress during their college tenure
- Over 60% of students report health-related issues as the main stressor.
- Approximately 20% of students report being stressed six or more times in one year.
- Approximately 10% of students thought about suicide.

Reasons for stress include coursework and exams, adjusting to living away from home, their financial situation, and worried about their future after graduation. Recent surveys about the impact of Covid-19 also self-reported as a student stressor. According to a recent American College Health annual survey (2016), stress impacts academic performance resulting in lower exam and class grades. Students are requesting their academic institution to provide them with effective stress reduction tools (American College Health Association, 2016). Educational institutions do offer mental health counseling for their students. Although over 60% of students seek counseling for these issues, offering scientifically based self-help opportunities and mindful exercises will provide another strategy for students to alleviate their stress (Winnerman, 2017).

A literature review confirmed there are effective mindfulness tools to alleviate student stress levels (Shonin, et al, 2015). Dr. Jon Kabat-Zinn, who created a ‘mindfulness movement’ decades ago, considers mindfulness as an awareness that emerges from paying attention on purpose in the present moment from a non-judgmental perspective. This concept was derived from the Buddhist teachings of stress reduction and relaxation (Kabatt-Zinn, 1982). Over the years, he has successfully applied these techniques to clinical populations.

Research has indicated that these techniques, mindfulness-based interventions (MBIs) can be successfully applied to many different populations. MBIs is a process that focuses on developing a state of non-judgmental awareness of the body and environment while encouraging curiosity, openness, and acceptance of the present situation (Bishop, 2004, Hoffman & Gomez, 2017)). Typical examples of mindfulness include meditation and yoga and variations of these exercises.

At the beginning of the study, students will be asked to take a survey regarding their mental health stress level. The survey, Perceived Stress Scale, developed in 1983, is a 10 item self-report stress assessment instrument, which is used to compare subjects’ stress related to current events. The students will be provided two mental health wellness apps, student website, counseling information or be taught mindfulness wellness exercises. Each month, the student will be asked to report which resource they used and to complete the Perceived Stress Scale survey. The surveys and information will be provided in Canvas, the learning management software used by the college. The survey were created in Qualtrics and linked to Canvas. The research project will take five months – January -May. There will be two sets of cohorts: students enrolled in graduate and undergraduate health professions (HP) classes and undergraduate Theater and Dance courses.

The Health Professions students will be provided with two mental health wellness choices: one mental health app, one student website, contact information for the Rollins College Mental Health counseling center and 24-hour hot-

line. The theater students will be taught one Mindfulness Based Intervention by a theater professor and will also be provided mental health counseling information.

The study focused on the following:

- 1) *Research question one: Will mindfulness strategies taught by faculty reduce their perceived stress levels?*
- 2) *Research question two: Will the mental health resources reduce their perceived stress levels?*
- 3) *Research question three: Did the Perceived Stress Scale survey help the students manage their stress levels?*

Approximately 90 students enrolled in the study. This presentation will discuss preliminary results, strengths and weaknesses of the study and the importance of providing mental health services to all students, regardless of majors.

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Principles of Financial Accounting Experiential Learning Project: A Comprehensive Case as an Alternative to a Cumulative Final Exam

Oral

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1. Longwood University

Increasing engagement and meaningful assessment in principles level accounting courses can be difficult. Assisting students, with varied backgrounds and interests, to fully grasp material covered in a principles of financial accounting course necessitates innovative approaches. The traditional principles level financial accounting course often culminates in a cumulative final exam that requires students to review and memorize a substantial amount of information in a short period of time. This paper proposes a project that provides an alternative cumulative assessment where students use the information learned throughout the semester to prepare level-appropriate financial statements. The proposed final project guides students through the accounting cycle of a hypothetical company including the preparation of journal entries, adjusting entries, closing entries, t-charts, trial balances, financial statements, and financial statement analysis. Students are given transactions to record for the last quarter of a year, which include, but is not limited to, items related to the following: payroll, sales revenue, inventory, depreciation, notes payable, long-term asset acquisition and disposal, petty cash, accrued liabilities, dividends, common stock, allowance for doubtful accounts, and bonds. Importantly, students must use an Excel template to complete all of these tasks. Students must correctly use formulas and referencing between tabs to earn credit. An automated grading software tool can be used to simplify the grading process for instructors. This project is designed to enhance students' understanding and retention of concepts learned throughout the semester and to increase their ability to synthesize the concepts for application in realistic scenarios. Using a 5-point Likert scale, preliminary results indicate that students find the project to be thought-provoking (mean=4.50) and challenging (mean=4.74). Students also find that the project is effective in helping them enhance their understanding of the basic accounting concepts (mean=3.85), enabling them to actively participate with the course material (mean=4.12), giving them a better understanding of the accounting cycle and financial reporting process (mean=3.79), and helping them enhance their Excel skills (mean=4.29). Finally, students indicate that they learn more from this final project than a cumulative final exam (mean=3.38). As such, with continuous improvement, this project has the potential to provide students with a meaningful and lasting learning experience in principles of financial accounting courses.

Sabbatical Leave in Non-Academic Professions: An Idea Whose Time Has Come

Oral

Prof. John White¹

1. United States Coast Guard Academy

Sabbatical leave is a benefit that is commonly associated with higher education. The faculty member has a chance to focus on research and/or new collaborative projects that they find difficult to pursue simultaneously with their teaching, advising, and service responsibilities. The sabbatical provides the professor the opportunity to “recharge and refresh” and return to their responsibilities reinvigorated, which also benefits the institution. In light of the recent COVID disruption, employee claims of “burn-out,” and the subsequent resignations of many workers, would not other industries benefit from instituting some type of paid sabbatical leave? This study looks at the purpose of sabbatical leave in academia, as well as the costs and benefits non-academic professions might expect from implementing such a policy.

Service delivery quality evaluation- A queuing theory based approach

Oral

Dr. Xiaofeng Zhao¹

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Waiting lines and delays have become commonplace in service operations and significantly affect service quality. This research aims to develop an approach to evaluate the quality of the service delivery process based on the queuing theory. The service delivery quality is measured by the gap between a customer's expectations of service and perceptions of the service delivered. The queuing theory is applied to estimate the expected average waiting time and the waiting time variance. The closed-form results can be implemented in parameterized experiments to conduct a what-if analysis. This paper contributes a method that service managers can use to evaluate the quality of service delivery process designs in a waiting time context. As an example, the drive-through time of vehicles at a fast food restaurant is evaluated.

Teaching Fashion Merchandising and Marketing to Adapt to the Post Pandemic Environment in the Fashion Industry

Oral

*Dr. Jennifer Yang*¹

1. Marymount University

COVID-19 pandemic caused many changes in consumer behaviors that affected the fashion retail business. Some of the changes include the increase in shopping online or mobile, buying online and picking up in store (BOPIS), same-day delivery, to list a few. It is assumed that many fashion merchandising and marketing instructors in higher education have been adapting to these changes. However, teaching the discipline in the times of uncertainty during the COVID-19 global health crisis has been undoubtedly more challenging than ever. This proposed concept paper explores the pedagogical strategies that can be effective in helping students navigate the changes that may occur in the post-pandemic fashion retailing industry.

In a typical fashion supply chain, companies develop fashion lines and purchase necessary raw materials (e.g., fabrics, trim, buttons) 18 to 24 months before products are displayed on retail floors, and retail buyers purchase products 3-6 months in advance [4]. This typical practice provides a glimpse of how it has been already challenging to effectively merchandise fashion products catering to ever-changing consumer demands in the fashion market, even before the COVID-19 pandemic [8].

When the pandemic led to a lockdown in the U.S. in March 2020, the fashion industry came to a screeching halt. This meant that the existing orders had to be canceled or the stocks were piling up with little to no retail outlet to be sold. This sudden change in demand forced the fashion industry to operate lean with higher productivity, especially given the physical limitations such as social distancing [6]. For example, fashion retailers staffed less employees in stores to efficiently cater to consumers who shopped online and utilized curbside pick up options.

Along with increased productivity, fashion companies have made an effort to adapt to the unpredictable consumer demands of fashion products, ranging from a minimal demand during the pandemic lockdown in 2020 to a strong demand seen since the retail store opening and strong economy through 2021 and 2022 [5]. One way of adapting to the unpredictable demand is to reduce the turnaround time between supply chain partners (e.g., manufacturers and retailers). One example would be fashion manufacturers using augmented or virtual reality (AR/VR) technology in a virtual showroom to promote fashion products to wholesalers or retailers [7]. Similarly, fashion retailers can give customers the option to virtually try on garments at the retail level and share related data with supply chain partners such as wholesalers or manufacturers [3]. Using such technology to adapt to unpredictable demand ironically can build data to more accurately predict consumer demands. In turn, adoption of such technology can lead to more agile and flexible manufacturing and timely delivery of products to retailers. Adoption of various technologies was useful during the pandemic. Such technologies are expected to provide appropriate customer experience going forward in the post-pandemic world. Recently, the fashion industry is bracing for another big change that may come with the possibility of an economic recession, steep inflation rates, and ongoing supply chain disruption [5]. It would be meaningful for students to learn from how the industry pivoted to stay successful during the pandemic and apply the principles to changes that may shape the future of the industry.

This proposed study will explore effective ways to prepare students for their career in the fashion industry in the post pandemic environment.

First, explain to them how various technologies are used throughout the fashion supply chain, to help them develop pragmatic skills that can be utilized in their future career. This may include quantitative skills for retail merchan-

dising math, virtual showroom technology, omnichannel order fulfillment, and use of information technology in merchandise allocation. For example, in the post-pandemic world where omnichannel fulfillment will be more common, as the companies practiced more store fulfillment, it would be important for students to learn how store fulfillment works and debate advantages and disadvantages of using store fulfillment.

Second, help students develop effective visual, oral, and written communication skills where consumers are accustomed to communicating with fashion companies through various touchpoints (e.g., social media, store, website) and develop strategies to impactfully communicate with consumers in the consumer-centric and image-driven fashion industry. This may range from customer service provided in person to direct message automation on social media. Simulating social media management or email/video marketing may be an example of a learning experience that may be helpful for students. Debating the effectiveness of livestream shopping can be one of the ways to help students think critically about what is to come in the fashion retailing industry.

Third, help students solve real-world problems related to supply chain management in a post-pandemic world. As we experienced during the pandemic, issues can arise with sudden changes in demand, increased desire for environmentally sustainable products made by socially responsible fashion companies, and possibilities for supply chain disruptions. These issues are currently still affecting how consumers shop for fashion products [2]. Facilitating students' critical thinking in solving such problems can help them develop skills to adapt to changing business environments. In addition, students who can prove that they developed such skills may attract employment opportunities. For example, developing implementable strategies to reduce packaging for fashion retailers can be valuable experience for students in the post-pandemic environment, because consumers have already been exposed to a significant surge of e-Commerce and subsequent consumption of product packaging that either fills up landfills or minimally recycled [1].

This proposed pedagogical presentation can provide examples to effectively guide students in fashion merchandising and marketing. However, principles of the proposed pedagogical strategies can be easily expanded to application in teaching business disciplines.

TEACHING MARKETING STUDENTS TO DEVELOP READING WRITING AND CRITICAL THINKING SKILLS

Oral

Dr. Michael Latta¹

1. Coastal Carolina University

The Educational Testing Service (ETS, 2010, 4) identifies ‘student’s ability to ‘recognize assumptions; recognize the best hypothesis to account for information presented; infer and interpret a relationship between variables; and draw valid conclusions based on information presented.’ Roohr, Liu, and Liu (2017), examined learning gains of college students’ and found after being in college for either one or two years that they did not show large significant gains in critical thinking, reading, writing and math. Amount of time in college had to increase to three years before some significant gains occurred for reading and writing, but no gains occurred for critical thinking. It is contended here, that multiple choice tests cannot help students develop any of the three skills. In addition, it is contended here, that ability to read and write coherently is required to develop critical thinking skills. Course design is crucial in demanding focused effort by students to develop abilities in reading, writing and critical thinking.

Teaching the Undergraduate Bachelor's Degree Information Systems Majors Capstone Course Using the Report of ISYS 2020 Committee Recommendations

Oral

Dr. Chandrashekar Challa¹

1. Virginia State University

Teaching the Undergraduate Bachelor's Degree Information Systems Majors Capstone Course Using the Report of ISYS 2020 Committee Recommendations

Technical Training and Soft Skills - Why Internships are a Win-Win for Students

Oral

Prof. Gail Moore¹

1. Lander University

Faculty encourage students to participate in internships to gain major-specific knowledge and make contacts in their field. Internships are becoming more popular with students over the past 5 years, with a 23 percent uptick in the number of students who participate in this kind of experiential learning. While students do learn technical training in an internship they also have the ability to experience, practice and hone soft skills. Soft skills are skills such as communication, teamwork, leadership, and problem solving. These skills are the skills employers are seeking above and beyond technical skills. When the goal in internships becomes not only helping students focus on their intended field of study, but also learning the soft skills requested by employers, the internships benefit students in a multitude of ways. The question becomes how does the academic environment structure an internship to ascertain that students are learning the soft skills as well as the technical skills needed to succeed? This paper focuses on internships and their benefits to students in both a technical and soft skill aspect as well as assignments and measuring tools used in internship classes to instill and assess the internship.

Technological Infrastructure Issues at Universities Exposed during the COVID-19 Pandemic

Oral

***Dr. Constance Lightner*¹, *Dr. Carin Lightner-Laws*², *Dr. Tameka Womack*²**

1. Fayetteville State University, 2. Clayton State University

The COVID-19 pandemic exposed significant issues in the technological infrastructure at universities that impacted revenue, enrollment, and the overall learning environment. The digital infrastructure ranges from online teaching/learning and virtual engagement to billing for distance education. We offer pragmatic insight about how to close the gap in the quality of education for online and on-campus learners, so that we can minimize the adverse impact of the next global pandemic or natural disaster.

We also examine disparities in the way online, face-to-face, in-state, and out-of-state tuition/fees are billed for 50 schools in the top ten University systems in the US. The inconsistent billing has contributed to a significant loss of revenue during the pandemic and is a barrier that will hinder schools from being prepared for the next crisis if is not adequately addressed. Although our research highlights challenges that universities are grappling with, we also provide suggestions on how to improve the technological infrastructure and create a more agile academic environment that can easily shift from face-to-face to online.

The Effects of Different Virtual Team Projects During the COVID-19 pandemic

Oral

Prof. Heather Carle¹, Dr. Cara Scheuer¹, Dr. Stephanie Swartz²

1. Coastal Carolina University, 2. Hochschule Mainz - University of Applied Sciences

This study conducted during the COVID-19 pandemic demonstrates that virtual team projects have a positive effect on students' intercultural sensitivity (ISS), computer self-efficacy, perceived ease of use of online learning, and COVID-19 anxiety. Different effects were observed according to project type such that technology-related outcomes and ISS ('respect for cultural differences') improved more for students that participated in tech projects. While COVID-19 anxiety lessened more for students that participated in non-tech projects. Our study contributes to existing research on the benefits of virtual team projects for student development and provides a more nuanced view of these projects and their practicality for both instructors and students

The Effects of the New CPA Exam in 2024

Oral

Ms. Allison Talish¹

1. Roanoke College

By: Allison Talish

This poster will provide an overview of the new CPA exam coming out in 2024. The CPA exam was first established in 1896. The exam experiences some minor changes frequently, but major overhauls are few and far between. In 2024, there is expected to be some major changes to design and content in the exam.

By incorporating evidence from reliable sources, this poster will show the differences between the CPA exam that we all know now and the new version coming out in 2024. It will also give an overview of how the overall structure and design of the exam will be different. The transitional period between these two versions of the CPA exam will be a little bit confusing. There will be some insight into this transitional period, and how to know which exam a person will be eligible to take. The final section of this poster will provide some reliable and in-depth resources, which could be of benefit to other smaller colleges looking for information on how these changes could affect the courses being taught to prepare students for the exam.

The CPA exam will be undergoing a major overhaul, and the new version will be released in 2024. The goal of this exam has always been to prepare test candidates for the working world, which means that there is constant change. Colleges want to help students feel prepared to tackle this exam, especially since many do attempt it shortly after graduation. In knowing this, it is important for colleges to be up to date on any exam revisions so that their courses can be updated to reflect these, and better prepare students to take the exam.

The Efficacy of Various Instructional Methods and Course Lengths: A Cross-Sectional Analysis

Oral

*Dr. Jacob Voegel*¹, *Dr. Matthew Peters*²

1. Coastal Carolina University, 2. Lander University

The efficacy of face-to-face (F2F) vs. online vs. hybrid learning is a topic of great conversation and research today (Ebner and Gegenfurtner, 2019). Each comes with its advantages. While F2F instruction offers richer communication, less distraction, and a better opportunity to network with the instructor and peers; online learning offers engaging/unique delivery methods, lower costs, and convenience. Regardless of possible advantages of online learning, many institutions and faculty have pushed back against offering specific courses in an online format. Typically, this is due to (1) the course design being largely quantitative, composing of a sizeable team-based projects, being hands-on nature, etc.; or (2) a lack of faculty capability due to a poor support, assistance, or training (Chiasson, Terras, and Smart, 2015).

In regards to faculty capabilities, all entities, individuals and institutions alike, have capabilities of which they are either not aware or have simply never exploited. In times of crisis, those capabilities often come to light and are exploited out of necessity to survive. One of the silver linings of the COVID-19 pandemic was the realization that most of the courses historically only offered in a F2F format can in fact be taught efficiently and effectively online. While institutions of higher learning and faculty have always had these capabilities, the COVID-19 pandemic forced them to be exploited.

Within this study, the authors investigate a course that prior to the COVID-19 pandemic, was offered primarily in a F2F format. Since the spring 2020 semester (the start of the COVID-19 pandemic), the course has been offered in online, hybrid, and F2F formats, as well as in 16, 8, and 5-week time frames. Conducting a cross-sectional analysis, the authors examine the efficacy of each instructional format and time frame. Data utilized in this research include final course grades, assignment grades, peer/team evaluations, and student evaluations of teaching. Controls for instructor and assignment type are applied. Data was gathered from a mid-sized university.

The Impact of Supply Risks and Information Technology Integration on Supply Chain Performance through Supply Chain Resiliency

Oral

***Dr. Hasan Uvet*¹, *Dr. Saban Adana*², *Dr. Hasan Celik*³, *Dr. Sedat Cevikparmak*⁴, *Mr. Yavuz Idug*⁵**

1. Georgia Gwinnett College, 2. John Carroll University, 3. Robert Morris University, 4. DeSales University, 5. University of North Texas

Recent supply chain disruptions show us how international trade is susceptible to any change in the global environment. During the COVID-19 outbreak, we observed disruptions caused by supply and demand sides. To mitigate these risks, adopting new technologies to increase supply chain resiliency provides us with new opportunities for the accuracy of decision-making processes. On the other hand, the adoptions of technologies like RFID provide a better vision for building agile and robust supply chains. Therefore, in this study, we investigated the impact of information technology integration to supply chain performance through supply chain resiliency while investigating the impact of supply risks simultaneously.

The importance role of TQM and LSS concepts in the current state of SCM research field and its future direction

Oral

Dr. Maryam Mahdikhani¹

1. Assistant Professor- College of Charleston

This study aims to shed lights on the findings of previous research that focused on the quality management practices including total quality management (TQM) and lean six sigma (LSS) in the supply chain management field. With the use of scientometric techniques, the trend topics in the field were identified to ease the understanding of current status of research and its potential gaps for the future studies. The findings of this study highlight the most active authors in the field, along with network of topics in SCM field.

The Role of Centers for Financial Literacy on Student's Retirement Security at Academic Institutions

Oral

Dr. Aref Hervani¹, Dr. Michael Fekula¹

1. Lander University

This paper examines the role of financial literacy on an individual's retirement security. Financial literacy impacts the knowledge and skills needed to effectively manage one's financial resources for a lifetime of financial security. Individuals with financial literacy knowledge have the necessary skills and confidence to apply knowledge toward effective decisions. Financial literacy improves financial well-being of an individual, leading to wise investment decisions, higher levels of savings, that would ultimately provide a sound and secure retirement planning for retirement days. The objective of this research paper is (1) to examine the role of financial literacy centers at colleges and universities on student's financial literacy acquisition and how this knowledge would affect their planning for retirement security at old days; (2) to provide a framework for 4-year institutions on how to implement their financial literacy centers when faced with limited funds; and (3) identify a three-constituent strategy for those with scarce resources comprised of faculty research, student services, and community outreach to establish a sustainable center for financial literacy.

THE VALUE OF IMPLEMENTING PROVEN BUSINESS ORGANIZATIONAL AND OPERATIONAL STRATEGIES IN HIGHER EDUCATION INSTITUTIONS: A COMPARATIVE STUDY

Oral

*Dr. David Fowler*¹, *Dr. Jon Musgrave*², *Dr. Jill Musgrave*³

1. Lander University, 2. Morehead State University, 3. Union College

Corporations utilizing effective organizational development and lean operational methodologies often exhibit competitive advantages over their rivals (Cavallini, 2008; Madhani, 2020; Namada, 2018). Institutions of higher education have been slower to adopt said methodologies as many operational models are not populated with administrative members not well-versed in proven business strategies (Fowler, 2022). However, many colleges and universities are beginning to adopt effective operational models that deploy competitive business methodologies, and they are realizing success.

The purpose of this study is to analyze and compare two colleges in the southern United States that are analogous in geographic location, age of operations, and program offerings. The study's primary investigator gathered data considering the organizational effectiveness of the two institutes as well as made personal observations for four years. The two organizations took different approaches to operations as one deployed developmental and lean practices and the other did not.

The inquiry presents findings of the data analysis and personal observations, and it is evident the institution using modern business strategies is outperforming its competitor significantly. This investigation provides firsthand insights that may provide benefit to scholars researching these phenomena and to practitioners in the field wishing to achieve competitive advantage within their organizations.

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Towards Exploring the Role of Institution based Trust in Cryptocurrency Adoption

Oral

Dr. Anupam Nath¹

1. Georgia Gwinnett College

Cryptocurrency is a recent innovation and phenomenon in the current decade which promises to change the fiat currency as we know it. The emergence of blockchain technology has enabled Cryptocurrency to invade the financial industry. The technology behind the Cryptocurrency and this newer environment for transactions have caused uncertainties among the general people who are not information technology experts. A similar scenario occurred with the emergence of e-Commerce a few decades ago. Institution-based trust played an important role in understanding users' perceived trust in the E-commerce environment (McKnight et al., 1998). Institution-based trust helps individuals operate within an impersonal and unfamiliar environment (Zucker, 1986).

Hence, in this research, we develop a theoretical model to understand the role of Institution-based Trust in Cryptocurrency. Extant research has identified two dimensions of institution-based trust: structural assurance and situational normality (McKnight et al., 1998). In the proposed model, we identify the Perceived quality of the technology behind a Cryptocurrency, the Perceived effectiveness of technology behind a Cryptocurrency, and the Perceived Trustworthiness of the technology behind a Cryptocurrency as the basis of Institution-based Trust. This theoretical model serves as a basis for understanding the role of trust in the adoption of Cryptocurrency.

UNDERSTANDING CUMULATIVE VICTIMIZATION AND TRAUMA-INFORMED PEDAGOGY

Oral

***Dr. Jill Musgrave*¹, *Dr. David Fowler*², *Dr. Jon Musgrave*³**

1. Union College, 2. Lander University, 3. Morehead State University

Abstract

Research suggests that between 20% and 40% of students enter college with a history of child maltreatment (c.f., Duncan, 2000; Freyd et al., 2001; Gibb et al., 2009, & Welsh et al., 2017). These students are at a higher risk of experiencing cognitive delays and emotional difficulties resulting in poor academic performance or noncompletion of their degree. Furthermore, experiencing childhood maltreatment is also a risk factor for depression and anxiety, drug abuse, post-traumatic stress disorder, the perpetration of crime, and future victimization.

Education plays a moderating role for each of the aforementioned risk factors. Creating a safe and predictable learning environment can decrease students' anxiety thus increasing academic performance and the likelihood for degree completion. This presentation will discuss how to identify when students are in distress in the classroom and what pedagogical practices can minimize students' stress and anxiety.

Using Course Management System (CMS) Behavioral Data to Improve Prediction of Freshman Persistence.

Oral

*Dr. Inigo Arroniz*¹, *Dr. Edward Showalter*²

1. Randolph-Macon College, 2. Randolph Macon College

INTRODUCTION:

The retention of existing students is an important metric for student success, graduation rates, and the financial health of higher education institutions. Retention efforts come in various forms, but a key element in retention is early identification of at-risk students for retention efforts to have the greatest chance of success. As with quality control inspections, measures can be taken at the point of intake (e.g., admissions information, standardized test scores, demographic indicators), at the end of courses (e.g., specific course grades, failure rates, overall GPA, pre-registration for the following term), or at one or more points during a term (e.g., unsatisfactory grade reports, midterm grades.)

This paper will outline retention efforts currently in force at a small Liberal Arts undergraduate institution and some of the advantages, disadvantages, and success of those efforts. In addition, we outline a new data analytics-based effort being piloted in Fall 2022. The new effort will analyze student interaction frequency with the course management system (CMS) on an ongoing basis to seek patterns which might indicate a student is at risk.

BRIEF INSTITUTIONAL HISTORY OF RETENTION AND RETENTION EFFORTS:

Two studies done two decades ago reported that the five-year first-year student to sophomore retention rate at the time was just under 80% in 2000, and the long-term average was 78%. [1],[2]. Important findings from these studies were that the primary predictors of likelihood to persist were academic performance as measured by first-year GPA, integration into college life, and expected performance determined through high-school GPA and standardized test scores. One of the variables considered in the study was participation in a first-year seminar course, at the time an option for the student, however participation in this course did not improve retention prediction models. [1],[2] Since that report the retention rate has varied from a low of 72% (2006) to a high of 87% (2017).

Table 1

The institution's strategic plan passed in 2009 established a short-term goal of increasing the retention rate to an average of 80% with a longer-term goal of a rate in the mid-80% range. As Table 1 shows, this was achieved, although there is still a great deal of variability in that rate.

To improve and better understand retention a cross functional "retention committee" was established composed of representatives of the provost's office, registrar, student life, academic support, athletics, and the faculty. One of the difficulties in determining at-risk students was the disparate sources of data that might be useful. There was data being gathered by several areas of the college, but there was not a centralized location for the data making access and use cumbersome.

The College adopted and implemented retention software (Pharos 360) in the Fall of 2016. This software platform pulls data from several data sources across the campus including the registration and admissions. The data available to a user is protected with a single-sign-on (SSO) and dual factor authentication process, and not all data is available to all users depending on their role in the college. Two key features of this software are the ability to get up to date contact information on students and to report an "alert" about a student of concern who may be struggling and need academic or other forms of assistance. These alerts are electronically routed to a member of the administration staff (usually a dean of the registrar) who then route the information to the appropriate faculty, aca-

ademic advisor, academic support personnel etc. This system then becomes the primary channel of communication about the student issue. An e-mail is sent to the intended recipient which contains only a notice that there is added information for them on the system.

While the timing of the implementation of the retention software does coincide with an improvement in overall retention, there are other initiatives that have also taken place so no causality can be determined. As part of the College's reaffirmation process in 2018 the College embarked on a new Advising initiative focused primarily on first year and pre-major advising. An advising center was added to academic support services, and all First-Year students were enrolled in a one semester one credit hour extended orientation course lead by their first-year advisor.

CURRENT STUDY: FOCUS AND SIGNIFICANCE:

All these efforts combined to improve retention during recent years, however, there have been drops in retention in the last two years and there is still room for improvement. Each of the actions listed above require direct faculty and staff involvement to determine if a student is at risk and are thus indirect assessments often only observed well after student behavior changes. An example would be the delay between when assignments are due and when they are graded. A direct assessment linked to specific student behavior (turning in the assignment on time) may provide an earlier indication of potential concern or behavioral change.

This concern was noted in a recent review of the literature on Student Retention and Educational Data Mining [3]. "Traditional student performance factors such as grades, attendance, economic, and demographic are considered ignoring other vital factors such as personal, cognitive, and behavioral factors. Other features that can be explored are teacher-related such as student-teacher relations, and the qualifications for the assigned teacher may have the potential to boost the predication accuracy." ([3] p.72497-72498)

The goal of this project is to identify students at risk of leaving the institution. Building a predictive model of student retention is important because it may enable the institution to identify students at risk and implement remediation policies to reduce the number of exits. The exits from the institution can occur for a myriad of reasons but common situations include a) poor academic performance, b) lack of motivation, c) financial difficulties, d) social difficulties, e) serious illness of student or close relative, and f) geographic relocation of the student or close relative(s). For this initial modeling effort, we will treat all student exits equally as in many cases the student does not provide information regarding the underlying motive for exiting the institution. If this information becomes available a more nuanced modeling approach to predictive efforts may be possible.

This study will add information from the course management system (CMS) to other variables studied in the past to investigate whether the direct measure of student CMS activity can improve a predictive model. This is in line with current suggestions for future research. "Each Course differs from one another in the way the assessments are presented and marked. Therefore, building a comprehensive predictive model is required by considering features that can be shared by students across different courses in an institution. Another approach could be to use data from courses that share the same teaching and learning methods, assignment marking system and course structure. Lastly, future researchers should also consider using low-cost variables that do not always require excessive effort in data collection." ([3] p.72497)

- **Short term research question:** Does analysis of CMS data provide information that may be used to determine retention intent. (Is there significant differentiation within the results?)
- **Long Term research question:** Does analysis of CMS data provide information that is of higher accuracy or timeliness than current retention information?

METHOD: SUBJECTS AND CLASSIFICATION MODELS:

We expect to Model the data in two waves. In Fall of 2022 we complete our first cross sectional dataset that includes all undergraduate students in the intuition (about 1500 students). The first wave of data is cross sectional in na-

ture and will provide a series of traditional explanatory variables or features such as demographic (e.g., gender), academic (e.g., SAT scores), activity (e.g., part of an athletic program), along with the behavioral data (e.g., number of times logging in to the CMS system) about the students as well as the dependent variable of interest which is whether the student enrolls in the following semester for classes.

The second wave of data to be obtained in Spring of 2023 will be comprised of the same variables but will have weekly behavioral values for the CMS data enabling the modeling of temporal shifts in student behavior. We hope that the time series data will enable us to model the exits more accurately as we will be able to detect the “weak” signals more accurately. For retention classification modeling in both waves of data each dataset is split in 70% train and 30% test subsets, training the models on the training portion of the data, and evaluating their predictive accuracy on the test portion of the data.

We use four different classification models to determine the probability that any given student will leave the institution (exit): Logistic Regression (LR), Support Vector Machine (SVM), Random Forests (RF) and Artificial Neural Networks (ANN). In all cases the dependent variable is whether the student returns for the following semester and registers for classes. In all models the general estimation approach can be summarized as

where

Where J is the cost function associated with the model, θ is the vector of unknown parameters, y is the dependent variable (exit), and x contains the features or variables used to predict the exit pattern. We find the parameters that minimize the cost function given our dataset. The different models specify different cost functions given their parametrization.

The performance of the classifiers is assessed using the standard measures of accuracy, recall, precision and F1. The classifier metrics are defined as follows:

CONCLUSION:

This abstract outlines an ongoing research project investigating using course management system (CMS) behavioral data in addition to more traditional variables (e.g., High School GPA, Standardized Test Scores) to improve retention prediction efforts both in terms of accuracy (likelihood to persist) and speed (earlier identification of at-risk students.) The conference paper and presentation should include the early weeks of data analysis from the Fall 2022 semester and demonstrate feasibility of the modeling process.

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When Should You Begin Receiving Social Security Payments? A Holistic Approach

Oral

Prof. John White¹

1. United States Coast Guard Academy

It is commonly known that you may receive your Social Security benefits as early as age 62. However, the payment will increase by 8% for each year you defer your payments, up to age 70. If you expect to have a long retirement, waiting can be very beneficial financially. The decision on when to take your Social Security benefits is made difficult by several factors. First and foremost, your death date is uncertain. But there are other factors that complicate this decision. These multiple factors should be considered when making this decision.

Papers

A Literature Review of Green Supply Chain Management

Dr. Damitha Bandara – University of Tennessee at Chattanooga
Ms. Margaret Schulte – University of Tennessee at Chattanooga
Mr. Jordan Man – University of Tennessee at Chattanooga

May 3, 2022

Abstract

This study aims to review the literature on the most researched topic in Green Supply Chain management and provide potential future opportunities. The increasing importance of energy and sustainability has created plentiful opportunities and strategies for remodeling classic supply chain designs. We evaluate numerous published articles and models from 2000-2021, from science Direct/Elsevier journals, Emerald-Publication, Taylor and Francis, Wiley inter-science, and Springer link. The literature classifications are conducted to present a comprehensive summary of the most prominent articles in the green supply chain, from optimization to literature reviews. This paper's contributions to the green supply chain offer an integrated definition of GSCM and then categorizes the articles revealing the most explored topics, providing summaries of articles for essential details. Finally, the study attempts to investigate areas that have been overlooked in the world of GSCM and offers insight into future exploration of the discipline.

Keywords: Green Supply Chain, Biomass to Bio-energy, Waste reduction, Zero emission, Sustainability

1 Introduction

Supply chain management (SCM) has become a more recent topic of discussion amongst the masses; however, the concept of SCM began in the 1970s, while research and use sprang up exponentially beginning in the 1990's [2]. Thus, conducting studies for optimization of the supply chain has equivocally increased, including those that minimize transportation costs [9] [33], optimize supply chain networks [15] [23], improve inventory planning [47], and more. In recent years, the focus has shifted to sustainability. Environmental resources are finite and rapidly depleting, to the point where the conflict between economic expansion and environmental protection has piqued SCM's interest, spawning a new field of study called green supply chain management (GSCM) [58] [1]. Sustainability has become an emerging trend shifting the competitive landscape [36] and has fast become vital for the future of innovation [43], with many businesses adopting various sustainability initiatives to achieve a competitive advantage, or at least maintain competitive parity.

Green supply chain management (GSCM) focuses on the implementation of green development strategies, focusing on waste reduction, using more sustainable materials, and more efficient processes; GSCM helps prevent waste from flowing into the environment [57] [44]. GSCM seeks to develop options that not only create environmental benefits but also increase profits [58] [30] [19].

Globally the industrial sector consumes more energy than any other; a combination with rising concerns of climate change and a push from regulators (e.g., the 2012 European Energy Efficiency Directive) has switched the industry's focus towards creating a more sustainable environment. Organizations play a critical role in accomplishing higher sustainable objectives, commonly referred to as "going green." [10].

Although academics have been interested in green supply chain management since the beginning of the twentieth century, research in this area has only seen a dramatic increase in publications on the topic these past two decades. Over the past decade, there have been many articles produced on the topic of GSCM by previous researchers; few of which focus on the methodology of GSCM [22] [50], while others focus on specific aspects and practices [26] [25]. This study, however, takes on another approach and identifies the most common topics of interest within the green supply chain discipline, which have been explored before categorizing them by topic and offering a direction for further exploration. As the above discussion suggests, there is consistent growth in evaluating green supply chain management practices and performance. Thus this study aims to review the literature in GSCM and present insights and directions for future research. The contributions of this paper are twofold. First, this study identifies the major categories in GSCM, which helps readers understand and view the literature from other dimensions. Second, the study presents insights and future research direction for understanding the concept and further exploration in GSCM. The paper is organized as follows; In Section 2, we discuss the detailed methodology and journal selection procedure. Section 3 presents the observations, insights, and Findings. Section 4 discusses the conclusion, limitations, and direction for future research.

2 Methodology

We began the study by searching the keywords and terms such as "green supply chain," "green supply chain management," and "GSCM" on academic databases for published papers. However, to gain a focused approach, the search was narrowed to published journal articles from 2000-2021, in journals from Science Direct/Elsevier, Emerald, Taylor and Francis, Springer, and Willey as the refined category. Some articles share similar terms in the title, and articles overlap in the keyword search; thus, duplicates were removed from the study. The initial search result retrieves various sources, including books and other publications but were excluded as they were considered outside of the scope for this research, as we only wanted to deal with these sub-sections of publications. As a result, we found 52 articles that formed the sample for this

study. When searching these terms into the academic database, we used quotations marks (""") and plus signs (+) around key terms, a technique called phrase searching, which narrows the search to retrieve only those results in which the exact phrase appears. Papers were reviewed and categorized into areas that narrowed down the published papers into six categories: general performance, literature reviews and overviews, case analysis, multi-objective, biomass to bioenergy, and big data in GSCM, as shown in Figure 1

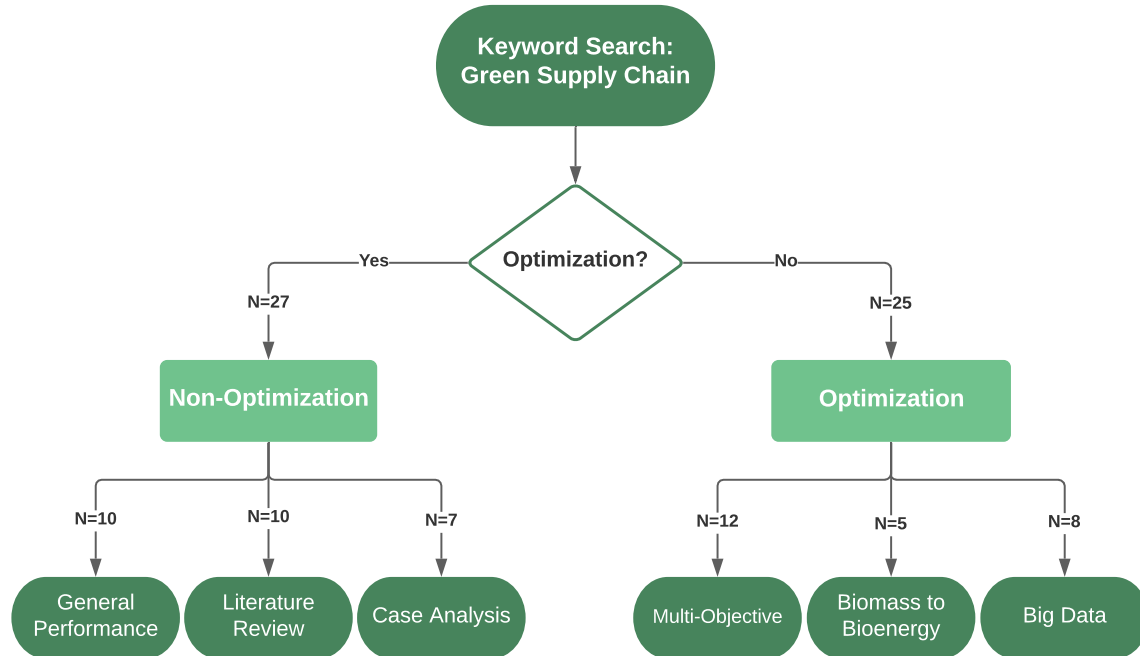


Figure 1: GSCM search subcategories

In the next section, we discuss the summary of each article in detail based on the above six categories.

3 Observations and Findings

Multiple articles are cited for each subcategory; however, a select few are further analyzed and discussed. After each subsection, a summary of the pertinent articles is included in the table, including the research’s reference, objective, methodology, and future opportunities presented in the paper. We found the two broad categories of ”optimization” and 5 ”non-optimization” general terms to separate thinking. Here, optimization is more specific and niche work in its related clusters, while non-optimization is encompassed the multiple aspects of GSCM as a whole (e.g., literature reviews and applied methodology to case analysis). This paper begins widely by evaluating general performance literature, then proceeds into more particular topics.

3.1 General performance

Green supply chain management is defined as integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes and the delivery

of the final product to the consumers as well as an end-of-life management of the product after its useful life [38]. Ten papers are included in the summary table, shown in Figure 3.1. In addition, We have provided the detailed summary below for the articles with interesting finds.

(Laosirihongthong, Adebanjo, & Tan, 2013)[32] examined the deployment of pro-active and re-active practices in the implementation of green supply chain management (GSCM) and analyze their impact on environmental, economic, and intangible performance by considering business strategy as organizational focus. Data collected from a sample of 190 ISO 14001 certified manufacturing companies in Thailand were used to test the research hypotheses, which found that the threat of legislation and regulation (re-active practices) was a consideration that resulted in companies enhancing their environmental, economic, and intangible performance. In addition to this, the paper found reverse logistics practices (pro-active practices) had low levels of adoption and do not have a significant impact on GSCM performance, therefore organizations need to be wary as pursuing a low-cost strategy may in fact impact negatively on their ability to invest in GSCM.

(Lee, Kim, & Choi, 2012)[34] explored green supply chain management (GSCM) practices and their relationship with organizational performance, particularly, exploring the effects of GSCM efforts and other organizational factors on firm performance of small and medium enterprises (SMEs) that serve as suppliers to large customer firms in the electronics industry. The paper develops a research model relating GSCM practice and business performance through three organizational variables (employee satisfaction, operational efficiency, and relational efficiency) as moderators. Findings revealed that a significant indirect relationship were found between GSCM practice implementation and business performance through mediating variables of operational efficiency and relational efficiency indicating that business performance is improved when GSCM enhances operational efficiency and operational efficiency.

(Longoni et al., 2016)[35] specifically targets the environmental dimension and investigate how environmental values and principles can be diffused in a firm to improve a full spectrum of environmental concerns. Focusing on green human resource management (GHRM) as a process that can deploy environmental principles and values among employees and remove people-related barriers to the implementation of GSCM practices. Specifically, the pre- sent study (i) tests the relationships between a set of GHRM and GSCM practices and a full spectrum of environmental performance and financial performance and (ii) tests the mediating role that GSCM practices play in the relationships between GHRM and organizational performance. As a result, the study contributes to two ongoing debates in the business ethics literature. First, we provide new insights on how companies can implement cross- functional environmental management systems that fully respond to their ethical responsibilities toward the natural environment. Second, we extend the debate on the effects of environmental management practices on both environmental and financial performance with original empirical evidence. In line with its objectives, the paper first confirms that both GHRM and GSCM positively affect financial and environmental performance, thus supporting the idea that trade-off effects on the two types of performance are not always likely. Second, the study confirms that GHRM and GSCM exert their effects in a joint rather than in an independent—fashion; indeed, the results support the mediating role of GSCM as a mechanism that explains the relationship between GHRM and environmental and financial performance. Therefore, the findings support the idea that an effective environmental management should not be based on a set of stand-alone management systems, but it requires firms to operate its cross-functional deployment within their different management systems and organizational units

Articles in General Performance

Reference	Title	Objective	Methodology	Future Work
(Ali, Bentley, Cao, & Habib, 2015)	Green supply chain management – food for thought?	The influence of green supply chain management techniques on the performance of small and medium-sized food retail businesses in the United Kingdom is investigated in this article.	A non-probability sample of 84 partakers was used for a quantitative angle. Five hypotheses were generated and the partial least square-structural equation modeling approach was used to test them.	Deciding how firm size affects GSCM techniques, and other country analysis are potential avenues.
(Bansal and Roth, 2000)	Why Companies Go Green: A Model of Ecological Responsiveness	The aim of this research is to evaluate the motivations for why companies involve eco-friendly practices.	An analytic induction inductive method. Relevant literature is evaluated to set hypotheses in an iterative process.	Future work might research test the prevalence of the motivation findings.
(Gotschol et al., 2014)	Is environmental management an economically sustainable business?	The purpose of this article is to see if environmental management is a financially viable enterprise.	1400 Italian managers were contacted to participate in a questionnaire. Experts checked the questions for content validity and other reliabilities have been confirmed.	Firms from other locations should be questioned.
(Laosirhongthong, Adebajo, & Tan, 2013)	Green supply chain management practices and performance	The goal of this research is to look at how proactive and reactive strategies are used in the deployment of GSCM and assess their influence in environmental and business performance.	190 credited Thailand manufacturing companies are investigated for this study. Factor analysis is applied to test construct validity and multivariate linear regression is used to validate test criteria.	N/A
(Lee, Kim, & Choi, 2012)	Green supply chain management and organizational performance	This study evaluated GSCM practices with company performance, focusing on small and medium enterprises.	Data from 223 small-medium enterprises in Korea was gathered to test business performance. Structural equation modeling was implemented.	Furthering survey instruments and analyzing this method with a different industry or country are recommendations.
(Longoni et al., 2016)	Deploying Environmental Management Across Functions: The Relationship Between Green Human Resource Management and Green Supply Chain Management	This research investigates the gap between human resource and environmental management and the GSCM practices.	A multi-respondent survey is adopted that is in line with the theoretical framework. This is so the insight is from the most dependable management personnel.	Focus on social performance and support of different approaches to the data are suggested further developments.
(Lubin and Esty, 2010)	The sustainability imperative	The emerging megatrend of sustainability's journey is evaluated.	The history, quality, IT, value creation, execution, and performance are aspects of sustainability that are considered.	N/A
(Nidumolu et al., 2009)	Why sustainability is now the key driver of innovation	Sustainability becoming a competitive advantage for companies is discussed.	The authors suggest that there are five stages of change that enterprises have to incorporate sustainability into their practice.	N/A
(Zhao et al., 2012)	Using game theory to describe strategy selection for environmental risk and carbon emissions reduction in the green supply chain	This research uses game theory to analyze GSCM strategies chosen for lowering life cycles and carbon emissions.	A game theory approach is used to lower environmental issues in the supply chain manufacturers' perspective.	Considering different demands and different manufacture entities and including upstream and downstream are areas for improvement.
(Lai et al., 2002)	Measures for evaluating supply chain performance in transport logistics	The goal of this study is to examine the construct of supply chain performance in transportation logistics and design a measuring instrument for it.	The supply chain performance measurement designed has 26 items for effective shipping, logistics, and consignees.	Focusing on different relationships with SCP might provide useful information for the field.

Figure 2: GSCM-General Performance Summary

3.2 Literature reviews and overviews

Literature reviews are vital for researchers to grasp the current state and understand limitations and opportunities discovered by their research predecessors. We found ten relevant articles listed in the table (See Figure 3) , and five of these are discussed further below.

(Fahimnia, Sarkis, & Davarzani, 2015)[14] present a structured review of green supply chain management literature. Their paper finds that there is a relative concentration of the more influential works amongst a handful of scholars. Yet, as the field continues to mature, many additional authors have joined this sub-discipline of supply chain management expanding the work in a variety of areas. The geographic dispersion of the works did shows that Europe, lead the way followed by North America. Using an objective clustering approach, conceptual and empirical studies have set the foundation and represent the most influential works. Topical literature classification shows that prescriptive, normative, quantitative modeling has started to take on greater importance and will likely be the direction of future research.

(Malviya & Kant, 2015)[39] present insights into the conceptualization and methodological research bases of the GSCM. A range of online databases from 1998 to August 2013 were searched containing the word “green supply chain” in their title and in the phrases to provide a comprehensive listing of journal articles on GSCM. Each of the 177 articles found were further reviewed and classified. The major findings from the paper show that survey research holds greater credibility and the trend in survey research is moving from exploratory to model building and testing. GSCM research related to organizational practices, environmental issues, process, performance, and sustainability were found to be most widely published topics within the GSCM domain.

(Srivastava, 2007)[51] presents a literature review of GrSCM that covers the entire scope of the field's activities, in which the paper highlights the ongoing integration phase in GrSCM. The depth of research in various categories has been different; many specific empirical studies have been carried out, and categories such as re-manufacturing have been studied to a great depth. Even, within re-manufacturing disassembly has been studied to a very detailed level. While other categories, such as RL, have only recently received more coverage. This paper focuses on less-explored categories. An evolutionary timeline is created based on the issue context classification and scope for future practice and study, considering all important and seminal papers published in the field of GrSCM. The resulting classifications along with timeline and cited references can therefore be used as a broad frame of reference to develop concepts and models that facilitate managers and other stakeholders trying to integrate environmentally sound choices into supply-chain management. By consulting observational research, practitioners will obtain a better understanding of real-world issues and how other organizations have attempted to solve them. The content in this paper is a useful starting point for practitioners to adapt and improve their own initiatives and procedures.

(Tseng, Islam, Karia, Fauzi, & Afrin, 2019)[52] aims to review the literature in green supply chain management (GSCM) published from 1998 to 2017 and presented their insights and directions for future research by collecting data from Scopus and ISI Web of Science databases. According to the report, research on drivers or barriers analysis of green supply chain management is on the decline, although mathematical optimization models for enhancing decision making in pursuit of environmental efficiency is on the rise. Furthermore, the study discovers a steady increase in the assessment of green supply chain management activities and performance. While academics have been interested in green supply chain management since the beginning of the twentieth century, this study finds a dramatic increase in publications on the subject from 2010 to now. Influential authors, top journals, top contributing countries, top contributing institutions, and contribution by disciplines are all identified in this report. This study presents a comprehensive but straightforward conceptual model of green supply chain management.

(Marchi & Zaroni, 2017)[40] observed that very few works integrated energy efficiency concerns into the study of supply chain management using both qualitative and quantitative approaches thereby they present a systematic review of papers on the integration of energy efficiency in supply chain design and management. They saw that publications that propose for a qualitative approach primarily focused on demonstrating the importance of energy issues in affecting supply chain efficiency, the best decision-making process, and the potential to improve energy performance through collaborative efforts among supply chain participants. While most of the reviewed studies' quantitative models primarily seek to incorporate the additional costs associated with energy flow into the overall supply chain cost, only a few studies have considered energy efficiency as an objective feature or a decision-making variable. Thereby the authors' findings suggest that energy conservation is still understudied when it comes to supply chain design and management and thus, there are many opportunities to develop this topic from the practice and research point of view which include (i) The effects that the introduction of the energy topic have on the supply chain economic and environmental results and on the form of cooperation; (ii) How supply chain management can support the development of energy efficient measures to overcome existing barriers; (iii) How different learning curves and knowledge of participants along the supply chain can influence the outcomes and (iv) The effects introduced by considering risks and uncertainties that characterize the current environment.

Articles in Literature Reviews and Overviews

Reference	Title	Objective	Methodology	Future Work
(Fahimnia, Sarkis, & Davarzani, 2015)	Green supply chain management: A review and bibliometric analysis	This research gives a comprehensive bibliometric and network analysis that uncovers insights that have not been properly appreciated or appraised in earlier assessments on the subject.	This work begins by distinguishing 1000 published articles. Research clusters are then established for topological analysis, identification of key research topics, interrelations, and collaboration patterns.	An opportunity presented by this paper is additional formal modeling in GSCM with real applications.
(Gong, et al., 2019)	A Bibliometric Analysis of Green Supply Chain Management Based on the Web of Science (WOS) Platform	The goal of this project is to examine the research progress and dynamics of green supply chain management at the frontier.	1391 articles were obtained from the years 2007 to 2018 and a bibliometric analysis method is performed to understand research hotspots.	The introductory period of green products, linking the whole chain for GSCM, using real data, and green incentives are areas for growth.
(Igarashi et al., 2013)	What is required for greener supplier selection? A literature review and conceptual model development	The available literature on green supplier selection is examined in this research.	General variables like theoretical viewpoint, type of research, and more specific considerations are how the articles are considered. There are 60 publications in all that have been reviewed, all of which were published in peer-reviewed journals between 1991 and 2011.	The authors suggest that further research be conducted to cover four dimensions of GSS: alignment, tools, process, and supply chain context.
(Kumar and Chandrakar, 2012)	Overview of Green Supply Chain Management: Operation and Environmental Impact at Different Stages of the Supply Chain	This study promotes the use of Supply Chain Management with a sustainable component to underline the need of environmentally friendly solutions.	Important factors in each stage of the supply chain are evaluated on the basis of going green as well as globalization of the supply chain stages.	N/A
(Malviya & Kant, 2015)	Green supply chain management (GSCM): a structured literature review and research implications	The goal of this paper is to look at how green supply chain management research is described by means of categories such as, country, authors, methodology, industries, etc..	177 articles were found from databases, range from 1998 to 2013, and were searched using the phrase "green supply chain." These papers are then reviewed, classified, and allocated to sub-categories.	In further literature reviews of GSCM, the journals used to identify articles and keywords used to find appropriate and all papers in the topic could be expanded upon.
(Marchi & Zanoni, 2017)	Supply Chain Management for Improved Energy Efficiency: Review and Opportunities	This work intends to provide a comprehensive assessment of publications published in academic journals on the integration of energy efficiency in supply chain design and management, therefore identifying possible research streams to fill void in the literature.	A systematic review is conducted by combining keywords in databases and 44 papers were found suitable for in-depth review.	Figure 9 in the paper describes multiple outlets for further research, including e-commerce and additive manufacturing.
(Pan et al., 2015)	Strategies on implementation of waste-to-energy (WTE) supply chain for circular economy system: a review	This review analyzes the waste-to-energy supply chain as a solution to energy demand, waste management, and greenhouse gas emission.	Several waste-to-energy technologies are evaluated and considered and portfolio options are illustrated for circular economy systems. Eight key "task-forces" are presented for implementing WTE in a supply chain.	"Water for energy" and "energy for water" are green technology areas for improvement.
(Sarkis et al., 2011)	An organizational theoretic review of green supply chain management literature	This study aims to use organizational theories to categorise GSCM literature and address the field's current standing and future direction.	Nine clusters of organizational theories are implemented to divide recent green supply chain management literature.	Opportunities for the field are adherently focused on in this paper and presents multiple topics to research.
(Srivastava, 2007)	Green supply-chain management: A state-of-the-art literature review	This work presents a comprehensive and innovative approach to the field of GrSCM. The literature on GrSCM is extensive, beginning with its formulation and focusing on the 'reverse logistics angle.'	The literature is classified by the problem context and methodology used. The different mathematical techniques are mapped and a timeline of papers involved is provided.	Data sharing across the entire supply chain, focus of GrSCM on a firm level, and understanding RL with the product life cycle are a few opportunities discussed.
(Tseng, Islam, Karia, Fauzi, & Afrin, 2019)	A literature review on green supply chain management: Trends and future challenges	This study seeks to examine the literature on green supply chain management produced between 1998 and 2017, as well as provide insights and research directions for the future.	A systematic process is followed to gain data from appropriate sources. A systematic method to classify current literature produced a four-step method to sectoring the research. Several databases are used.	Some later suggestions of research are investigating supply chain partner perspectives, implementing big data, and using real-life data.

Figure 3: GSCM-Literature reviews and overviews

3.3 Case Analysis

Case studies are vital for any research field interested in real-world practicality. As theoretical research expands in GSCM, the validity of the results and applicability should be checked and expanded on. There are seven papers summarized in the table (see Figure 4) below, and three are discussed more in depth.

(Jai & Rutherford, 2010)[27] attempts to add a cultural-relational dimension to supply chain risk management (SCRM) literature by highlighting the problem of supply chain relational risk (SCRR) and the cultural differences between China and the West. The paper states that to create a mutually beneficial partnership, both parties need to understand the cultural differences and processes of cultural adaptation. A cultural adaptation is proposed as a solution, with the hopes that firms mitigate the relational risks associated with cultural differences. Extending on prior work in SCRM a relational-cultural dimension is added. With a view to mitigation of SCRRs, the authors of this paper develop a conceptual process model, which describes a relationship-building process incorporating cultural adaptation for the creation of a mutually beneficial partnership, which features a hybrid cultural interface.

Laying the foundation for future research, this research reveals the mechanisms of cultural adaptation at each stage in the relationship-evolving process and also its outcome, i.e. the nature of the HCI and the causal relationship between cultural adaptation and partnership performance. Ultimately, benefiting both the Western buyers and their Chinese suppliers by increasing awareness of cultural differences and by supplementing a framework for cultural adaptation and a set of partnership performance measures. The application of mechanisms of cultural adaptation at each stage in the relationship-building process may help

organizations develop, reevaluate and revise role definition more effectively. An understanding of cultural adaptation in the context of defined cultural differences may help mitigate SCRR between Western buyers and Chinese suppliers by reducing interfacial cultural tensions, and by improving trust and commitment between members. This research has the potential to benefit many cross-cultural partnerships.

(Cosimato, Silvia; Troisi, Orlando, 2015)[13] provides insights into the impact of innovation on supply chain management (SCM) greenness, to which a framework is provided aimed at a sustainable and environmentally friendly approach to supply chain management. With the aim of looking at how logistics companies are attempting to address recent environmental problems, as well as the role that emerging green technologies play in making them "green" and successful. The authors examine the effects of green supply chain management (GSCM) practices on economic efficiency and corporate competitiveness. To which a background discussion on Green Logistics and GSCM is presented, and the authors describe research questions that should be investigated, using the DHL case study as a guide. Which, according to the evidence, is inextricably linked to the development of a much more sustainable and environmentally friendly approach to SCM, based on reduced ecological impact, cost savings, quality, reliability, performance, and energy efficiency. Therefore, environmental regulation must be followed in this context to achieve not only a decrease in ecological damage but also a boost in overall economic gain.

(Zhu, Sarkis, & Lai, 2008)[58] present the findings of a cross-sectional survey of manufacturers in four typical Chinese industries, namely power generation, chemical/petroleum, electrical/electronic, and automobile, to assess their perceived GSCM practices and link them to supply chain loop. The results reveal that Chinese organizations' capabilities in adopting GSCM practices in various industries, as well as the fact that these practices are not applied equally across the four. There are several academic contributions of this study to the logistics literature. First, by extending research in logistics management from a "green" viewpoint. Though there have been studies on assessing supply chain efficiency (e.g., Lai et al., 2002 [24]), there has been less research on the environmental aspect of supply chain management, which is an important part of supply chain performance in modern business logistics. This study widens the avenue for further research in this area with an empirical investigation of the adoption of GSCM in four industries in China. Next, the paper examined at how logistics practices, such as GSCM and CLSC, were adopted in various industrial contexts, discovering that different industries' contexts contribute to different levels of adoption of logistics practices. The cross-industry investigation into China provides logistic researchers with analytical insights into how and why logistics activities are adopted differently in various industrial contexts. The research leads to the advancement of theory in logistics research on logistics practice adoption by answering such questions Will certain GSCM factors be more or less important in some industries than in others and under what circumstances? In addition to that, the study added the various aspects of GSCM to the logistics literature, as well as a validated scale for calculating the five different factors of the GSCM build. The discussion of the GSCM build and calculation provides logistics researchers with a valuable conceptual and methodological reference for further study in this under-researched field of logistics management.

Articles in Case Analysis

Reference	Title	Objective	Methodology	Future Work
(Ala-Harja and Helo, 2014)	Green supply chain decisions – Case-based performance analysis from the food industry	From a greening standpoint, this study examines instances from the food business, focusing on order-picking, shipping, warehousing, and distribution.	Empirical data is gathered by using scenario analysis at food processing companies. Using a case study, three decision types are analyzed. SCOR metrics are used to calculate metrics in each scenario.	N/A
(Cosimato, Silvia; Troisi, Orlando, 2015)	Green supply chain management: Practices and tools for logistics competitiveness and sustainability. The DHL case study	This study investigates how green technologies are incorporated into logistics organizations and how it can remain competitive.	Practices in GSCM are investigated, further research questions are prompted, and a case study of DHL is conducted.	Future studies should use comparison studies with a high sample size to experimentally test the obtained conclusions.
(Islam et al., 2018)	Assessing green supply chain practices in Bangladesh using fuzzy importance and performance approach	The objective is to assess the leather industry in Bangladesh and apply a hybrid method vital for green supply chain practices.	The fuzzy set theory is used and analysed to identify performance levels. A set of 34 measures was developed that account for upstream and downstream partners.	Adopting a larger sample size for analysis would improve the validity of the results.
(Jai & Rutherford, 2010)	Mitigation of supply chain relational risk caused by cultural differences between China and the West	The goal of this research is to bring a cultural-relational layer to the literature on supply chain risk management (SCRM).	In developing a framework, to understand, adjust and learn are the three elements included. The conceptual model includes the nature of a cross-cultural relationship.	The key measures and determinants laid out in this research could be used to obtain empirical evidence to see if there's a link between cultural adaptability and partnership performance
(Malik, M., Abdallah, S., & Hussain, M., 2016)	Assessing supplier environmental performance: Applying Analytical Hierarchical Process in the United Arab Emirates healthcare chain	The goal of this research is to use a decision support method for evaluating the environmental effectiveness of healthcare providers in the United Arab Emirates by converting supply chain professionals' qualitative judgements into a quantitative framework.	An Analytical Hierarchical Process demonstrates sections and decisions for a systematic assessment of suppliers by experts which will aid the UAE healthcare space.	A more diverse sample should be empirically tested to create a cross-sectorial analysis.
(Soda et al., 2016)	Implementation of green supply chain management in India: Bottlenecks and remedies	This research examines the existing SOPC supply chains in Punjab, with the goal of identifying barriers in the implementation of GSCM procedures.	Information from various literature review articles are used in this study. Benefits within innovations, industries, and corporate areas are looked at.	A case study of a company incorporating a green supply chain could improve the field.
(Zhu, Sarkis, & Lai, 2008)	Green supply chain management implications for “closing the loop”	Results from a survey involving four Chinese industries are evaluated on their green supply chain management.	Five dimensions of green supply chain management and twenty-two measurements were created. A sequence of surveys are presented.	Motivational research as to why companies do not implement GSCM and the relationship between adoption and performance could be further analyzed.

Figure 4: GSCM-Case Studies

3.4 Multi-objective and mathematical models

Strategic decision-making and enhancing environmental and economic performance have led to an exponential rate of papers relating to mathematics and other optimization models in the field of the green supply chain. Optimization models, especially, Multi-objective optimization, have grown in importance in the GSCM literature as a technique of supporting practitioners in solving real-world supply chain network difficulties. There were 12 articles tabled (see Figure 5) , and 11 have an expanded review.

(Amin & Zhang, 2013)[5] present among the first papers to investigations that consider multi-objective mathematical models under uncertain environment in CLSC (closed-loop supply chain) network configuration designed for multiple plants, demand markets, collection centers, and products. Application of the mathematical model was examined with two test problems for a copier remanufacturing example before being extended to consider environmental objective. The two methods were then utilized to solve the multi-objective programming model including weighted sums and e-constraint methods. Results showed that e-constraint method obtained more efficient solutions than weighted sums method and therefore, e-constraint method is selected for the example. The model also is developed by stochastic programming (scenario-based) to examine effects of uncertain demand and return on network configuration. With results demonstrating stochastic programming model gaining flexible optimal closed-loop supply chain configuration with the objective function near to the base-case.

(Zhao, Liu, Zhang, & Huang, 2017)[56] present a multi-objective optimization model to provide insight into green supply chain management while minimizing the inherent risks involved in the hazardous materials; such risk is generally associated with carbon emissions and economic cost. Three Scenarios are proposed to solve the optimization model, in which Scenario 1 minimizes risk first, then carbon emissions and finally economic cost. Scenario 2 seeks to minimize economic cost by minimizing both risk and carbon emissions, while Scenario 3 attempts to minimize risk, carbon emissions and economic cost at the same time. This study shows that Scenario 1 is superior to Scenarios 2 and 3 for reducing risk and carbon emissions,

promoting improvements in green supply chain management, and achieving long-term commercial success. It is expected that the best strategy of risk control and carbon emissions reduction can be determined through the application of the optimization, which is insightful to incorporate into the management practice thus to improve green supply chain management.

(Chen & Cheng Lee, 2004)[12] propose a multi-product, multi-stage, and multi-period scheduling model for a multi-echelon supply chain network with unpredictable consumer demands and product prices to cope with multiple incompatible objectives. Fuzzy sets are used to describe the sellers' and buyers' incompatible preferences on commodity prices, and the unknown market demands are modeled as several discrete scenarios with known probabilities. The supply chain scheduling model is built as a mixed-integer nonlinear programming problem to achieve several conflicting goals, including equitable benefit distribution among all participants, secure inventory levels, maximum customer service levels, and decision robustness in the face of unpredictable product demand, therein the compromised preference levels on product prices from the sellers and buyers' point of view are simultaneously considered. When robustness metrics are included in goals, the uncertainty of target values due to product demand uncertainties is greatly reduced. As a result, to achieve a compensatory solution among all supply chain participants, a two-phase fuzzy decision-making approach is presented and demonstrated successful in providing a compromised solution in an unpredictable multi-echelon supply chain network using a numerical example.

(Wang, Lai, & Shi, 2011)[53] introduces a green supply chain network design model with the distinguishing feature that considers environmental elements including environmental level of facility and environmental influence in the handling and transportation process. The paper presents a multi-objective model which consists of minimizing total cost and environmental influence. First normalizing normal constraint method are used to solve the model by general MIP solver CPLEX 9.0 to get the Pareto optimal set before testing the model by a six-node example and a case study. The Pareto optimal curve by the model provides a portfolio of configurations for decision makers and further computation experiments show that the model presented can serve as an effective tool in designing a green supply chain network. A further sensitivity analysis for the case study saw that improving the capacity of the network and increasing the supply to the facilities can decrease CO₂ emission of the whole network and total cost.

(Yeh & Chang, 2011)[54] introduces a green criterion into the framework of supplier selection criteria, with the aim of developing an optimum mathematical planning model for green partner selection involving four objectives such as cost, time, product quality and green appraisal score. To solve the conflicting objectives, the study adopted two multi-objective genetic algorithms to find the set of Pareto-optimal solutions, which utilized the weighted sum approach that can generate a greater number of solutions. To evaluate the performance of two genetic algorithms, called as MOGA₁ and MOGA₂, two indicators of each algorithm for four problems were compared: (1) average number of Pareto-optimal solutions, (2) CPU time. Results showed that MOGA₁ not only generates more number of Pareto-optimal solutions than MOGA₂ but also obtains better solutions than MOGA₂. Thence, MOGA₁ was superior to MOGA₂.

(Altıparmak, Gen, Lin, & Paksoy, 2006)[4] provides a mixed-integer non-linear programming model for multi-objective optimization of SCN, as well as a genetic algorithm (GA) approach to solve the problem that was encountered by a plastic product manufacturer in Turkey. With three goals in mind: (1) minimization of total cost comprised of fixed costs of plants and distribution centers (DCs), inbound and outbound distribution costs, (2) maximization of customer services that can be rendered to customers in terms of acceptable delivery time (coverage), and (3) maximization of capacity utilization balance for DCs (i.e. equity on utilization ratios).

Two different weight methods were introduced in the proposed GA to deal with multi-objective and enable the decision maker to consider a larger number of alternative solutions. To test the performances of the GA with two different weight approaches, referred to as GA A1 and GA A2, the papers consider the

three problems that were formed from the original problem and were different from each other according to selected objectives. With results showing that although GA A1 was able to produce more Pareto-optimal solutions than GA A2, the diversification process had a significant impact on the quality of the Pareto-optimal solutions. GA A1 was then compared to MO SA using five problems derived from the original issue. In terms of both the average number of Pareto-optimal solutions and the accuracy of those solutions, GA A1 outperformed MO SA. In the future, the author suggests that a new multi-objective SCN design problem solving methodology based on tabu search could be established, and the efficacy of GA A1 could be investigated using this methodology. In addition, the model will account for cost and demand volatility, allowing for the creation of new uncertainty-aware solution methodologies.

(Azaron, Brown, Tarim, & Modarres, 2008)[7] develops a multi-objective stochastic programming approach for supply chain design under uncertainty with demands, supplies, processing, transportation, shortage, and capacity expansion costs are all considered as the uncertain parameters. In order to develop a robust model, two additional objective functions are added into the traditional comprehensive supply chain design problem; So that, the multi-objective model includes (i) the minimization of the sum of current investment costs and the expected future processing, transportation, shortage and capacity expansion costs, (ii) the minimization of the variance of the total cost and (iii) the minimization of the financial risk or the probability of not meeting a certain budget. After the realization of uncertain criteria, unreliable suppliers and capacity expansion are also incorporated into the model. Finally, the analysis employs the goal attainment technique to arrive at Pareto-optimal decision-making solutions.

In a multi-objective scheme to build a stable SC network, the proposed model in this paper accounts for the minimization of estimated overall cost, total cost uncertainty, and financial risk. According to the numerical experiments, considering risk directly affects the design of the SC networks under uncertainty. The trade-off between estimated overall cost and risk terms can be obtained using this approach. The relationship between the design goals was demonstrated. This method of generating various possible configurations can aid the decision-maker in selecting the best design from all the generated Pareto-optimal solutions based on their preferences. The goal attainment technique solves the multi-objective SC design problem and generates the Pareto-optimal solutions. Goal attainment method is one of the multi-objective techniques with priori articulation of preference information given. This approach has the same drawbacks as target programming in that the optimal solution is responsive to the goal vector and the decision-weighting maker's vector. In terms of computational time, however, the goal attainment method has fewer variables to deal with, making it one of the better methods for solving this large-scale mixed-integer nonlinear programming problem. In this case, a meta-heuristic technique such as genetic algorithm or simulated annealing will be appropriate for solving large-scale cases. The multi-objective problem can also be solved using an interactive multi-objective technique like SWT or STEM. The biggest drawback of interactive methods is that they need many more variables and stages to solve the related single-objective optimization problems to obtain the final solution than goal attainment techniques. The proposed model can be generalized to the multi-period scenario, considering the related production, transportation, and inventory-holding costs at various time intervals. In this case, the lifetimes of the suppliers can be thought of as independent random variables of time-dependent continuous or discrete distributions like exponential or geometric. Then, a proper stochastic optimal control model to solve the resulting problem is needed to be developed.

(Jamshidi, Ghomi, & Karimi, 2012)[28] addresses the modeling and solving of a supply chain design for annual cost minimization, while considering environmental effects. This paper considers the supply chain's cost elements, such as transportation, holding, and backorder costs, as well as the supply chain's environmental impact components, such as the amount of NO₂, CO, and volatile organic particles emitted by facilities and transportation. The author proposes a multi-objective optimization problem based on these two components (cost and environmental effects). The facilities and transportation options in this model

are capacity constrained and included are multiple transportation options with varying costs at each stage of the chain. The paper then utilizes a memetic algorithm in combination with the Taguchi method to solve this complex model. Lastly, a novel decoding method and priority-based algorithm for coding the solution chromosome is proposed. The performance of the proposed solution method was examined against the hybrid genetic Taguchi algorithm (GATA) on a set of numeric instances, and results indicate that the proposed method can effectively provide better results than previous solution procedures.

(Sazvar, Al-e-hashem, Baboli, & Jokar, 2014)[49] proposes a bi-objective model to optimally replenish a deteriorating product in a two-echelon supply chain considering total supply chain costs and environmental impacts under an uncertain demand and partial backorder assumption. A stochastic programming approach is applied to deal with demand uncertainty. The proposed model is examined by applying it to a real case from the radiopharmaceutical industry. Results show that companies which allow a minor reduction in the system's profits, will be able to improve their GHG criteria significantly; industrial managers can thus deal with the green issue without any concern about losing a considerable amount of profit.

In supply chain network design (SCND) and the order allocation problem (OAP), sustainability has become a growing concern. As a result, there is still a void in the quantitative modeling of OAP-based sustainable SCND. This gap is addressed in the article by considering the sustainable OAP in the context of the sustainable SCND as a strategic decision. (Govindan, Jafarian, & Nourbakhsh, 2015)[21] proposed supply chain network is composed of five echelons including suppliers classified in different classes, plants, distribution centers that dispatch products via two different ways, direct shipment, and cross-docks, to satisfy stochastic demand received from a set of retailers. The problem has been mathematically developed as a multi-objective optimization model, with the goal of minimizing the total costs and environmental impact of simultaneously combining SCND and OAP. A novel multi-objective hybrid approach called MOHEV is proposed to resolve this issue, with two strategies for its best particle selection procedure (BPSP), minimum distance, and crowding distance. MOHEV is composed of two multi-objective algorithms: the adapted multi-objective electromagnetism process algorithm (AMOEMA) and the adapted multi-objective vector neighborhood search (AMOVNS). According to the findings in the paper, sensitivity analysis of algorithm performance versus problem dimensions revealed that MOHEV generated better solutions than NSGAI and MOPSO, and that MOHEV(cd) is superior to MOHEV(md) in most situations. The applicability of the method is shown using a case study from the automotive industry.

Multi-scale challenges, multi-objective and sustainability challenges, and multi-player challenges are three main technological challenge areas where awareness gaps in supply chain design can be tackled. The work by (Garcia & You, 2015)[17] offers an overview of opportunity areas, a summary of related technological challenges, and a perspective on how to solve these challenges in supply chain design. The results of the paper show that globalization and technological development have brought markets, companies, and countries closer together than they have ever been before, allowing for sufficient opportunities to develop or refine supply chain design.

Enterprise-Wide Optimization (EWO) techniques and society's growing interest in energy/sustainability topics are two of the most important opportunities identified for supply chain design advancement with EWO providing opportunities for modeling and optimizing supply chain designs. Energy and sustainability are becoming increasingly important to the public as well as policymakers all over the world. This opens the possibility of incorporating energy and sustainability considerations into supply chain planning and optimization. Developing effective methods to evaluate the economic, environmental, and social impacts of supply chains is a key opportunity in this region.

Articles in Biomass to Multi-Objective and Mathematical Model

Reference	Title	Objective	Methodology	Future Work
(Altıparmak, Gen, Lin, & Paksoy, 2006)	A genetic algorithm approach for multi-objective optimization of supply chain networks	To find Pareto-optimal solutions for the multi-objective supply chain network design problem, this paper employs two separate weight approaches to allow the decision maker to evaluate a larger number of alternative solutions.	The first adopted weight value approach is situated on the random weight approach where the weights are randomly selected for each step of the process to avoid local optima. In the second weight value approach, weights are chosen based on the ideal point begot in each step. An experimental study is conducted using data from an actual company.	A new solution based on tabu search could be developed to retrieve Pareto-optimal solutions for the multi-objective supply chain network design problem.
(Amin & Zhang, 2013)	A multi-objective facility location model for closed-loop supply chain network under uncertain demand and return	This paper proposes a multi-objective mathematical model under uncertain environment in a closed loop supply chain to minimize the total cost.	The model proposed extends to consider environmental elements by weighted sums and e-constraint methods where the e-constraint method is modified to a mono-objective optimization problem. The impact of demand on the network composition by stochastic programming is investigated and computational results are shown to handle return uncertainties.	A new method using standards such as Eco-indicator 99 could be proposed to analyze a larger number of scenarios. A heuristic approach could be developed to solve for multiple periods.
(Azaron, Brown, Tarim, & Modarres, 2008)	A multi-objective stochastic programming approach for supply chain design considering risk	In this paper, a multi-objective stochastic programming approach is proposed for supply chain design uncertainty.	A deterministic mathematical formulation for the supply chain design problem is described and a stochastic programming approach with two stages is proposed to account for the minimization of costs, variance, and financial risk.	The sample strategy's performance is beyond the scope of this work, but it can be used as a starting point for future research in this field.
(Chen & Cheng Lee, 2004)	Multi-objective optimization of multi-echelon supply chain networks with uncertain product demands and prices	This paper aims to alleviate multiple incommensurable aims for multi-echelon supply chain networks by optimizing conflict objectives and the uncertain product prices problem were there are typical demand uncertainties.	A MINLP model is formulated, achieving fair product distribution across the network participants, customer service, safe inventory levels, demand uncertainties, and product price preference. The linear increasing membership function and fuzzy aggregation are used to derive the satisfaction of the decision.	N/A
(Garcia & You, 2015)	Supply chain design and optimization: Challenges and opportunities	This paper reviews research opportunities and challenges in supply chain design by noting sustainability growth and technical algorithmic, modeling, and computational hardships.	Two key opportunities (enterprise-wide optimization and energy and sustainability) are described, followed by the challenges (multi-scale challenges, multi-objective and sustainability challenges, and multi-player challenges) along with the modeling and computational challenges in each group.	Big Data and analytical strategies for optimization in supply chains, water-energy nexus for water management, integrated optimization across multiple temporal scales, and in-depth multi-scale modeling are further areas to study.
(Govindan et al., 2015)	Multi criteria decision making approaches for green supplier evaluation and selection: A literature review	The objective of this work is to examine research on green supplier selection published in journals and proceedings.	After performing a review, a classification framework is created, literature is tabulated, and the results are presented.	The use of sensitivity analysis is encouraged and comparative analyses could be completed for multi-criteria models.
(Govindan, Jafarian, & Nourbakhsh, 2015)	Bi-objective integrating sustainable order allocation and sustainable supply chain network strategic design with stochastic demand using a novel robust hybrid multi-objective metaheuristic	In this paper, the gap in the qualitative modeling of sustainable supply chain network design is covered by considering the order allocation problem as a strategic decision.	A novel multi-objective optimization hybrid model approach is formulated with minimum distance and crowding distance as the two strategies for its best particle selection procedure. An automotive industry case study is used.	It is recommended that the proposed model be extended to a closed-loop supply chain by adding collection, recycling, and disposal centers. Also, to develop a more complete optimization model, the vehicle route may be incorporated.
(Jamshidi, Ghomi, & Karimi, 2012)	Multi-objective green supply chain optimization with a new hybrid memetic algorithm using the Taguchi method	The objective of this paper is to use modeling to minimize annual costs in a supply chain while simultaneously considering environmental effects.	A memetic algorithm along with the Taguchi method are used to solve the complex multi-objective optimization problem. Additionally, priority based algorithm and a novel decoding method are proposed for coding the solution chromosome.	N/A
(Sarvar, Al-e-hashem, Baboli, & Jokar, 2014)	A bi-objective stochastic programming model for a centralized green supply chain with deteriorating products	The goal of this study is to create a stochastic mathematical model and suggest a novel replenishment policy for degrading products in a centralized supply chain.	A liner mathematical model is proposed which considers inventory and transportation costs, environmental consequences of uncertain demand, greenhouse gas, and financial and environmental criteria. A sensitivity analysis is performed and managerial recommendations are offered.	A three-echelon supply chain to take GHC into account, considering a more detailed reverse logistics process, and involving quantity discount into a new model are considered for future work.
(Wang, Lai, & Shi, 2011)	A multi-objective optimization for green supply chain network design	The research offers a model that takes environmental investment decision-making into account throughout the supply network design phase, utilizing multi-objective models to account for both cost and environmental impact.	A multi-objective model is used to minimize total cost and environmental impact, and a normalized normal constraint method is used to solve the model. This is tested using a case study and a six-node example. Sensitivity analysis is applied to reduce cost and CO emissions by boosting network capacity.	In order to improve its relevance to real-world scenarios, other aspects of the supply chain such as transportation modes and demand uncertainty should be taken into account. Additionally, expanding the study by developing new approaches for solving this multi-objective model is an option.
(Yeh & Chang, 2011)	Using multi-objective genetic algorithm for partner selection in green supply chain problems	The goal of this study was to create an optimal mathematical planning model for selecting green partners based on four criteria: cost, time, product quality, and green assessment score.	This paper uses two multi-objective genetic algorithms to determine the set of Pareto-optimal solutions which used the weighted strategy. An experimental analysis was used to compare the average number of Pareto-optimal solutions and CPU times.	A modified weight sum approach to gain more Pareto-optima solutions could be developed, and cost and demand uncertainties might be considered.
(Zhao, Liu, Zhang, & Huang, 2017)	An optimization model for green supply chain management by using a big data analytic approach	This work proposes a multi-objective optimization model for a green supply chain management strategy that reduces the danger posed by hazardous products, as well as the associated carbon emissions and economic costs.	A multi-attributive decision making technique is chosen that uses a performance assessment that multiplies the weight of each target by the associated attributive value to incorporate carbon emission reduction into management practice. The Binary Dominance Matrix is used to weigh the importance of risk, carbon emissions, and cost.	Further study can be conducted by examining the impact of held and backordered inventory on supply chain network optimization.

Figure 5: GSCM-Multi objective

3.5 Biomass to bio-energy

Biomass has been considered an aspect of GSCM that can reduce environmental harm compared to its fossil fuel counterparts [55]. Therefore, it is imperative to consider bioenergy in SCM functions to improve energy aspects of the chain. Five articles are listed (see Figure 6), and all are considered further.

(Lakovou, Karagiannidis, Vlachos, Toka, & Malamakis, 2010)[31] present a generic system component

along with the unique characteristics of waste biomass supply chains (WBSCs) that differentiate them from traditional supply chains followed by a discussion of state-of-the-art energy conversion technologies along with a classification of all related literature. The critical synthesis highlights the rapidly evolving research field of biomass-to-energy production that focuses on biomass-to-energy production technologies, noting that very few studies address critical supply chain management issues, or that the ones that do only focus on (i) the assessment of the potential biomass and (ii) the allocation of biomass collection sites and energy production facilities. Logistics and supply chain management are shown to be areas of critical importance for the successful energetic utilization of waste biomass. As such, decisions regarding biomass logistics operations are said to be rather harmful for the environment if not planned carefully, the study states that they need to become a priority.

(Yue, You, & Snyder, 2014)[55] describe the key challenges and opportunities in modeling and optimization of biomass-to-bioenergy supply chains. Reviewing the major energy pathways from terrestrial and aquatic biomass to bioenergy/biofuel products as well as power and heat with an emphasis on “drop-in” liquid hydrocarbon fuels; key components of the bioenergy supply chains are presented, along with a comprehensive overview and classification of the existing contributions on biofuel/bioenergy supply chain optimization. As reviewed, cellulosic and algae-based hydrocarbon biofuels have numerous advantages over ethanol and biodiesel in compatibility with existing distribution infrastructure, implication on food price and land competition, and potential for substituting various high-value petrochemicals. The multi-scale modeling and optimization framework used can preserve a holistic view and facilitate informed systematical research in fields of molecular engineering, unit operation, process design, supply chain management, and sustainability assessment. Opportunities and challenges highlighted emerge from multiple spatial and temporal scales in the biofuel supply chain systems are discussed. Perspectives on centralized-distributed network design, multi-player interaction, and integration with other supply chain systems are also revealed. Additionally, the classification of decisions into strategic and operational levels according to their influences on the temporal scale. Finally investigating issues associated with biofuel supply chains in the threefold sustainability—economy, environment, and society, as well as the uncertainty and risks. Non-food end-uses of biomass derivatives are also introduced in this paper, identifying the opportunities for power and heat supply and advanced bioproducts.

(Rentizelas & Tolis, 2009)[46] present a paper to serve a decision support system, with the aim of investigating and optimizing a bioenergy supply chain and conversion facility with the goal of meeting current energy demand in the most cost-effective way possible. The approach used has several unique features, such as the integration of computational biomass logistics calculations with holistic bioenergy system modeling and optimization. For district heating and cooling applications, the device includes the option of tri-generation. Furthermore, the model was able to handle multi-biomass scenarios, allowing it to determine the most cost-effective biomass mix for the application under consideration. To address the limitations posed by the combination of analytical logistics modeling and system-wide optimization, a hybrid optimization approach was used for system-wide optimization. The approach had the advantage of defining the best solution for the entire system. To illustrate the model’s inherent capabilities, a case study has been presented. The case was a tri-generation application in a municipality in the Thessaly region of Greece focusing on statistical data for the region’s biomass resources. The model calculates the best size and position for a bioenergy conversion plant, as well as the biomass mix to be used. The results provide the prospective investor a lot of information about the details of the best facility design and fuel supply chain, as well as the sensitivity of the investment to a set of investment parameters.

(Babazadeh, 2018)[8] presents a robust optimization method to deal with the deep uncertainty of a green biomass-to-bioenergy supply chain system design. The proposed model is a MILP one that considers the path from feedstock supply centers to biodiesel consumer centers to achieve global optimum solution. Also,

in the proposed model, CO2 emissions of all involved processes are calculated through SimaPro environmental assessment software and incorporated in optimization of biodiesel supply chain network. Due to the deep uncertainty of the parameters of the studied problem, it is not possible to construct probability or possibility distributions to model their uncertain behavior. Therefore, a set-induced robust optimization method is utilized to deal with the deep uncertainty of the proposed model. The proposed model is applied in a real case in Iran. Since Iran is planning to reduce environmental pollution in large and industrial provinces, the outcome of this research will help policy makers to efficiently utilize biodiesel through taking into account optimum strategic and tactical decisions in biodiesel supply chain network. The achieved results show that the proposed model could be efficiently employed in biodiesel supply chain network under deep uncertainty conditions. Also, to reduce total CO2 emissions, it is necessary to spend more money.

(Pavlou et al., 2016)'s[45] paper deals with the supply chain management of green (e.g. grass) biomass. Specifically, three different supply chain systems, in terms of machinery configurations, were analyzed and evaluated in terms of task times and cost performance. Using a functional modeling methodology, the structural representations of the systems, in terms of activities, actions, processes, and operations, were generated and implemented by the ExtendSim® simulation software. It was shown that the models can identify the bottlenecks of the systems and can be further used as a decision support system by testing various alternatives, in terms of resources used and their dimensioning. This allows for the configuration of the optimal system based on the criteria of total operation cost and/or total operation time.

Articles in Biomass to Bioenergy				
Reference	Title	Objective	Methodology	Future Work
(Babazadeh, 2018)	Robust Optimization Method to Green Biomass-to-Bioenergy Systems under Deep Uncertainty	This work proposes a robust optimization strategy for dealing with the high levels of uncertainty in the design of a green biomass-to-bioenergy supply chain system while minimizing costs and maximizing carbon trade.	This proposed model uses the Eco-indicator 99 with SimaPro software. To describe the deep uncertainty of parameters, a set-induced robust optimization approach is used. In Iran, the proposed model is being used in a real case.	In the future, researchers could develop heuristic algorithms for large cases. Another effective future research project is to use the adaptive robust optimization approach for the suggested model to improve the performance-conservatism trade-off.
(Lakovou, Karagiannidis, Vlachos, Toka, & Malamakis, 2010)	Waste biomass-to-energy supply chain management: A critical synthesis	This paper provides a comprehensive review of the research as it relates to all parties engaged in the design and management of waste biomass supply chains.	This paper lead a discussion of cutting-edge energy conservation technologies, as well as the classification of any pertinent literature that results. Then the inherent hierarchy of the decision-making process for WBSC design and planning is identified, and a categorization for of research activities are mapped as strategies, tactical, and operational.	Studies in the future might primarily focus on assessing potential biomass and allocating biomass collecting locations and energy generating facilities.
(Pavlou et al., 2016)	Functional modeling for green biomass supply chains	The supply chain management of green biomass is the subject of this study. Three distinct supply chain systems were investigated and assessed in terms of job durations and cost performance, based on their machinery configurations.	ExtendedSim simulation software is used to implement activities, actions, processes, and operations. The models were compared to the sensitivity of input factors that are known with some uncertainty, such as the projected yield and machinery performance.	Continuous modeling for in-field biomass drying process, the expansion of the supply chain to include the biomass drying process, and implementing models for physical area coverage are all subjects to study further.
(Rentizelas & Tolis, 2009)	An optimization model for multi-biomass tri-generation energy supply	Presented here is a decision support system for multi-biomass energy conservation utilization. This aspires to back investors by the investigation of current tri-generations in an area.	The system's holistic modeling, energy conversion facility, and heating and cooling network are combined in this approach to yield maximum financial gain. A demand-driven hybrid optimization method is used to overcome limitations by taking into account regulatory, technical, logical, and social pressure. A case analysis is applied to a section in Thessaly, Greece.	Investigating the impact of low-cost storage choices on the investment analysis assessment is a suggestion for future research.
(Yue, You, & Snyder, 2014)	Biomass-to-bioenergy and biofuel supply chain optimization: Overview, key issues and challenges	The goal is to identify the major research difficulties and possibilities in modeling and optimizing biomass-to-bioenergy supply chains utilizing Process Systems Engineering (PSE) tools and methodologies, as well as to plan a course for tackling these issues.	Data was incorporated from various sources, including a survey questionnaire for Chinese manufacturing industries and expert input. Questions are divided into sections about pressure/drivers, GSCM practices, and performance.	Optimization of isomers in manufacturing or fuel performance, biofuel sustainability, and molecular engineering guided to system engineering approaches are a few suggestions for further research.

Figure 6: GSCM-Biomass to bio-energy

3.6 Big Data in Green Supply Chain

With the popularity of the internet, the rapid development of the Internet of Things (IoT), and the Cloud, global data are increasing rapidly. In this information age, lot of data generates at both supplier and buyer side. However, most of the supply chain decisions still do not incorporates the big data characteristics into the decision-making models despite the potential to provides a competitive edge to the business organization and makes the supply chain resilient and sustainable [16] [11]. This paper found eight articles listed (see Figure 7) regarding the big data issue and six are discussed below.

(Lui & Yi, 2017)[37] studies the pricing policies of a green supply considering targeted advertising input and products greening costs in the Big Data environment, a green supply chain with one green manufacturer and one retailer was chosen. After that, the demand feature was updated and the operating model of targeted ads in the Big Data world was examined. Four game scenarios based on the Stackelberg and Nash Equilibrium game theories were proposed, and the shift patterns of prices with the green degree and the input level of targeted advertising were analyzed. The results indicated that the optimal retail price and the wholesale price had a negative correlation with the green degree and the input level of targeted advertising. Furthermore, as a pioneer, the green producer or retailer can boost their own advantages, demonstrating that "first-mover advantage" exists. This study offers theoretical guidance on pricing policies for green supply chain participants in the Big Data context, considering targeted ads and product green degree.

(Kaur & Singh, 2018)[29] proposes a model for a sustainable supply chain that combines procurement and logistics. The model helps with lot sizing, supplier selection, and carrier selection. The model considers carbon trading policy to account and manage total emissions caused during procurement and logistics, where excess/saved emissions are directly linked to the objective function in terms of carbon cost. By simultaneously minimizing procurement and carbon emissions costs, an efficient and optimal trade-off between a firm's economic benefits and its environmental obligations are created.

The model is solved with three variables that have large data characteristics (3V's). Big data captures changes in parameters such as prices, capacities, and demand fluctuations in real time. As a result, the model approach can absorb volatility by integrating big data into supply chain modeling. The model, however, employs a carbon cap-and-trade strategy to control overall carbon emissions generated by procurement. Different carbon emission costs incurred during purchasing, storage, and inventory keeping are also considered. However, the integration of big data into modeling increases computational time, and the model is unable to solve optimally, as seen in this paper. As a result, axioms are formed to relax the model, allowing it to solve the problem optimally for up to 18 time periods. For large-scale problems involving big data, a heuristic (H-1) is also proposed, which offers a solution that is very close to optimal (with up to 5 percent error). Using proposed heuristics, large-scale problems with big data characteristics are solved in a fraction of a minute (H-1). The proposed sustainable procurement and logistics model based on big data can be tested using various meta-heuristics, or a new heuristic solution can be proposed to strengthen and compare the proposed heuristic.

(Nguyen, Zhou, Spiegler, Leromonachou, & Lin, 2018)[42] proposes a novel classification framework that provides a full picture of current literature on where and how BDA has been applied within the SCM context. Using the content analysis methodology of Mayring (2008), this paper offers a literature review which examined 88 journal papers to provide a full picture for academics and practitioners of where and how BDA has been applied within the SCM context. A classification framework was developed based on four research questions: (1) in what areas of SCM is BDA being applied? (2) At what level of analytics is BDA used in these SCM areas? (3) What types of BDA models are used in SCM? And, finally, (4) what BDA techniques are employed to develop these models? Addressing these questions will help reveal gaps in research, which lead to future research directions. The research found gaps highlighted in SC function areas

including quality control in manufacturing, dynamic vehicle routing and in-transit inventory management in logistics/transportation, and procurement etc. The paper uncovers that SCM is the multi-level process by which all functions are interlinked, thus, fragmental efforts of BDA adoption to only one or two functions will not yield any significant and long-lasting competitive advantage. The paper recommends horizontal integration by aligning BDA applications in different functions is recommended to avoid such fragmented efforts. In addition to this, the paper suggests future research that should focus on cross-functional problems such as vehicle routing and facility location, supplier selection and order allocation. Before mentioning the limitations of this study.

(Arunachalam, Kumar, & Kawalek, 2018)[6] conducts a bibliometric and thematic study of research papers published between 2008 and 2016 with the aim of providing a systematic literature review of Big Data Analytics capabilities in supply chains, as well as developing a capabilities maturity model and contributing to theorizing BDA capabilities in supply chains. The organized methodology used for the literature review revealed current contributions to BDA and SCM research, revealing a substantial increase in the number of papers published in recent years, with social media-based academic research emerging as an important discipline in the supply chain sector. According to the findings, BDA may be useful if companies can build the necessary skills to efficiently use big data. Unlike previous study, this paper's conceptualization of BDA capabilities is holistic and data-driven, focusing on the importance of recognizing the provenance of big data in the supply chain and optimizing the data generation process first. Second, it emphasizes the importance of incorporating and standardizing data from disparate sources to provide analytics systems with more consistent data sets. Third, various forms of analytics are discussed, as well as the importance of incorporating the results into the business process. Prescriptive analytics, in contrast to descriptive and predictive analytics, needs very little human involvement (Puget, 2015), revolutionizing the decision-making process. Fourth, the importance of data visualization and data-driven culture in increasing versatility and adaptability is addressed from the perspective of value creation and users. Moreover, the effectiveness of cloud computing and absorptive capability in enhancing value from BDA investment is also clarified. This study makes significant contributions to both theory and practice. The conceptualisation of BDA capabilities would help academic researchers to embark on new empirical research in this domain. It contributes to the on-going debate of BDA in SCM context and supports a comprehensive understanding of this evolving technology from the systematic literature review and conceptualisation of key capabilities. This research contributes significantly to both theory and reality. Academic researchers would benefit from a better understanding of BDA capabilities before embarking on new empirical research in this field. It contributes to the ongoing discussion about BDA in the sense of supply chain management and promotes a thorough understanding of this emerging technology through a systematic literature review and conceptualization of key capabilities.

(Govindan, Cheng, Mishra, & Shukla, 2018) [20] examines novel approaches, practices, and prospects for big data analytics and applications in logistics and supply chain management; examining several ways to develop big data analytics and applications for logistics and supply chain management, including technology-driven monitoring techniques, financial performance relationships with data-driven supply chains, and implementation challenges and supply chain maturity with big data. The discussions on big data characteristics, efficient implementation practices, and assessment and implementation approaches are then summarized; having selected five research papers to be included into the issue the key findings in the paper saw that the use of big data analytics in supply chain and logistics management is being thoroughly investigated in several ways and through various fields of operation.

Drawing on bibliometric and network analysis (Mishra, Gunasekaran, Papadopoulos, & Childe, 2018) [41] presented an extensive review of literature on Big Data and SCM spanning over a 10-year period (2006–2016). The paper offers insights regarding the contributions of scientific journals towards advancing Big Data related research and the contributions of researchers to the emerging field of Big Data. The

study contributes to the literature on Big Data and extends current reviews in that: it goes beyond a simple systematic study of the field’s literature by proposing and employing bibliometric and network analysis techniques to identify and compare the most influential works (based on citations, co-citations and PageRank) in addition to identifying and proposing six clusters (‘Conceptualisation of Big Data and analytics’, ‘Big Data and SCM’, ‘Big Data tools and algorithms’, ‘Big Data applications in healthcare’, ‘Big Data and forecasting’, and ‘Data mining and applications’) that focus on particular areas of Big Data, from conceptualisation to methods and tools and applications in SCM and healthcare. The study also provides professionals and consulting companies involved in optimizing supply chain benefits, such as providing managers with insight that will allow them to reap the benefits of Big Data and analytics in SCM in their daily work in addition to identifying future needs in the relevant ‘clusters’ to take appropriate decisions on investments and improvements on current tools/techniques of Big Data.

Articles in Big Data in Green Supply Chain				
Reference	Title	Objective	Methodology	Future Work
(Arinachalam, Kumar, & Kawalek, 2018)	Understanding big data analytics capabilities in supply chain management: Unravelling the issues, challenges and implications for practice	The purpose of this article is to conduct a systematic evaluation of big data analytics capabilities throughout the supply chain and to construct a capabilities maturity model.	The bibliometric and thematic analysis of research publications from 2008 to 2016 is presented in this study. There are 82 peer-reviewed papers and 13 maturity models that are analyzed.	Incorporating other forms of data, data quality monitoring, real world cases of in-memory analytics, shifting from heuristics to data-driven decision making, and the positive effect BDA has on performance are a few suggestions for later research.
(Brown et al., 2011)	Are you ready for the era of ‘big data’	The purpose is to evaluate the impact and questions of big data use in enterprises.	The article outlines five big questions for big data that managers should be considering.	N/A
(Govindan, Cheng, Mishra, & Shukla, 2018)	Big data analytics and application for logistics and supply chain management	The goal is to examine fresh approaches, practices, and prospects for big data analytics and implementations in logistics and supply chain management.	The Scopus databases were utilized to look through several forms of information on BDA. 313 pieces were considered and a few are highlighted and discussed.	N/A
(Kaur & Singh, 2018)	Heuristic modeling for sustainable procurement and logistics in a supply chain using big data	This study provides a supply chain obtainment and logistics model that is ecologically friendly.	Mixed Integer Non Linear Program and Mixed Integer Linear Program models were utilized with real time parameters. A heuristic is applied to solve the large big data problems.	Different heuristic approaches might be applied in later work. The model could be extended for stochastic parameters or to consider late deliveries and shortages for later research.
(Lui & Yi, 2017)	Pricing policies of green supply chain considering targeted advertising and product green degree in the Big Data environment	The goal is to investigate the pricing strategies of a green supply in the Big Data environment, taking into account targeted advertising input and product greening expenses. This study provided theoretical recommendations on pricing strategies for green supply chain members in the Big Data context, taking into account targeted advertising and product green degree.	Based on the Stackelberg and Nash Equilibrium game theories, four game circumstances were provided, and the price change trends with the green degree and the input amount of targeted advertising were investigated.	Green supply chain pricing strategies should be investigated in the future using a multi-channel green supply chain or a multi-stage supply chain. A two-stage green supply chain comprising a green supplier and a green manufacturer should also be considered next.
(Mishra, Gunasekaran, Papadopoulos, & Childe, 2018)	Big Data and supply chain management: a review and bibliometric analysis	This research examines the literature on Big Data and Supply Chain Management dating back to 2006 and uses bibliometric and network analysis approaches to offer a full understanding of the area.	286 articles are assessed and compared using citations and PageRank. Six research areas are developed to evaluate challenges and future research.	Future research is suggested for each of the six clusters: "Conceptualisation of Big Data and analytics", "Big Data and SCM", "Big Data tools and algorithms", "Big Data applications in healthcare", "Big Data and forecasting", and "Data mining and applications."
(Nguyen, Zhou, Spiegler, Leromonachou, & Lin, 2018)	Big data analytics in supply chain management: A state-of-the-art literature review	This study presents a new categorization structure that gives a complete picture of the current literature on where and how big data analytics has been used in the context of supply chain management.	A new framework for classification is introduced and addresses how big data analytics is applied to the supply chain, the level of big data is used, the types of big data analytics models used, and big data analytics techniques.	This paper proposes multiple further research opportunities including SC functional level research, horizontal BDA-driven SC integration, combining analytic techniques for a better model, and more.
(Wamba et al., 2015)	How ‘big data’ can make big impact: Findings from a systematic review and a longitudinal case study	This research proposes an interpretative framework that explores the definitional viewpoints and uses of big data, based on a systematic review and case study findings. The report also includes a taxonomy that may be used to better comprehend big data and its role in generating business value.	First, a thorough review of previous literature and articles involving big data is conducted. Then, a case study is conducted for an Australian state emergency service.	Further research is suggested in big data’s role in organizational performance to reach a competitive advantage.

Figure 7: GSCM-Big Data in Green Supply Chain

4 Conclusion, limitations, and direction for future research

The paper summarizes the highlights of this study based on three main observations made about the field of green supply chain. The first observation is the exponential growth of the field has seen over the years. Analyzing the number of published papers and observing the annual changes, Gong, et al., (2019)[18] shows that from 2007 to 2018, the number of documents increased year on year from 14 articles in 2007 to 367 in 2018. With an average annual volume of publications increased by 58.83% with an average annual growth rate of 45.51%, we can see that the field of GSCM has exploded and will continue to do so as the combination

of rising concerns about climate change, resource depletion and a push from regulators are coming into the forefront.

As the study highlights, green supply chain management, which integrates environmental issues into supply chain management, has been increasingly implemented by more and more organizations, thus with the exponential growth and attention we have seen in the field has spread to over disciplines. No longer does the topic belong to one single domain such as supply chain and operations, it has found itself crossing into other disciplines like economics, business strategy, production, and manufacturing.

While there was a relative concentration of literature reviews and other documents introducing in the topic of GSCM, the field has since matured and therefore authors have begun to explore more sub-disciplines of green supply chain management expanding the work in a variety of areas such as multi-objective, mathematical optimization modeling and even trying to incorporate big data in supply chain. This trend will likely grow as those who integrate environmental issues into their domains, not only tackle the looming climate concerns but can also find that GSCM practices have a positive influence on efficiency and profitability [3].

As for limitations, our study only includes articles from 2004-2021; this gave our study a good look into the area of green supply chain, however, it is understood that the inclusion of other databases would have yielded a greater number of articles to which we could have observed and categorized.

Additionally, during the late 1980s and early 1990s, the concepts of supply chain management and environmental management as strategic organizational practices for gaining competitive advantage received increased attention. However, the relative importance of these strategic practices can be easily traced back to the early periods of the environmental management movement of the late 1960s [48]. Thereby, future studies in this area should expand the length of time observed to include publications from 1960 to 2021 (present). Furthermore, publication types were limited to articles for the scope of this study however the inclusion of other publication types (books, dissertations, reports etc.) would simply help make the same assertions we have made but with greater confidence.

The rise of global warming awareness with constricting time has caused an increased pressure on firms to improve their sustainability practices, including in their supply chain management. Although growing, there is still a large space for GSCM research development. The solid foundation of research that has already been conducted in the field has paved the way for strong additional research, including the optimization categories developed in this paper. Aside from further research from our limitations, three opportunities in the field are suggested.

First, along with the rise of GSCM research, big data research in supply chain management has also been increasingly studied. Although this paper highlights a few articles that connect the two, the space is generally sparse and holds strong potential for future research. This paper finds the need for research that uses a larger data set, specifically expanding out of individual region, industry, or company's scope to more confidently test the validity of GSCM methodology validity.

Second, as the baseline for GSCM research has become more set, it will be important moving forward to the supply chain as a whole instead of individual aspects. This will allow for the different subcategories researched to be incorporated to the larger picture. By doing this, testing demand, relationships, procedures, and practices of the whole will account for further research.

Third, multi-scale modeling poses challenges in terms of modeling, optimization, and uncertainty, particularly as supply chains become larger and more interconnected. Future supply chain design and optimization models must account for several spatial and temporal scales, posing modeling and optimization challenges. Uncertainties exist at all scales within a supply chain, and they also must be appropriately modeled. Addressing the design and optimization of all scales of a supply chain results in significant algorithmic and computational challenges that must be addressed. Large-scale integrated models or surrogate models have been proposed as possible methods to handle these complexities. Better interventions and models for a vari-

ety of economic, environmental, and social goals would be needed for multi-objective supply chain design. In the multi-objective modeling and optimization of supply chains, life cycle-based optimization approaches were shown to be a viable option.

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A NEW MULTIPLE CRITERIA TWO-STAGE NETWORK DEA MODEL: AN APPLICATION TO BIOMASS-BIOFUEL LOGISTICS

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ABSTRACT

The two-stage network data envelopment analysis (TSN-DEA) has been extensively applied to measure the overall efficiency score for the decision-making units (DMUs) with a two-stage network process. But the TSN-DEA's frequent inconsistency in generating efficiency scores makes it challenging for decision-makers to select the most efficient DMUs. This paper proposes a new procedure of using a multi-objective programming model to evaluate DMUs consistently. We exhibit the applicability of the proposed approach through the biomass-biofuel logistics network (BBLN) design problem. A case study demonstrates that the proposed method identifies the efficient BBLN schemes more consistently than the traditional TSN-DEA.

KEYWORDS: Two-Stage Network, Data Envelopment Analysis, Efficiency Score, Decision Making Unit, Multiple Criteria, Biomass-Biofuel Logistics Network

INTRODUCTION

Data Envelopment Analysis (DEA) methods have been widely accepted to identify and separate efficient DMUs from inefficient ones. On the contrary, the efficient decision-making units (DMUs) with a perfect efficiency score (ES) of 1.000 for the single-stage classical DEA (C-DEA) model will always have an ES of 1, regardless of the less efficient DMUs in the reference sets. In other words, the ES of efficient DMUs in the C-DEA model would not change whether inefficient DMUs are evaluated together with efficient DMUs (see Zhu, 2014). For the single-stage (SS), the C-DEA was first introduced by Charnes et al. (1978) to assess the efficiency of a set of DMUs that consume multiple inputs to generate various outputs. But the C-DEA intrinsically aims to identify efficient DMUs and the efficient frontier, so its use has been proved to be insufficient for discriminating between efficient DMUs. But the two-stage network DEA (TSN-DEA) frequently generates inconsistent ES, depending on the DMUs in the reference set. Thus, the rankings generated by TSN-DEA often confuse decision-makers when the top-rated DMUs should be identified.

Sexton et al. (1986) propose a cross-evaluation concept for peer evaluation rather than the C-DEA's pure self-evaluation. Doyle and Green (1994) suggest a cross-evaluation matrix for ranking the units by applying the cross-efficiency DEA (CE-DEA) model. Generally, the CE evaluation can provide a full ranking for the DMUs. But, as Doyle and Green (1994) note, the non-uniqueness of CE scores and non-consistent rankings have been critical issues for applying the CE-DEA. As the numbers of outputs and inputs increase, the problems of using C-DEA or CE-DEA will be apparent. Li and Reeves (1999) propose a multiple-criteria DEA (MC-DEA) model under multiple objective linear programming models. The MC-DEA model involves a broader definition of relative efficiency than the classical one introduced by Charnes et al. (1978). They (1999) claim that efficiency criteria, more restrictive than the C-DEA, will yield fewer efficient DMUs and allow less input/output weight distribution flexibility. However, they do not explain how to rank DMUs if several DMUs under evaluation are efficient.

This paper follows Hong's work (2021) for the single-stage network process, which applies multiple criteria DEA by transforming the original DMUs into the new simpler DMUs with two inputs and a single output, regardless of the numbers of inputs and outputs that the original DMUs use and produce. We transform the two-stage network (TSN) system into a single-stage system so that several DEA-based methods can be

applied to evaluate and identify efficient ones. Using the biomass-biofuel logistics (BBL) system that can be modeled as the TSN process, this study checks if the proposed method assesses the efficiency of DMUs more accurately and ranks DMUs more consistently than the traditional TSN-DEA method.

EVALUATION PROCEDURE

As mentioned before, Hong (2021) proposes transforming DMUs with the TSN process into the DMUs of the single-stage network process. This paper extends Hong's procedure to the TNS process. See Figure 1. Once DMUs under evaluation are transformed by the multiple criteria DEA (MC-DEA) method, the two popular DEA methods, CE-DEA and SE-DEA, are applied to rate DMUs. The main idea of cross-efficiency DEA is to use DEA to do peer evaluation rather than pure self-evaluation. Phase I, the self-evaluation phase, is where DEA scores are calculated. In Phase II, the weights/multipliers arising from Phase I are applied to all DMUs to get the cross-efficiency score (CES) for each DMU. In Phase I, let $E_{\omega\omega}$ represent the DEA score for DMU $_{\omega}$, the ω^{th} option generated by the MOP model in (18)-(25), which is obtained from the following LP model:

$$\text{subject to} \quad \begin{aligned} \text{Max } E_{\omega\omega} &= u_{\omega} \theta_{\omega}^{cen}. \end{aligned} \tag{1}$$

$$v_{1\omega} M_{\omega} + v_{2\omega} D_{\omega} = 1, \tag{2}$$

$$u_{\omega} \theta_j^{cen} - [v_{1\omega} M_j + v_{2\omega} D_j] \leq 0, \forall j, \tag{3}$$

$$u_{\omega}, v_{i\omega} \geq 0, i = 1, 2.$$

The CE of DMU $_j$ called a rated DMU, using the weights that DMU $_{\omega}$ has chosen in the model by (1)-(3), is given by

$$E_{\omega j} = \frac{u_{\omega} \theta_j^{cen}}{[v_{1\omega} M_j + v_{2\omega} D_j]}, \quad \omega \text{ and } j = 1, \dots, \Omega, \omega \neq j. \tag{4}$$

DMU $_{\omega}$ is called a rating DMU in (4). Then, Doyle and Green (1994) use Eq. (4) to set up the CE matrix that consists of the self-evaluation value, $E_{\omega\omega}$, in the leading diagonal and peer-evaluation value, $E_{\omega j}$, in the non-diagonals. By averaging $E_{\omega j}$ in (4), the CES for DMU $_j$ is defined as

$$CE_j = \frac{1}{\Omega} \sum_{\omega=1}^{\Omega} E_{\omega j}. \tag{5}$$

The idea of super-efficiency (SE) is that a DMU under evaluation is not included in the reference set of the C-DEA model and then with its inclusion. Notably, the SE-DEA model has significance for discriminating among efficient DMUs. Now SE score (SES) for DMU $_{\omega}$ is obtained from

$$\text{Max } SE_{\omega} = \mu_{\omega} \theta_{\omega}^{cen}. \tag{6}$$

subject to

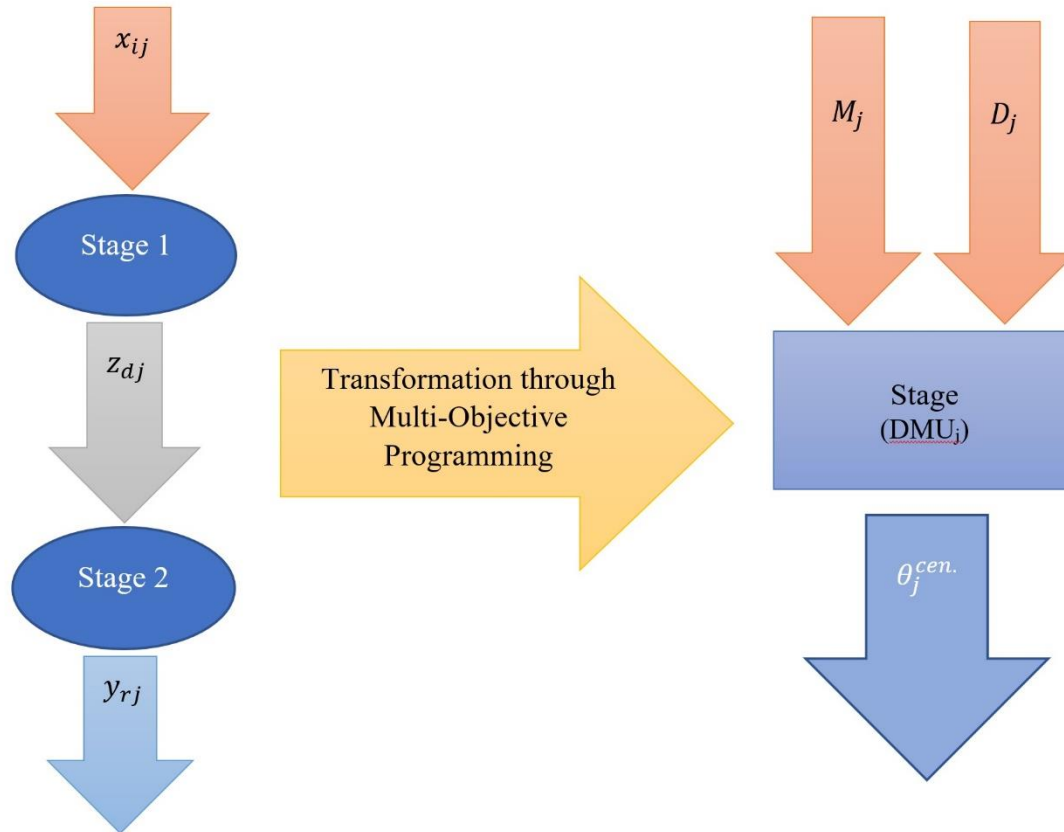
$$v_{1\omega} M_{\omega} + v_{2\omega} D_{\omega} = 1, \tag{7}$$

$$\mu_{\omega} \theta_j^{cen} - [v_{1\omega} M_j + v_{2\omega} D_j] \leq 0, \forall j \text{ and } j \neq \omega, \tag{8}$$

$$\mu_{\omega}, v_{i\omega} \geq 0, i = 1, 2.$$

This study utilizes CES and SES for evaluating and ranking the transformed DMUs.

Figure 1: Transformation of DMU with TSN process into single-stage DMU



APPLICATION TO BIOMASS-BIOFUEL LOGISTICS

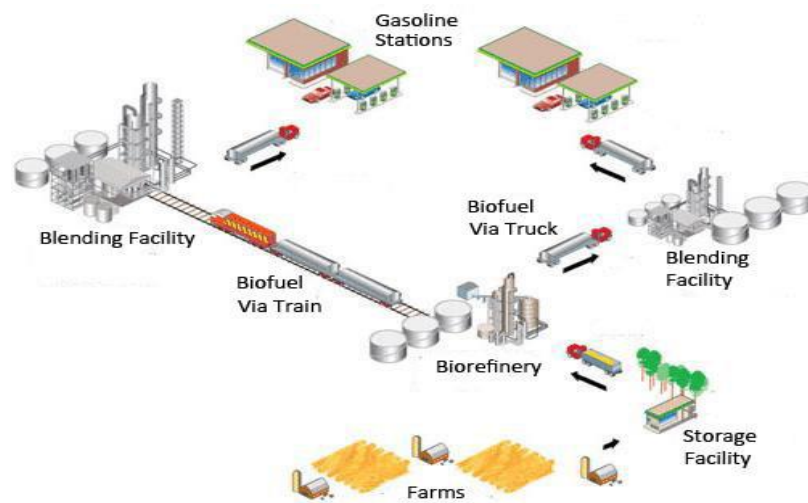
Biofuel has been considered a potential energy source and has gathered much attention. In this vein, Balaman and Selim (2015) emphasize that, in recent years, design, operation, and management issues in renewable energy supply chains are increasingly gaining importance in parallel with the rising interest in renewable energy sources. Balaman (2019) also stresses that developing integrated frameworks to design resilient and efficient supply chains should be one of the core priorities to boost this topic's research.

Most biomass-biofuel logistics network (BBLN) models in the references reviewed by Atashbar et al. (2018) have considered four types of biofuel-related facilities. They are a supply point – a farm or harvest site (HS), a storage point – a storage facility (SF), a production point – a biorefinery (BRF), and a demand point – a blending station (BS). Eksioğlu et al. (2009) consider the BBLN structure, depicted in Figure 2. An SF is a potential site to store and preprocess pre-treat biomass to make a better-quality biomass feedstock and/or biomass stocks to a more valuable density to transport more cost-effectively. Direct transportation of biomass from an HS to a BRF is allowed. The direct transportation cost is usually higher than going through the SF since the immediate shipping of biomass from an HS to the BRF requires more storage space and

operations and preparation to be processed into biofuel. See van Dyken et al. (2010). Thus, the conversion rates to biofuel of biomass feedstocks shipped from SF to BRF are usually higher than those for biomass feedstocks imported from HS to BRF. Biofuel is transported from BRFs to BSs to be blended with gasoline and then distributed to gas stations. When the locations of BSs and their demands are given, transportation costs mainly depend on the capacity of BRFs and the proximity of BRFs to BSs.

Following Hong's model (2020), which considers EPA-tracked sites and candidate sites for biofuel facilities (See Figure 3, 2015), this study finds multiple objectives as primary performance metrics, applying the goal programming (GP) model to accommodate these multiple objectives in a single objective function. Solving the GP model for a given weight set assigned to those multiple goals would generate a scheme/option of BBLN. The number of schemes created by the GP model depends on the number of weight sets. Then, we apply DEA methods to evaluate and eventually identify efficient BBLN strategies.

Figure 2: Schematic of the biofuel logistics



Designing the BBLN could be viewed as a two-stage network process. The total cost and demand-weighted covered distance are the inputs to the first stage, generating the amount of collected biomass feedstocks. The output from the first stage becomes an input to the second stage to produce the two outputs, the amount of biofuel production and a population free of air pollution generated by the BRFs. In the first stage, the amount of collected biomass feedstocks is measured using the total logistics cost, the maximum demand weighted coverage distance, and the outputs are the expected amount of biomass feedstocks. In the second stage, the expected amount of biomass feedstocks delivered to the BRFs, the expected amount of biomass feedstocks are then used as an input, while the expected amount of biofuel production and pollution-free score are used as outputs. The proposed multiple criteria TSN DEA method is applied to identify efficient ones from those schemes generated by solving the GP for various values of the weight set.

After evaluating 1,001 BBLN configurations generated by the GP model, we consolidate these configurations to 319 DMUs. By applying the MC-DEA method, 319 DMUs with TSN process are transformed into the DMUs with the SSN process. The two DEA methods, CE-DEA and SE-DEA, are applied to identify the most efficient BBLN, as depicted in Figure 4. In Figure 4, a black solid arrow line represents a shipment of biomass from an HS to an SF, a green solid arrow line a direct shipment from an HS to a BRF, and a golden arrow line a shipment from an SF to a BRF, while a dotted arrow line indicates a shipment of biofuel from a BRF to a BS.

Figure 3: EPA tracked sites and candidate sites for biofuel facilities.

EPA Tracked Sites in South Carolina with Biorefinery Facility Siting Potential

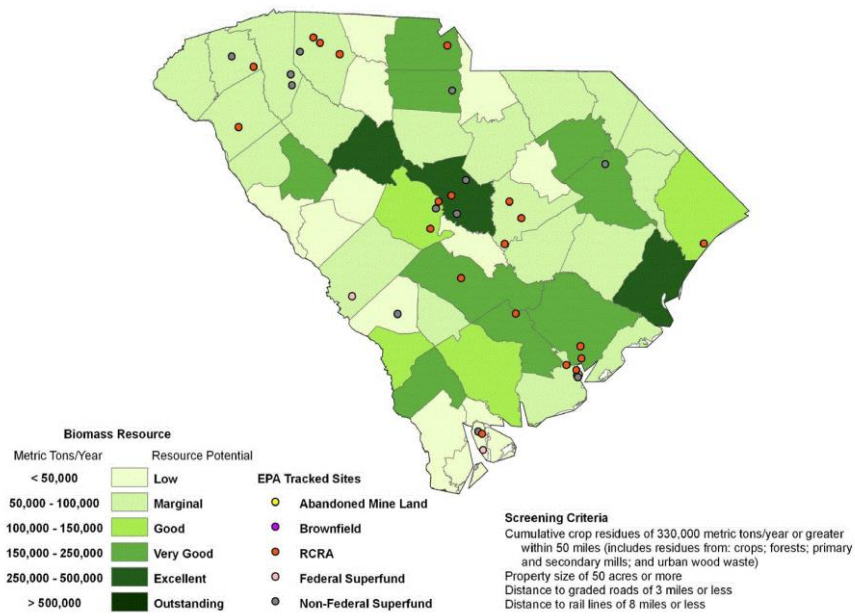
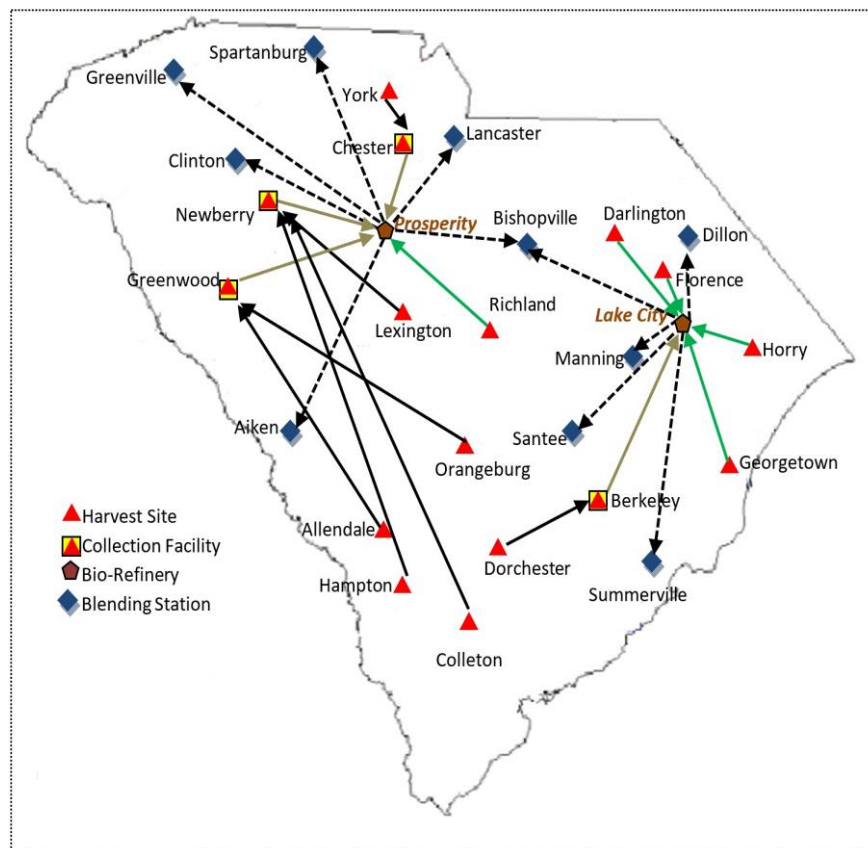


Figure 4: The most efficient biofuel logistics network



SUMMARY AND CONCLUSIONS

This paper proposes a new procedure for evaluating the DMUs in the TSN process, applying the multiple-criteria DEA (MC-DEA) method to TSN formulation through the multi-objective programming model. This procedure transforms the TSN process into a single-stage process so that the two most popular single-stage DEA methods, such as the cross-efficiency (CE) and the super-efficiency (SE) methods, can be applied to rank the DMUs in the TSN process. This paper uses the proposed method for designing efficient and robust biomass-biofuel logistics networks (BBLNs). Contrary to the traditional logistics network models focusing primarily on cost-efficiency or revenue-efficiency, five (5) performance measures are considered simultaneously to design balanced BBLNs. A goal programming (GP) technique is applied. Solving the GP model with multiple values of the weights assigned to each performance measure offers decision-makers various BBLN alternatives or schemes. Through a case study for the design of BBLN, the applicability of the proposed transformation approach is demonstrated.

The proposed transformation method performs well, compensating for the traditional TSN DEA method's critical weaknesses. Specifically, this procedure identifies the highly ranked DMUs more consistently than the conventional TSN method. Besides, the transformation method might reveal different BBLN schemes for designing supply chain schemes, which could be more efficient and robust than traditional TSN DEA alone. Thus, the proposed method could help the decision-makers identify biorefinery's robust locations, which usually require enormous investments. Furthermore, recognizing the efficient and robust BBLNs through the proposed procedure would appeal to potential investors interested in investing in the biomass and biofuel industry when gasoline fuel prices are expected to keep rising for many future reasons.

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A Qualitative Analysis of eDiscovery Workflows Using the Customer Service Theory

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Abstract

The current eDiscovery Reference Model (EDRM) follows the same process that document review professionals adhered to prior to the advent of automated review platforms. Items are preserved, collected, reviewed, produced, and presented. The only difference now is that people are not reviewing paper anymore. The modern eDiscovery Services Provider models their business around the EDRM without considering the vast amount of valuable information that can be harnessed from the very sources they are collecting data from for review. This paper explores a more effective workflow for litigation support professionals to adhere to when conducting audits, employee misbehavior inquires, lawsuits, Intellectual Property Theft Investigations, or any other eDiscovery function. Under the current model, the skills of highly trained and experienced cyber-forensic examiners are only leveraged for the collection and culling of documents and emails from endpoints in which customers have every legal right to collect all forms of data from. Instead of collecting, culling, and processing, we propose implementing the skills of examiners to find and parse web browser history, USB connection activity, and other user assisted actions in conjunction with ongoing document review efforts. The proposed improvement of the current process will help customers acquire valuable data faster, help eDiscovery service providers increase revenue, and help improve the skills of the cybersecurity professionals already working for said service providers.

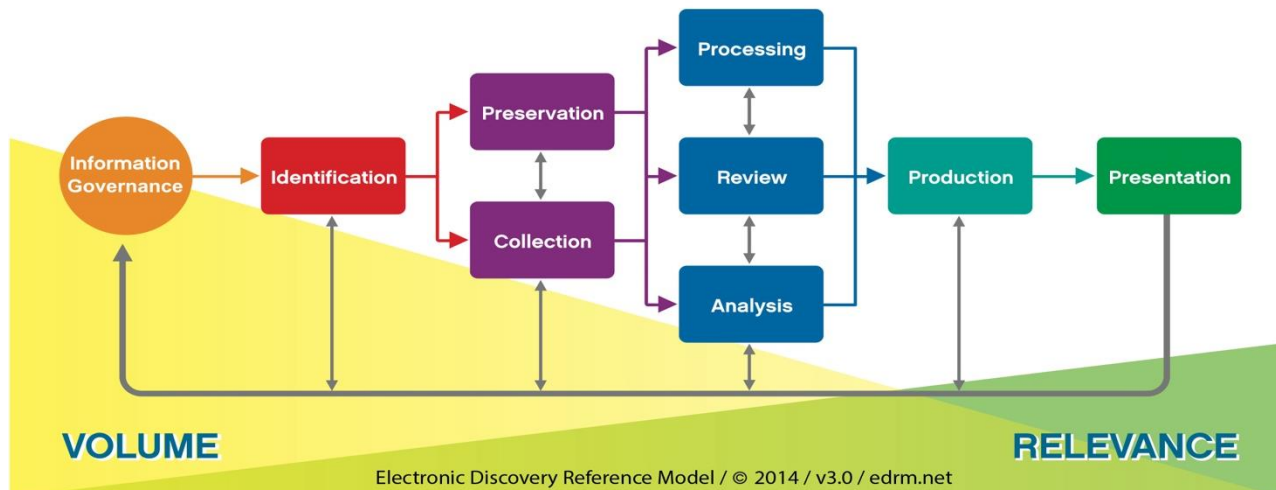
Introduction

Customer service theory explains how to attract customers and keep them with the business and foster personalized, competent, convenient, and proactive service. Electronic Discovery (eDiscovery) can be defined as the identification, collection, and production of Electronically Stored Information (ESI) in response to a request for production in a lawsuit, investigation, second request, and other procedures. *Zubulake v. UBS Warburg LLC, 2004* sprung some of the first set of standards to be adhered to related to eDiscovery. Details pertaining to the case will be discussed further. But the biggest takeaway from this case is the eventual amendment to the Federal Rules of Civil Procedure regarding eDiscovery. The case also gave rise to the (still) booming business of eDiscovery consulting, data processing, hosting, and assisted review (de St. Aubin, 2013). eDiscovery firms advise on the preservation of data pertaining to a given legal process, conduct the collection of said data, cull out non-responsive data, process it, and host it for review. The collection and processing of the data will be the main topic of this paper.

Collections are conducted by some of the best trained (and overworked) cybersecurity professionals in the world. The full spectrum of data that a party is entitled to collect from an opposing party in a civil suit isn't even looked at because of the lack of implementation of those

collection experts. The experts we speak of go by Digital Forensic Examiners, Forensic Analysts, Computer Forensic Analysts, Cyber Forensic Examiners, or (as we refer to each other) Examiners. The purpose of this paper is to propose a revised workflow for eDiscovery that better leverages the capabilities of these people to help produce more meaningful results for customers, as well as evolve the data collection divisions of eDiscovery to make them a worthwhile “profit center” as opposed to a “cost center”. We will go over the current process of eDiscovery procedures, the general workflow adhered to by Digital Forensic Examiners, and the proposed guideline for eDiscovery firms around the world to adhere to.

II. The eDiscovery Reference Model



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The current process for eDiscovery usually starts with a lawsuit. Some entity somewhere files a grievance with another. As one would expect, the issues are handled by attorneys representing said entities. In most cases both law firms have preferred eDiscovery service providers. Both parties will negotiate whose service provider will handle the collection and processing. They may agree to share the same environment for document review, or the entity producing the data may decide to conduct a privileged review on their end before delivering their data in bulk to the opposing party. In other matters, both parties may be subject to discovery. The eDiscovery service provider may be conducting collections and hosting data for both. Either way, for the most part, the process follows the eDiscovery Reference Model (EDRM) from inception to project completion (EDRM model 2020).

Current Methodologies

The EDRM isn't a legislation-prescribed process to be adhered to during discovery, but it does draw inspiration from the Federal Rules for Civil Procedure. It's more of a guideline that eDiscovery professionals try to follow to best meet customer requirements in accordance with compliance standards. The EDRM presents eight phases during eDiscovery Operations: Data Identification, Collection, Processing, Review, Analysis, Production, and Presentation (EDRM model 2020).

Information Governance

Although some in the industry refer to this as the “most important phase in the EDRM process”, Information Governance (IG) is *not* an actual phase of the EDRM process, and I'm not

including it as such. However, it's worth mentioning that this whole process falls under the umbrella of IG. Information Governance is a concept which encompasses the strategic management of all elements of the data life cycle. To include how data is stored and where, how it will be protected, the policies and procedures related to its retention and destruction, as well as who and how it will be collected in the event of litigation (Grama, 2022). Again, not a phase in the process. But an all-too-common occurrence in this process is for an eDiscovery service provider to begin the process of advising a customer on the preservation of data, only to learn that no one has the slightest clue where their data is being stored, or if any of it has been deleted. A topic that will be discussed further in the recommendations section

Identification

During a lawsuit, an organization will receive a notice listing all the types of records that will require preservation. The organization will then be legally obligated to preserve said data. The organization being sued, or the opposing party will dispatch legal teams to conduct interviews and other activities to help determine what types of data will be responsive for said legal action. An interesting point to note is that Forensic Examiners are *never* included in this conversation. And WEdo mean NEVER. They aren't even contacted until the Collection phase (we'll get to that later as well). Once it's clear what is needed, actions are then taken to lock that data in place.

Preservation

Be it a preservation order from the court, or an organization's own general counsel placing data on legal hold; during the preservation phase of the EDRM, practitioners (usually working for an organization's Information Assurance Office) will take technical or physical actions to ensure that identified data is preserved in its exact form for immediate or eventual collection. Remember, Data Retention policies and Data Destruction policies are both integral parts of Information Governance. Most records (in an organization that has an established Information Governance program) follow a life cycle that ends with destruction (Grama, 2022). Placing an item on Legal Hold basically tells the technical experts of that organization's Information Management program to pull that data out of its natural life cycle and preserve it until further notice.

Collection

It may come as a surprise for some, but there isn't a phase in this model that presents as many problems, requires as much technical expertise, and demands as much commitment and collaboration than this one phase. As suggested earlier, in many instances, organizations do not have any Information Governance programs in place, no one has taken the time to identify relevant data or (believe it or not) preserve it. Data sources may be locked up in encrypted storage containers requiring constant collaboration with the organization's IT Departments, who are more often than not either stretched thin with their own priorities or haven't the slightest clue how an organization's data is being organized in the systems they manage. Then there's the matter of collecting from mobile devices. Automatic updates to mobile phones occur monthly (Lustosa, 2018). Every time a phone updates it can imply a complete rearrangement in how examiners collect data, or worse, whether or not they can collect it. It isn't uncommon for a customer to wait 4-6 hours for their phone to collect only to find out that the manner in which data was collected from their phones did not capture the needed artifacts for the relevant data to

be indexed, or that the data the examiner collected rests in an encrypted backup container that the customer had unwittingly set a long-forgotten password for. Once all the expected (and unexpected) challenges faced in the collection phase have been mitigated, examiners will then hash all collected data (obtain a file's fingerprint at the exact state that it's in at the time of the collection), and begin the culling of system artifacts (non-user-generated data) in preparation for submission for processing.

Processing

Assuming all data submitted for processing fits the format required for processing, processing can then commence. Processing involves ingesting data and identifying its type (i.e., DOCX, PDF, XLSX, etc.). It's important to note that this doesn't mean the items are being identified by their extension. A file can easily have its extension changed by an end-user utilizing Windows without the need to even be an administrator. Every file has what's called a "header". When you ask your Operating System (OS) to open a file, your OS is directed to the file's location on your computer's hard drive. Once the location is identified, the first thing the system notes is the type of file its being expected to present to you; since this information is found at the beginning, or head of the file, it's called a header (this becomes important later). After that, any TIFF or PDF files have Optical Character Recognition (OCR) performed on them. As you may know, some PDFs and TIFFs are just documents that were scanned and saved to a computer. If the scanner used to perform this action doesn't have OCR built in to its system, the documents are being scanned in as photos (even if their file extension is showing you that it's a PDF). The individual characters (or letters, numbers, etc.) have to be identified by the processing software and indexed. Which brings us to the next and final step in processing: Indexing. Indexing data is what makes searching possible. Indexing means your software is creating an "Index" of every individual character and groups of character contained in every single ingested document. This "index" is saved in the processing job's case file. When review commences, anytime someone searches for a word or group of words in the software's interface, it references the casefile's index. If the phrase is found, it pulls the source out of a repository housing a copy of the processed data and presents the results to the interface. Which brings us to the next phase...

Review

This is the most time consuming, costly, and error-prone phase of the EDRM (Beumer, 2020). Although it's supposed to be conducted by attorneys and/or paralegals, its mostly conducted by scores of inexperienced High School Diploma-wielding \$15/hour contractors working under the "tutelage" of one or two Review Attorneys. This phase consists of manually culling out irrelevant user-generated documents and emails, redacting Personal Identifiable Information (PII), redacting any other forms of data that both opposing legal teams agree on redacting, and of course, identifying documents relevant to the matter at hand. Note: depending on data size and complexity, this phase may take months, or even years to complete. We are personally hosting data that a group of investigators have been reviewing since October of 2019, and that example doesn't exemplify the upper ranges of the time it takes to review data in the world of eDiscovery.

Analysis

A common phrase in the eDiscovery field is "Analysis is ongoing". Meaning that

throughout every component of the EDRM involves some form of analysis. The analysis consists of cross-referencing responsive items from different data sources, correlating clues, identifying patterns, discussing evidence obtained during custodian interviews, and other investigative actions.

Production

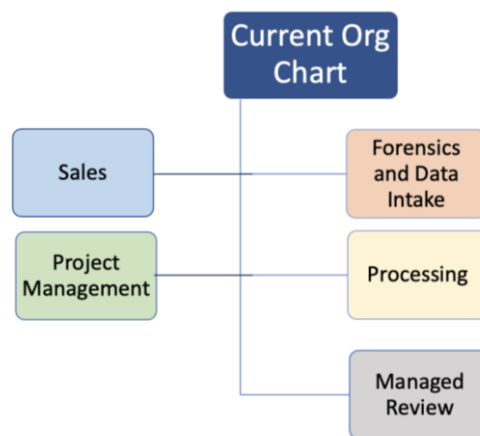
Once evidence has been identified, stakeholders need to agree on the best way to produce it. All data needs to be produced in a defensible matter that considers the strong possibility that opposing counsel will attempt to question the data's authenticity. Considerations for how data will be presented has to be taken into account as well. A common request from attorneys is to have data produced as PDFs. Easier said than done when producing data found in the (for example) 50th column of the 17th table of an excel spreadsheet, or producing evidence obtained from a conversation in a proprietary company messaging system. Data such as those examples do not really translate well in a PDF. A practitioner can expect the Production phase to look more like a trial-and-error effort.

Presentation

Finally, everything in a legal proceeding must eventually be presented in trial or deposition. After all the evidence has been analyzed and produced, it has to be presented in a manner that does not leave room for questioning its authenticity. The presentation phase outlines a brief overview of the process taken to obtain the presented data, along with the analysis's conclusion.

Current Structure

My Org Charts will not include Executive departments, Administrative, Human Resources, or other Non-Operational sections of a given eDiscovery firm. Although essential, my proposed changes to the current guidelines focus on the sections that manage data.



-Sales

Sales representatives working for eDiscovery companies maintain relationships with law firms that follow them throughout their whole careers. Sales reps are usually paid a salary plus a 5 to 15 percent commission (Rimbey, 2021). Some eDiscovery customers use the same service provider for ongoing hosting subscriptions that can last for several years. In instances like that, sales reps can continue receiving commissions for those subscriptions for as long as the customer remains subscribed. Sales Reps will join in on the kickoff call then let Project Managers handle

the rest of the matter. Sales Reps are responsible for submitting invoices for billing. Any removal of hours billed by belligerent departments usually needs to get approved by executive management. As a norm, only Sales Reps receive commission for billed consulting hours and charges incurred while processing and hosting data.

-TPM

Technical Project Management (TPM) departments oversee eDiscovery Operations from inception to project completion. They schedule all calls, are responsible for ensuring project timelines are being met, oversee the transfer of data throughout every phase of the EDRM, and submit billed hours and charges from all departments to Sales for final invoicing. Outside of Reviewing, Technical Project Management usually bills the greatest amount of consulting hours during eDiscovery projects.

-Forensics and Intake

Forensic Departments are responsible for the defensible collection of data for eDiscovery projects. Collections may be conducted remotely, or in person. Examiners are expected to be able to travel at a moment's notice to collect data as quick as possible for ongoing operations. They must be able to work independently, without any supervision. On the ground, environments during collections can get hostile. Examiners are sometimes hired by opposing counsel to the individuals submitting data for discovery. Roadblocks to capturing data are expected and occur frequently. A good examiner is both technically proficient and customer-facing (a difficult combination to find in this field). An Examiner usually partakes in the initial Kickoff call with the customer and is expected to immediately decide if the data needing collecting can be collected with the resources available to the company (with potentially dire consequences for getting the answer wrong). An Examiner is then expected to partake in project scoping calls. The purpose of the scoping call is to gain an understanding of the total number data sources needed to collect information from all hardware configurations. During collections, they're expected to consistently update the Project Manager of the collection status (who is usually being consistently pressed for updates by the customer). Examiners maintain the chain of custody for evidence submitted for imaging, as well as prepare data for processing. Any data that does not meet the needed format for processing needs to be configured by the forensics department to meet the needs of the processing department. The structure of forensics departments varies from firm to firm. Some eDiscovery firms double as Cybersecurity/Risk consulting companies. In companies such as those, Examiners will wear "dual hats": serving as Incident Response Experts, and Digital Forensic Collection personnel. Some companies group their Data Intake departments with their Forensics and Digital Investigations departments. In instances where a forensic collection is deemed unnecessary, or other situations where data is just transferred to eDiscovery companies in masse for processing, Data Intake teams are responsible for downloading said data and transferring it to Processing Departments. As you can probably deduce, this is where roles and responsibilities get muddled. At times, Project Managers take the role of a secretary; scheduling calls between the examiner and the customer, duplicating efforts through the copy and paste of updates, and redoing scoping efforts as examiners gain a better understanding of the situation on the ground. There are occasions (though limited) when an examiner will be asked to perform an analysis on a collected endpoint and report findings to the customer directly, and even asked to generate official affidavits. The line between Project Manager, Digital Forensic Examiner, and Data Intake Specialist gets blurred depending on the given the project. The bulk of my proposed changes will focus on the efforts conducted by this department.

-Processing

The processing department of an eDiscovery Service Provider is the heart of the entire operation. An eDiscovery firm's entire business model hinges on the In/Out processing of data. As in, a negotiated price per Megabyte for data ingested, and a negotiated price per Megabyte for the amount of data that is exported and transferred back to the customer after processing. If the customer requires that data be hosted for review by the firm, the processing department will configure space on the company's servers for the data and provide the project manager login credentials to give to the customer for access to the portal, in order to commence reviewing data. If data fails to ingest, if custodian names are mismatching, or if items are encrypted, or if just about anything is wrong with the data during ingestion, the processing team notifies the Project Manager. The project manager then notifies forensics (note the extra step here). Forensics decides if the data will require recollecting, decryption operations, or if other refinements are necessary. Be it Nuix, Relativity, Ringtail, Discovery Attender, Intella, Relativity's interface with Nuix's engine, eDiscovery firms will base their entire operations around a brand of eDiscovery processing software. An eDiscovery Processing team member's day-to-day operations revolve around manually assigning custodian names to data sets and processing it, troubleshooting bugs in locally installed instances of whatever software their company considers themselves a "vendor" for, keeping the software updated, and keeping the systems they're run on operational.

-Managed Review

The Managed Review department of an eDiscovery firm is tasked with the painstaking process of reviewing hundreds of thousands of documents and emails in search for parameters prescribed by the customer. They can be tasked with finding documents related to their matter for bookmarking and exports or tasked with redacting items that are not responsive. The majority of the review staff is contracted just for the duration of the matter they are currently working.

Gaps in the Current Process

1. Data Classification in Information Governance

As it goes for most elements of a given for-profit organization, no one wants to invest in policies that do not directly support efforts taken in profit centers. We have personally worked with several organizations being sued where no one in their executive team can even tell me what a "Business Record" is-much less how it differs from non-responsive data that does not require submission for discovery. If no one in the organization has received training on records management, no one will know what to archive, how to archive it, where to archive it, and most importantly what not to discard. If nothing is classified and properly stored, unnecessary amounts of time and resources are spent attempting to recover deleted data. Anything that can be collected will have to be collected in full. Tens of thousands of dollars will potentially be spent culling out nonresponsive data. And then another set of tens of thousands of dollars will then be spent paying document review attorneys to then manually redact items that are not business records.

2. Organizations still Self-Collecting

And its happening because they are not being scrutinized for doing so. Under advisement from the legal teams they hire, organizations being investigated or sued are plugging USBs into their work computers, copying/pasting business documents on to them, then

shipping the USBs to their attorneys' offices. They're self-collecting emails using Google Takeout, and self-collecting text messages from their cellphones using iTunes backups. And what's striking isn't that they're doing this, so much as how no one is faulting them for it. With standard collection rates ranging from \$200-\$300/hour (Cybertrust-It, 2020) one can understand why an organization already spending their holiday bonuses on attorney fees would opt out of having Forensic Examiners properly image data being requested for discovery. But case after case the only items of interest for attorneys seems to be the substance of the data. Not so much how it was collected. The problem with this is no one is asking about the integrity of this data. How do we know everything was collected? Even if the individuals self-collecting the data are making a good faith effort to do the right thing, how are they accounting for any errors that occur while they are doing so?

3. Overreliance on Traditional Discovery Methods

The only thing that's really changed in Discovery over the last 30 years is the vector used to view requested documents. Instead of requesting paper business documents, legal teams or asking for electronic documents. Instead of hand written memos, legal teams are requesting emails. These methods are tried and true, and if law offices have found success in requesting them (on behalf of their customers) from opposing parties they should continue to do so. But it doesn't mean that they can't gain more from having technical experts review data from other sources. Not enough attention is being paid to document metadata and email headers. Across the board, legal teams have done a decent job over the last ten years requesting full images of computers but have fallen short in getting the most out of the data contained in those images. An overreliance on the standard workflow of (only) processing emails and documents leaves people oblivious to the fact that those methods are not capturing web browser history, cloud-hosted messaging systems, information about external storage devices that were used on the system, and other artifacts found on computers potentially containing vital information pertaining to their case.

4. eDiscovery Service Providers are not properly Leveraging their Forensics Teams

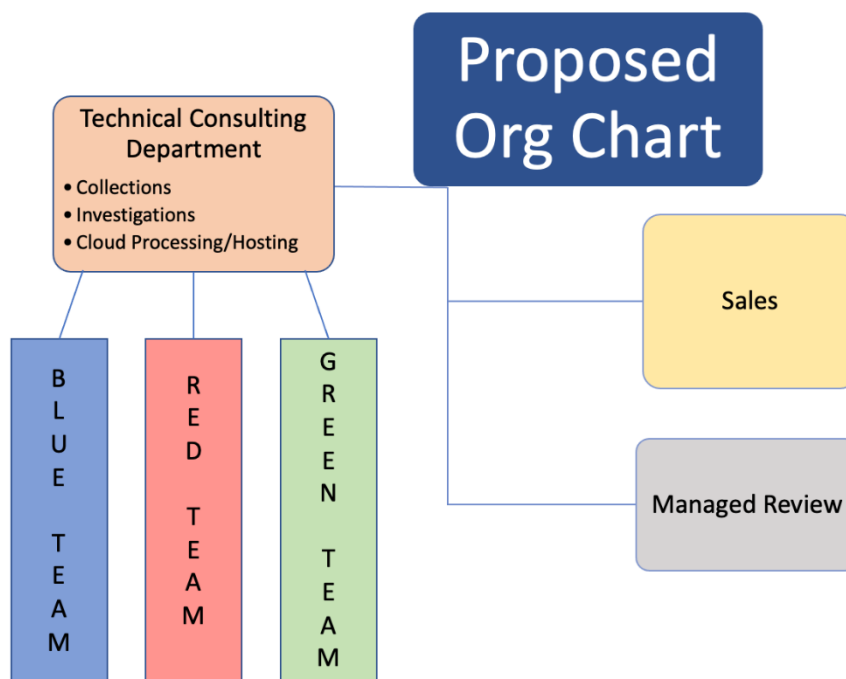
Digital Forensic Examiners are some of the highest paid, and technically skilled members in an eDiscovery company. The cost of retaining them in a market flooded with job openings for this high demand profession is usually significantly higher than the profits earned by their billable technical consulting hours. Due to this, forensics departments are often looked at as a cost of doing business in the eDiscovery field. The end-goal for an eDiscovery service provider is to get data processed. That's where you'll find the keystone to an eDiscovery service provider's business model. Customers get billed for both the cost of processing and the monthly cost of having the data hosted. If they require sets of eyes for assisted review, the customer is then billed for the hourly rate of Document Review Attorneys. Those are the traditional profit centers for an eDiscovery firm. Departments working anywhere else along the data's chain of custody are viewed as a cost centers. Regardless of whatever side of the courtroom hires the firm, eDiscovery Vendors are completely indifferent to whether either party in a dispute finds what their looking for in a given set of data. Often, the vendor won't even know what the outcome was for a case they hosted data for. The end results of these outdated workflows include customers paying upwards of hundreds of thousands of dollars to have review teams look

through endless amounts of collected data just to turn up empty handed, and Examiners working for those eDiscovery firms are burnt out trying to pump as much data as they can to get processed-while still feeling underutilized.

Proposed Improvements

My proposed workflow isn't meant to supplement the EDRM (although it can), it's meant to compliment the EDRM. It's meant to work alongside efforts taken by attorneys and reviewers. We will mention however, that my proposed process completely gets rid of the need for the traditional roles of Project Managers. My proposed workflow is better explained by first listing out structural changes to the usual eDiscovery Organizational Charts.

A. Proposed Structure



Sales

Its important to note that a Sales team usually falls under a department that includes marketing and account services. We are honing in on sales because eDiscovery projects usually stem from relationships that sales departments maintain and manage. The biggest change we propose involves the selling of a process vs a service (to be discussed further). The commissioning structure needs to be salary plus commissions. 20% commissions for up to the first full year of consistent data hosting. After the first year, commissions for an ongoing hosting project gets cut to 15%. Then 10% after third year on. Cutting the commission after the first and second year helps incentives finding more work. This will prevent having sales rep "coast" after securing a

large long-term hosting project. Maintaining the commission after the third year (instead of getting rid of it entirely like some firms do) encourages the sales rep maintain the relationship with the customer using the firm for long term hosting.

-Technical Consulting

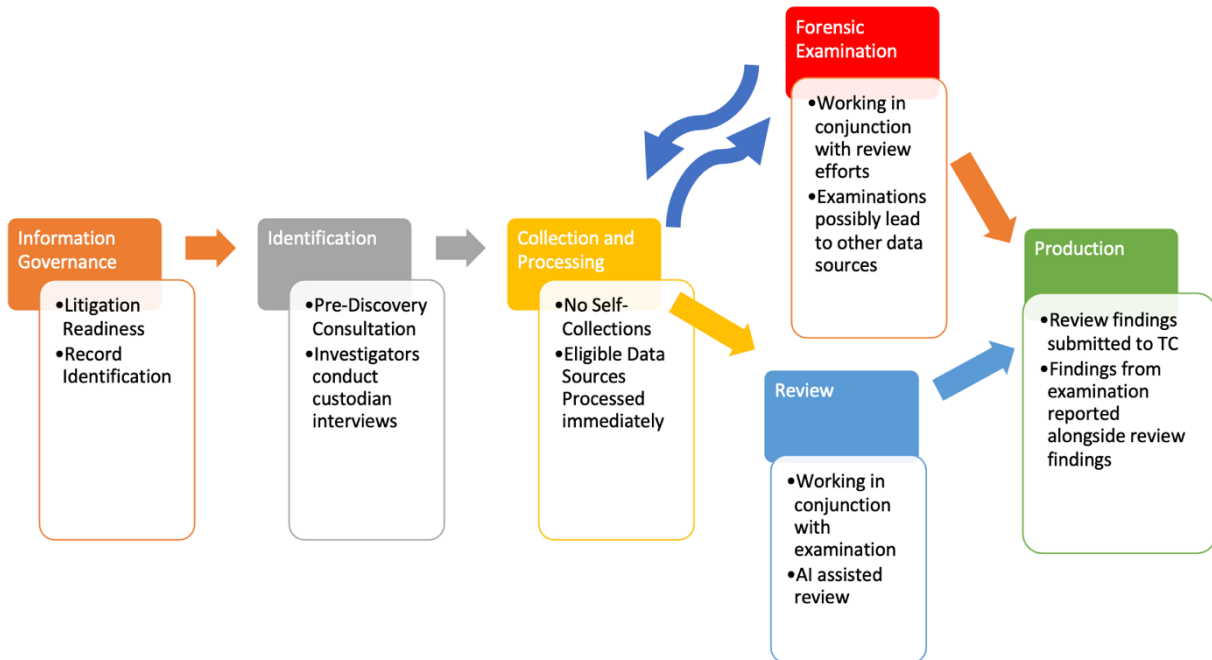
If “Processing” is the heart of eDiscovery right now, we propose this department take that mantle. The size of Technical Consulting teams as well as the number of teams can be scaled depending on the company’s size. For the sake of continuity, efforts should be taken to ensure that customers’ matters are handled by the same color team (reference figure 3). In essence, the Technical Consulting team will replace the need for the traditional role of Project Managers in the field of eDiscovery. Every single member of the Technical Consulting team will be a certified digital forensic examiner. Junior members of the team will manage Data Intake and handle their own uploads to cloud based processing software. Once the Intake Specialist has gained enough familiarity with the process, they will shadow examiners conducting collections. Collection Specialists will handle any form of collection that can’t be processed directly from the cloud-based processing program (to be discussed further). After several successful collections, collection specialists can begin shadowing investigations/examinations. Investigators will all have Private Investigator Licenses and will manage the full spectrum of eDiscovery projects using the improved workflow. The more experienced examiners will receive training in SQLite database reconstruction. This will be an integral part of the process. At this time there are about 1.96 million available applications on the apple Appstore and 2.87 million apps on the Google play store (Buildfire, 2021). It isn’t possible for digital forensic software to be able to parse every single type of messaging application an end user might employ in order to communicate. In order to keep up with the ever-changing nature of modern eDiscovery, eDiscovery firms need to have personnel on-hand able to reconstruct the databases collected from mobile devices. As stated previously, the Technical Consulting Team will leverage the use of cloud based processing systems. The need for an entire processing team used to manage on-premises servers is an outdated and expensive concept. Processing and hosting will be performed in the cloud exclusively. eDiscovery firms will simply subscribe to space in either Nuix or Relativity or any of the many cloud eDiscovery service providers offering the space and processors.

Managed Review

The most significant change in the workflow as it comes to manage review, will be the direct line of communication between reviewers and the forensics team. Instead of reporting issues like gaps in the provided information by the processed data to Project Managers, for them to then discuss with the customer’s legal team, the investigators in the Technical Consulting teams will be able to report gaps with advice on other avenues the team can take to find answers in their investigation using the wide range of knowledge they have in the field of data analysis. Another difference in this space will be the implementation of Artificial Intelligence (or Technology Assisted Review) to assist in the analysis of collected items.

B. Proposed Process

Information Governance



Litigation Readiness packages should include recommended improvements to existing document retention and document destruction policies. More importantly, everyone conducting business in a given organization needs to have updated and yearly records management training highlighting what a business document is and where its meant to be stored. Once Technical Consultants providing litigation readiness services gain an understanding of a customer's business document format, they can conduct Record Identification operations. Record ID is performed by deploying agents out to all of the endpoints in a business enterprise to then report back to a cloud based console with a listing of all files on the endpoints. There are several cloud-based software suites that offer this capability. They are used by cybersecurity professionals everyday to detect malicious files (G2, 2021). They can be leveraged to find business records. Trained cybersecurity professionals (already employed by eDiscovery firms as Forensic Examiners) can add conditions to scans to meet document specification that meet business record standards. Once an organization knows where data is, and has a plan for preserving and collect it, they can avoid taking systems out of commission during litigation, and potentially avoid fines.

Identification

The key to this phase of the improved EDRM lies in a solid understand of the process by the sales team. The concept that eDiscovery firms need to impress on their customers (Law Firms) is that they are not in the optimal position to gain an ideal level of understand of the data that should be requested from an opposing party for discovery. The digital landscape is continuously evolving. Windows updates the first Tuesday of every month (Fisher, 2021), and new messaging applications are either added to the Appstore or updated daily. Customers should not be waiting for the collection phase of the EDRM to learn of the vast number of potential data sources an examiner can collect data from. Technical Consultants should be present during custodian interviews during an investigation, if not conducting the interviews themselves. If an

eDiscovery firm is hired to assist in a company's internal investigation for a potential intellectual property theft matter, technical consultants will be best poised to learn of all of the potential data sources a potential offender would have had access to exfiltrate trade secrets. If Technical Consultants are sought after for advice prior to a discovery request is submitted, they would be able to advise attorneys on the ideal data sources they should request be preserved to best acquire the information they seek for their case, as opposed to having attorneys blindly ask for documents and emails. Technical Consultants can also ensure that the correct formatting for delivered documents are included in the discovery request, along with ensuring the right forms of metadata are preserved. These are the kinds of items that generic project managers are not in a position to advise on, even when they are consulted by law firms prior to discovery.

Collection and Processing

In the year 2021, migrations to Infrastructure as a Services (IAAS) platforms grew by 33% (Crosby Industry Analyst & NpdMike, 2021). This includes cloud hosted email services and other features hosted entirely in the cloud. There are several cloud hosted email suites, messaging platforms, and other cloud storage services that can be synced directly to cloud hosted eDiscovery software to commence processing immediately as data starts to ingest. Many eDiscovery firms or consulting firms that have eDiscovery departments know this, but do not leverage this capability. The reasons we have run into in my experience range from eDiscovery teams not being familiar with collection practices, or Forensics teams not having access to processing software reserved exclusively for processing teams, or otherwise simply not wanting to blur the lines between the two practices. By unifying the departments under one team, Collection and Processing can move into the same phase of the EDRM. Several eDiscovery software suites also have the capability to ingest forensic images entirely. This negates the process of exporting raw data out of images by forensics teams. This process can nearly triple the amount of time it takes to get data from source to hosting as well as potentially exposes the data to security risks and even potential (unintentional) metadata spoliation. A key focal point of this improved phase is that there really aren't any good reasons that still exist for end users to self-collect. Understandably, cost becomes a factor; but if data can be synced directly to processing software, that cuts the need to occupy forensics resources for something processing can do directly. Thus cutting the cost of paying the hourly rate for a forensic consultant to collect data for them. As for mobile devices and other endpoints that may sit outside of a company's managed enterprise, the need for forensic examiners to either remotely image or image in-person will still be needed for the foreseeable future. By consulting with experts during the identification phase, attorneys can ensure that discovery requests include the use of a third party to collect that data. It's the only way to rule out intentional obfuscation by the opposing party. And by attorneys advising against their own customers self-collecting, they can ensure a proper chain of custody is maintained and that data is always being hashed and archived properly. Noted, the IT Departments managing a company's endpoints are going to have a better understanding of their systems than any outside third party. But just by sheer lack of exposure to this process, they will not have the needed experience and training in the field of forensic documentation to ensure that their customers are being properly shielded from legal exposure.

Forensic Examination and Review

Although listed as two separate phases in the improved EDRM, they are listed as occurring synchronously. Forensic Examinations can provide an attorney with user-initiated

activity performed on the very endpoints that data was collected from. Anything from websites that were visited, the sizes of data that was uploaded (along with the times that they occurred), connections to other computers and storage repositories, a listing of USBs that were plugged in to the computer, names of files that were contained on those USBs, along with a practically endless universe of potential information. However, the discovery of these artifacts can only find meaning with context. The significance of a USB plugged in last week on Thursday may seem meaningless to a forensic examiner asked to find evidence of data exfiltration. But if the examiner has a line of communication with the review team currently going through processed emails, the examiner can then communicate that evidence to them. The reviewer may know of a meeting that occurred on that day from reviewing a calendar invite from an outside party. None of this is occurring right now in the field of eDiscovery. A review team's efforts are performed several steps after the data arrives at a forensic team's lab. This compartmentalization of both information and efforts is causing an over expenditure of resources that could be better utilized on other matters. By departments not communicating, customers are being left with unanswered questions, and eDiscovery firms are potentially missing out on more work. Artificial Intelligence (AI) or heuristics are also available through software already being used by eDiscovery firms. But due to a lack of training in these tools they are not being implemented. Studies show that properly employing AI during an investigation can increase review speeds by 15 to 20 percent (Hulsbos, 2020). Adding words related to a matter to eDiscovery software with machine learning capabilities can yield clustered results to a reviewer with not just traditional keyword matches. The results can also potentially include items of interest matching the context of the investigation. By pairing the results of these searches conducted by AI with efforts conducted by forensic examinations, a richer set of meaningful results can be delivered to a customer. This vastly differs from the current workflow of dumping data through the digital conveyer belt and hosting it for the customer to figure out themselves.

Production

The verbiage of a final production or presentation should be written by legal teams in close coordination with the Technical Consultants that managed the project. It should not be left up to the examiner to write the report entirely. And it should not be left up to a customer's attorney to write and submit using results delivered by forensic examiners. The ideal process starts with a "template" for an affidavit sent to the Technical Consulting team by the attorney listing the findings they found relevant to that particular case (note: they should send the template after they have reviewed the team's findings). The examiner then adjusts the verbiage to ensure that it remains objective and impartial and send the updated draft back to the legal team. In practice, this process can take a number of days to complete over several document drafts. But as we will demonstrate in the following case study, when the process is adhered to correctly, the results can better satisfy the customer, as well as open the door to follow-on successful business opportunities for the eDiscovery firm.

Case Study

Alpha V Bravo (2019)

After seeking consultation on this matter, we decided that it would be best to omit the actual names of the parties involved in this case study. Unfortunately, due to the strict Non-Disclosure Agreement We signed with the firm was working under, we are not in a position to disclose actuals names. However, details about a case "similar" to the one we are describing in

this case study can be found by researching *Keurig Dr Pepper Inc. v. Chenier, Civil Action No. 4:19-CV-505 (E.D. Tex. Aug. 22, 2019)*

Synopsis

Alpha inc. accuses Mr. Smith of sharing trade secrets with Bravo inc. A Forensic Examiner is hired to help prove whether Mr. Smith exfiltrated privileged information from Alpha and shared it with Bravo

Identification

Examiner contacts Alpha's IT department and inquires on any of Mr. Smith's previously issued workstations. Examiner was able to obtain Mr. Smith's previously issued laptop before it was reimaged for reuse.

Collection and Initial Examination

The examiner obtains custody of Mr. Smith's previously issued laptop and forensically images it. Upon examination of the image, it was discovered that file wiping software was installed on the endpoint. All user generated documents were presumably wiped. However, user initiated system data still persisted. The examiner was able to find evidence suggesting the Mr. Smith had logged in the Bravo inc.'s wifi using an Alpha inc. issued laptop. This fact, along with other corroborating information obtained through custodian interviews, and information obtained by reviewers during the analysis of Mr. Smith's company emails, led to Alpha inc.'s legal team requesting that Mr. Smith's personal laptop be submitted for discovery.

Second Examination

Mr. Smith's personal laptop was imaged and examined. Analysis of the laptop's USBSTOR (An artifact found in the system's registry containing information about connected USBs) revealed that several USBs had been connected to the laptop on a significant data related to the investigation. Also, an analysis of other artifacts on Mr. Smith's personal laptop revealed that one of the connected USBs contained filenames of the intellectual property in question. Note: the examiner did not have custody of the actual thumb drives. This information was obtained only by examining Mr. Smith's personal laptop.

The USB

Mr. Smith admits to use of the USB and ships a USB to the examiner. The examiner was able to quickly determine that this was NOT the USB in question. The examiner was able to determine this by paring the USB serial number on the submitted USB with what was recorded in the USBSTOR. The correct USB was eventually sent to the examiner, but it had been completely wiped. However, that USB contained a folder named "Spotlight-V100". This folder is automatically created only when a USB is plugged in to an Apple Computer.

Results

Mr. Smith never turned in this third (previously unknown) device. And Alpha inc. never got to the point where it felt the need to seek custody of it, nor did they press criminal charges. However, the evidence obtained during the forensic examination and the review of corporate emails did lead to a formal affidavit being submitted asking the Court to restrain Defendant John Chenier from allegedly continuing to act in contravention of binding restrictive covenants and

from misappropriating Plaintiffs' trade secrets and confidential information. The court found that Mr. Smith had breached his contract with Alpha inc. and ordered that Mr. Smith is not to provide competitive services to Bravo inc. It was also ordered that Mr. Smith was not to solicit any services on behalf of Bravo inc to any of Alpha inc's vendors. And he was of course, ordered to return any confidential information and/or trade secrets to Alpha inc.

Conclusion

In the example provided in the above case study, Alpha inc. had initially only sought traditional eDiscovery services from the examiner's firm. The only form of services they wanted was an email collection from Alpha's Office 365 instance, and processing of the collected emails. But through slight changes to the current process adhered to in cases like this, the vast majority of responsive data did not come from Mr. Smith's emails. They were obtained through both the examination of endpoints, and through open lines of communication between the examiner and the individuals conducting the review of Mr. Smith's emails.

This improved EDRM model can be scaled up to be implemented by eDiscovery firms running countless "Technical Consulting Teams", or run by a single team processing the occasional data set as a "Side gig". Regardless, implementation of this model can improve delivered results, save the customer money, and increase the revenue of eDiscovery firms by slashing overhead.

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A SIMULATED ANNEALING HEURISTIC FOR THE DYNAMIC GENERALIZED QUADRATIC ASSIGNMENT PROBLEM

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ABSTRACT

The dynamic generalized quadratic assignment problem (DGQAP) is the task of assigning a set of facilities to a set of locations for multiple periods in the planning horizon such that the sum of the transportation, assignment, and reassignment costs is minimized. The facilities may have different space requirements (i.e., unequal areas), and the capacities of the locations may vary during a multi-period planning horizon. Also, multiple facilities may be assigned to each location during each period without violating the capacities of the locations. This research presents mathematical models and a simulated annealing (SA) heuristic for solving the DGQAP problem. A set of six test problems are generated following the procedure available in the literature for the generalized quadratic assignment problem (GQAP). The performance of the heuristic is tested with respect to solution quality and computation time. The results shows that the proposed heuristic performed well on the set of test problems.

INTRODUCTION

Assignment problems are common combinatorial optimization problems that carries much importance in different fields ranging from logistics, manufacturing, business, telecommunication, healthcare, etc. There are mainly two types of assignment problems: one-to-one and many-to-one. For example, consider the quadratic assignment problem (QAP), a one-to-one assignment-type problem, which assigns equal-area facilities to locations while minimizing the sum of the costs of transporting materials between facilities and the costs of assigning (or installing) facilities to locations. In the QAP, each facility is assigned to a location, and each location is assigned to a facility (i.e., one-to-one assignment). The QAP was introduced by **Koopmans and Beckmann (1957)** and was proven to be NP Hard by **Sahni and Gonzales (1972)**. See **Burkard et al. (1998)**, **Loiola et al. (2007)**, and **Abdel-Basset et al. (2018)** for an extensive review of the solution techniques for the QAP.

There are many variants of the QAP. For some examples of different variants of the QAP see **Abdel-Basset et al. (2018)** and **Silva et al. (2021)**. One of them is the generalized QAP (GQAP) which is a many-to-one assignment-type problem. That is, more than one facility may be assigned to each location without violating location capacities, but each facility is assigned to exactly one location. More specifically, the GQAP is stated as the problem of assigning a set of M facilities to a set of N locations ($M > N$), without exceeding the capacities of the locations, such that the sum of the assignment and transportation costs is minimized. The formulation of the GQAP is given below and is an adaptation of the model presented by **Lee and Ma (2004)**.

$$\text{Minimize } z = \sum_{i=1}^M \sum_{k=1}^N a_{ik} x_{ik} + \sum_{i=1}^M \sum_{j=1, j \neq i}^M \sum_{k=1}^N \sum_{l=1, l \neq k}^N c_{ijkl} f_{ij} d_{kl} x_{ik} x_{jl} \quad (1)$$

$$\text{Subject to } \sum_{k=1}^N x_{ik} = 1, \quad \text{for } i = 1, \dots, M \quad (2)$$

$$\sum_{i=1}^M r_i x_{ik} \leq C_k, \quad \text{for } k = 1, \dots, N \quad (3)$$

$$x_{ik} = 0 \text{ or } 1, \quad \forall i, k \quad (4)$$

where M is the number of facilities, N is the number of locations, a_{ik} is the cost of assigning (installing) facility i to (at) location k , f_{ij} is the amount of materials flowing from facility i to facility j , d_{kl} is the distance from location k to location l , c_{ijkl} is the unit cost per distance unit of transporting materials from facility i (at location k) to facility j (at location l), r_i is the resource (or space) requirement of facility i , and C_k is the amount of resource (or space) capacity available at location k . The decision variables are defined as

$$x_{ik} = \begin{cases} 1, & \text{if facility } i \text{ is assigned to location } k, \\ 0, & \text{otherwise.} \end{cases}$$

Objective function (1) minimizes the sum of the assignment (or installation) and transportation costs. Constraints (2) ensure that each facility is assigned to only one location. Constraints (3) ensure that the capacity of each location is not exceeded, and the restrictions on the decision variables are given in (4).

The term in objective function (1) used to obtain transportation cost has a quadratic term (i.e., product of two variables). As a result, the mathematical formulation (1) – (4) is nonlinear and is called a binary integer nonlinear programming (BINLP) model. The model is linearized by substituting w_{ijkl} for $x_{ik}x_{jl}$. Then, replace objective function (1) with

$$\text{Minimize } z = \sum_{i=1}^M \sum_{k=1}^N a_{ik} x_{ik} + \sum_{i=1}^M \sum_{j=1}^M \sum_{k=1}^N \sum_{l=1}^N c_{ijkl} f_{ij} d_{kl} w_{ijkl} \quad (1a)$$

and add the following constraints

$$x_{ik} + x_{jl} - 1 \leq w_{ijkl} \quad \text{for } i, j = 1, \dots, M, k, l = 1, \dots, N \text{ where } j \neq i \text{ and } l \neq k \quad (5)$$

$$w_{ijkl} \geq 0 \quad \text{for } i, j = 1, \dots, M, k, l = 1, \dots, N \text{ where } j \neq i \text{ and } l \neq k \quad (6)$$

As a result, the linearized model, a mixed integer linear programming (MILP) model, for the GQAP consists of objective function (1a) subject to constraints (2) – (6).

The GQAP literature is very limited compared to the QAP literature. **Lee and Ma (2004)** presented the first formulation for the GQAP. Also, the authors presented three methods for the linearization of the formulation, and a branch and bound algorithm to optimally solve the GQAP. **Hahn et al. (2008)** presented a new algorithm based on a reformulation linearization technique (RLT) dual ascent procedure to optimally solve the GQAP. Similarly, **Pessoa et al. (2008)** presented two exact algorithms for the GQAP which combine a previously proposed branch and bound scheme with a new Lagrangean relaxation procedure over a known RLT formulation. It is important to note that the exact algorithms presented above are unable to solve large-size problems in reasonable time. However, the following heuristics (or approximation algorithms) are able to obtain “good” solutions for large-size problems in reasonable time. **Cordeau et al. (2006)** presented a linearization of the GQAP formulation as well as a memetic heuristic for the GQAP, which combines genetic algorithms (**Holland, 1975**) and tabu search (**Glover, 1986**). **Mateus et al. (2011)** proposed several greedy randomized adaptive search procedure (GRASP) with path-relinking heuristics for the GQAP using different construction, local search, and path-relinking procedures. **McKendall and Li (2017)** presented three construction algorithms and a tabu search heuristic for the GQAP. More recently, **Silva et al. (2021)** presented a parallel memetic iterated tabu search heuristic for the QAP and four of its variants, which includes the GQAP as one of its variants.

The GQAP has numerous applications related to facility design, scheduling, and network design. **Lee and Ma (2004)** first introduced the GQAP to solve the problem of assigning a set of production equipment (or facilities) to manufacturing sites (or locations). **Cordeau et al. (2006)** considered the application of GQAP on container yard management where the yard is partitioned into storage areas (or locations) and containers (or facilities) are assigned to these storage areas. **McKendall and Li (2017)** considered the application of assigning a set of machines (or facilities) to a set of locations on the floor of a manufacturing plant. Also,

Zou et al. (2010) considered a GQAP with an additional capacity constraint to assign tasks to processors. **Unal & Uysal (2014)** implemented GQAP to design the curriculum at a university.

In this paper, the dynamic GQAP (DGQAP) is considered. It is defined as the task of assigning a set of facilities to a set of locations for multiple periods in the planning horizon such that the sum of the transportation, assignment, and reassignment costs is minimized. The facilities may have different space requirements, and the capacities of the locations may vary during a multi-period planning horizon. Also, multiple facilities may be assigned to each location during each period without violating the capacities of the locations. The authors are unaware of the existence of this problem in the literature. However, an application of the DGQAP is the management of construction facilities during construction projects, where construction facilities (e.g., cranes, equipment, materials) are assigned to locations at a construction site for a multiple period planning horizon (**Elbeltagi et al., 2004**). Also, the applications presented above for the GQAP is applicable for the DGQAP when there are changes in the problem (input) data during the planning horizon. More specifically, if one or more of the following input data changes during the planning horizon, it would be better to solve the resulting problem as a DGQAP as opposed to solving multiple GQAPs, as will be discussed later.

- There are changes in either the amounts of materials transported between facilities or the costs of transporting materials between facilities.
- There are changes in the location capacities, which may change the distances between the locations.
- There are changes in the facilities requirements.

In this paper, mathematical models, a construction algorithm, and a simulated annealing (SA) heuristic is presented for the DGQAP problem. In section 2, the mathematical models are presented for the DGQAP, and an illustrative example is solved using one of the proposed models. A construction algorithm and a SA heuristic for the DGQAP are presented in Section 3. In Section 4, some computational results of the proposed techniques on a set of randomly generated test problems are given. Finally, Section 5 provides conclusions.

MATHEMATICAL MODELS FOR THE DGQAP

The DGQAP is the problem of assigning a set of M facilities to a set of N locations ($M > N$) for T periods in the planning horizon such that the sum of the transportation, assignment, and reassignment costs is minimized. The assumptions of the DGQAP are as follows.

- 1) The planning horizon is divided into multiple periods. Periods may be defined as weeks, months, quarters, or years.
- 2) The input data is deterministic and known. That is, for each period t , the number of units of materials transported between facilities i and j (f_{ij}), the distances between locations k and l (d_{kl}), the space requirement of each facility i (r_i), the capacity of each location k (C_k), the costs of assigning and reassigning each facility i to each location k (a_{ik}), and the unit cost per distance unit of transporting materials between each pair of facilities i at location k and facility j at location l (c_{ijkl}) are deterministic and known.
- 3) One or more facilities may be assigned to each location during each period such that the capacity of the location is not exceeded.
- 4) The objective is to minimize the sum of the transportation, assignment, and reassignment costs. The assignment costs are the costs of initially assigning (or installing) facilities to locations during the first period. Reassignment costs are the costs of reassigning (or reinstalling) facilities to different locations after the first period.

Next, a mathematical formulation is presented for the DGQAP, but first the decision variables are defined as follows.

$$x_{tik} = \begin{cases} 1, & \text{if facility } i \text{ is assigned to location } k \text{ in period } t \\ 0, & \text{otherwise} \end{cases}$$

$$\text{Minimize } z = \sum_{i=1}^M \sum_{k=1}^N a_{1ik} x_{1ik} + \sum_{i=1}^M \sum_{k=1}^N \sum_{l=1}^N \sum_{t=2}^T a_{til} x_{(t-1)ik} x_{til} + \sum_{i=1}^M \sum_{j=1}^M \sum_{k=1}^N \sum_{l=1}^N \sum_{t=1}^T c_{ijkl} f_{ij} d_{tkl} x_{tik} x_{tjl} \quad (7)$$

$$\text{Subject to } \sum_{k=1}^N x_{tik} = 1, \quad \text{for } i = 1, \dots, M, t = 1, \dots, T \quad (8)$$

$$\sum_{i=1}^M r_{ti} x_{tik} \leq C_{tk}, \quad \text{for } k = 1, \dots, N, t = 1, \dots, T \quad (9)$$

$$x_{tik} = 0 \text{ or } 1 \quad \forall i, k, t \quad (10)$$

Objective function (7) minimizes the sum of the assignment, reassignment, and transportation costs. Constraints (8) ensure that each facility is assigned to only one location in each period. Constraints (9) ensure that the capacity of each location is not exceeded in each period. The restrictions on the variables are given by constraints (10).

The mathematical formulation presented above for the DGQAP is nonlinear due to the nonlinear terms (i.e., the product of two variables) in objective function (7) and is called a BINLP model. In order to obtain the global optimal for the DGQAP, the nonlinear model above is linearized by using the standard transformation by substituting y_{tikl} for $x_{(t-1)ik} x_{til}$ and w_{ijkl} for $x_{tik} x_{tjl}$. This yields the following linearized objective function and the additional constraints.

$$\text{Minimize } z = \sum_{i=1}^M \sum_{k=1}^N a_{1ik} x_{1ik} + \sum_{i=1}^M \sum_{k=1}^N \sum_{l=1}^N \sum_{t=2}^T a_{til} y_{tikl} + \sum_{i=1}^M \sum_{j=1}^M \sum_{k=1}^N \sum_{l=1}^N \sum_{t=1}^T c_{ijkl} f_{ij} d_{tkl} w_{ijkl} \quad (7a)$$

$$y_{tikl} \geq x_{(t-1)ik} + x_{til} - 1, \quad \text{for } i = 1, \dots, M; k, l = 1, \dots, N (l \neq k); t = 1, \dots, T \quad (11)$$

$$w_{tijkl} \geq x_{tik} + x_{tjl} - 1, \quad \text{for } i, j = 1, \dots, M (j \neq i); k, l = 1, \dots, N (l \neq k); t = 1, \dots, T \quad (12)$$

$$y_{tikl} \geq 0 \quad \forall i, k, l \neq k, t \quad (13)$$

$$w_{tijkl} \geq 0, \quad \forall i, j \neq i, k, l \neq k, t \quad (14)$$

As a result, the linearized mathematical model for the DGQAP, which is a MILP model, consists of objective function (7a) subject to constraints (8) – (14). Next, a DGQAP instance is presented and solved optimally using the MILP model presented above and the commercial solver CPLEX.

Consider a DGQAP instance in which 6 facilities are assigned to 3 locations in a 2-period planning horizon (i.e., $M = 6, N = 3, T = 2$). The unit cost per distance unit of transporting materials between each pair of the facilities during each period is 2 (i.e., $c_{ijkl} = 2$). See table 1 below for the input data for a small DGQAP instance. For example, the cost of assigning facility 2 to location 3 in period 1 is 12 (i.e., $a_{123} = 12$), and the cost of reassigning facility 2 (located at either location 1 or 2 in period 1) to location 3 in period 2 is also 12 (i.e., $a_{223} = 12$). This occurs when the locations and facilities do not change during the planning horizon; notice, assignment and reassignment costs do not change for periods 1 and 2 (i.e., $a_{1ik} = a_{2ik}$ for all i and k). Also, the distance from location 3 to location 2 for both periods 1 and 2 are same, which is 3 distance units (i.e., $d_{132} = d_{232} = 3$). However, the space requirements of a facility during different periods may change due to either an increase or decrease in production capacity, for example. In the above data, the space requirement for facility 1 increases for period 2 from period 1 (i.e., $r_{11} = 2, r_{21} = 3$), but for facility 3 for each period, the facility requirement is the same (i.e., $r_{13} = r_{23} = 2$). Also, there is a possibility that the space capacity of a location may change during different planning periods. For example, additional space may

become available at a location. Notice the space capacity of location 1 during period 1 is 3 units (i.e., $C_{11} = 3$), but in period 2 it increased to 5 units (i.e., $C_{21} = 5$).

Using the data given in table 1, the MILP model presented for the DGQAP, objective function (7a) subject to constraints (8) – (14), and the commercial solver CPLEX (version 12.4), the following optimal solution is obtained. The nonzero values of the decision variable x_{ik} are as follows.

$$x_{113} = x_{123} = x_{133} = x_{141} = x_{151} = x_{162} = x_{213} = x_{221} = x_{233} = x_{241} = x_{251} = x_{262} = 1$$

In other words, in period 1 assign facilities 4 and 5 to location 1, facility 6 to location 2, and facilities 1, 2, and 3 to location 3. In period 2, assign facilities 2, 4, and 5 to location 1, facility 6 to location 2, and facilities 1 and 3 to location 3. See figure 1 for a display of the solution. Notice at the beginning of period 2, facility 2 (assigned to location 3 in period 1) is reassigned to location 1. Total assignment cost (AC) and transportation cost (TC) for period 1 is 92 and 90, respectively, and total reassignment cost (RC) and transportation cost (TC) for period 2 is 16 and 110. Thus, the total cost of the optimal solution is 308.

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Table 1. Input data for a small DGQAP instance.

AC = 92, TC = 90			RC = 16, TC = 110		
Location 1	Location 2	Location 3	Location 1	Location 2	Location 3
4, 5	6	1, 2, 3	2, 4, 5	6	1, 3
Period 1			Period 2		

Figure 1. Optimal solution for the small DGQAP instance with total cost of \$308.

Since this is the first paper known to the authors which consider the DGQAP, the DGQAP may be solved sequentially as multiple GQAPs. That is, for period 1 the GQAP may be solved, then the GQAP may be solved for period 2, and so on. As stated earlier, it would be better to solve the resulting problem as a DGQAP as opposed to solving multiple GQAPs, since finding the optimal (or good) solution for each subproblem (or period) oftentimes does not yield the optimal (or good) solution for the problem as a whole. Consider the data given in table 1, the MILP model presented for the GQAP, objective function (1a) subject to constraints (2) – (6), and the commercial solver CPLEX. The GQAP is optimally solved for periods 1 and 2 separately, and the following optimal solution is obtained for both problems where the nonzero values of the decision variables x_{ik} for period 1 are $x_{13} = x_{23} = x_{33} = x_{42} = x_{52} = x_{61} = 1$ and for period 2 are $x_{11} = x_{23} = x_{31} = x_{43} = x_{52} = x_{63} = 1$. In other words, assign facilities 6 to location 1, facilities 4 and 5 to location 2, and facilities 1, 2, and 3 to location 3 in period 1. In period 2, assign facilities 1 and 3 to location 1, facility 5 to location 2, and facilities 2, 4, and 6 to location 3. For a graphical display of the solution, see figure 2. Notice facilities 1, 3, 4, and 6 are reassigned to different locations in period 2. Total AC and TC for period 1 is 94 and 62, respectively, and total RC and TC for period 2 is 56 and 110, respectively. Thus, the total cost of the solution is \$322, which gives a higher total cost solution than solving the problem as a DGQAP. Notice the differences between the different costs obtained for each period in figures 1 and 2.

AC = 94, TC = 62			RC = 56, TC = 110		
Location 1	Location 2	Location 3	Location 1	Location 2	Location 3
6	4, 5	1, 2, 3	1, 3	5	2, 4, 6
Period 1			Period 2		

Figure 2. Solution for the small DGQAP instance with total cost of \$322.

HEURISTIC METHODS FOR THE DGQAP

Combinatorial Optimization Problem (COP) Model

Since the mathematical model can only be used to solve small-size problems in reasonable time, heuristics are developed for the DGQAP. As a result, additional notation is used to give another formulation of the GQAP. Using a combinatorial optimization problem (COP) formulation, the solution for the DGQAP is represented as $\mathcal{S} = \{\mathcal{S}_1, \mathcal{S}_2, \dots, \mathcal{S}_T\}$ where \mathcal{S}_t is used to represent the assignment of facilities to locations in period t where $t = 1, \dots, T$, $\mathcal{S}_t = (s_t(1), s_t(2), \dots, s_t(M))$ and $s_t(i) = k$, which means facility i is assigned to location k in period t . Therefore, the solution \mathcal{S} is represented as follows.

$$\mathcal{S} = \{\mathcal{S}_1, \mathcal{S}_2, \dots, \mathcal{S}_T\} = \{(s_1(1), s_1(2), \dots, s_1(M)), (s_2(1), s_2(2), \dots, s_2(M)), \dots, (s_T(1), s_T(2), \dots, s_T(M))\}$$

Considering the small DGQAP instance given in table 1, the optimal solution given in figure 1 is represented as $\mathcal{S} = \{\mathcal{S}_1, \mathcal{S}_2\} = \{(3, 3, 3, 1, 1, 2), (3, 1, 3, 1, 1, 2)\}$. For example, $s_1(2) = 3$ and $s_2(2) = 1$, which means in period 1 facility 2 is assigned to location 3 and is reassigned to location 1 in period 2.

Using the notation defined earlier for the problem parameters, the index representing location k (l) of facilities i (j) in period t is replaced with $s_t(i)$ ($s_t(j)$), and the COP model for the DGQAP is given as follows.

$$TC(\mathcal{S}) = \sum_{i=1}^M a_{1is_1(i)} + \sum_{t=2}^T \sum_{i=1}^M a_{tis_t(i)} r a_{ti} + \sum_{t=1}^T \sum_{i=1}^M \sum_{j=1}^M c_{tij s_t(i) s_t(j)} f_{tij} d_{t s_t(i) s_t(j)} \quad (15)$$

$$\text{s.t.} \quad \sum_{\forall i \text{ s.t. } s_t(i)=k} r_{ti} \leq C_{tk} \quad \text{for } t = 1, \dots, T, k = 1, \dots, N \quad (16)$$

Notice an additional variable $r a_{ti}$ is introduced into the second term to determine the reassignment cost of each facility i in period $t > 1$. That is, if facility i assigned to location k in period $t-1$ (i.e., $s_{t-1}(i) = k$) and is reassigned to location l ($l \neq k$) in period t (i.e., $s_t(i) = l$), then reassignment cost is incurred, and the variable $r a_{ti} = 1$. As a result, the variable is defined as follows.

$$r a_{ti} = \begin{cases} 1, & \text{if facility } i \text{ at location } k \text{ in period } t-1 \text{ is reassigned to location } l \text{ (} l \neq k \text{) in period } t \\ 0, & \text{otherwise} \end{cases}$$

Given a solution \mathcal{S} , equation (15) gives the sum of the assignment, reassignment, and transportation costs (i.e., total cost of solution \mathcal{S}). Constraints (16) ensure that the capacity of each location is not exceeded during each period. Next, a construction algorithm is presented for the DGQAP.

Construction Algorithm

The following construction algorithm is used to generate a solution for the DGQAP. It is similar to the first of three construction algorithms presented in **McKendall and Li (2017)** for the GQAP. However, it has been extended to include a multi-period planning horizon.

Step 1: Initialize the capacity of each location k for each period t (i.e., $C_t(k) = \{C_t(1), C_t(2), \dots, C_t(N)\}$ for $t = 1, 2, \dots, T$). Also, initialize the space requirement of each facility i for each period t (i.e., $r_t(i) = \{r_t(1), r_t(2), \dots, r_t(M)$ for each period t).

Step 2: For each period t , sort facilities in descending order with respect to $r_t(i)$ in the eligible facility set ($EF S_t$) and break ties by selecting facility with the lower facility number.

Step 3a: Set $t = 1$ and $k = 1$.

Step 3b: If $k > N$ (where $N =$ number of locations), then go to step 5b. Else, go to position 1 of set $EF S_t$ (i.e., set $p = 1$).

Step 4: Set $i =$ the facility in p th position of set $EF S_t$.

Step 5a: If $r_t(i) \leq C_t(k)$, then

1. Assign facility i to location k in period t (i.e., set $s_t(i) = k$), set $C_t(k) = C_t(k) - r_t(i)$;
2. Remove facility i from $EF S_t$. If $EF S_t$ is empty, then go to step 5b;
 - a. If $C_t(k) < r_t(i)$ for Last(i) in set $EF S_t$, then set $k = k + 1$, and go to step 3b;
 - b. Else, go to step 4.

Else, set $p = p + 1$, and go to step 4.

Step 5b: If $EF S_t$ is empty, then set $t = t + 1$. Else display “No feasible solution!” and terminate algorithm.

Step 5c: If $t > T$, terminate algorithm. Else, set $k = 1$ and go to step 3b.

To illustrate the construction algorithm for the small DGQAP instance given in table 1, for period 1 $C_1(k) = \{3, 3, 6\}$, $r_1(i) = \{2, 1, 2, 1, 2, 3\}$, and $EF S_1 = \{6, 1, 3, 5, 2, 4\}$ after step 2 of first iteration. Notice facility 6 has the largest facility requirement (i.e., $r_1(6) = 3$) and is listed first in the set $EF S_1$. However, since $r_1(1) = r_1(3) = r_1(5) = 2$ and $1 < 3 < 5$, then facilities 1, 3, and 5 are placed in set $EF S_1$ in that order (break ties

by putting lower facility number first). After steps 3a, 3b, and 4, $t = 1$, $k = 1$, $p = 1$, and $i = 6$. In step 5a, since $r_i(6) = 3 \leq C_i(I) = 3$, then set $s_i(6) = 1 = k$, $C_i(I) = C_i(I) - r_i(6) = 0 < r_i(4) = 1$, and $EFs_i = \{1, 3, 5, 2, 4\}$. Since $C_i(I) < r_i(4)$, set $k = 2$ and go to step 3b and continue. The construction algorithm generates the solution $\mathcal{S} = \{(2, 2, 3, 3, 3, 1), (1, 1, 3, 3, 3, 2)\}$ which gives a total cost of 598 (i.e., $TC(\mathcal{S}) = \$598$). Recall, the optimal solution $\mathcal{S}^* = \{(3, 3, 3, 1, 1, 2), (3, 1, 3, 1, 1, 2)\}$ and $TC(\mathcal{S}^*) = 308$.

Once a solution is generated using the proposed construction algorithm, an improvement algorithm (discussed below) is used to obtain a “good” local optimum. The proposed improvement algorithm consist of a simulated annealing (SA) heuristic and a steepest descent heuristic. Next, a SA heuristic is presented for the DGQAP.

Simulated Annealing (SA) Heuristic

Simulated annealing (SA) is a meta-heuristic used to solve many different types of COPs. **Kirkpatrick et al. (1983)** was the first to use SA to solve COPs. **McKendall et al. (2005)** presented two SA heuristics to solve the dynamic space allocation problem which is a generalization of the dynamic QAP, which will be discussed next. The first heuristic is a direct adaptation of the SA heuristic to their problem, and the second heuristic added a look-ahead and look-back strategy to the first. Similarly, **McKendall et al. (2006)** presented two SA heuristics to solve a dynamic QAP, called the dynamic facility layout problem. The first SA heuristic is a direct adaptation of SA to a dynamic QAP, and the second SA heuristic adds a look-ahead/look-back strategy to the first. More recently, **Huo et al. (2020)** presented a SA heuristic for a task assignment and path planning problem which is viewed as a three-dimensional vehicle routing problem. This problem is a generalization of the generalized assignment problem and traveling salesperson problem. Since the SA heuristic was successfully applied to several related COPs, in this research the SA heuristic is used to solve the proposed DGQAP.

The proposed SA heuristic is an adaptation of the first heuristic presented in **McKendall et al. (2005)** and **McKendall et al. (2006)** to the DGQAP. The proposed SA heuristic starts with an initial solution \mathcal{S}_0 (also called the current solution) obtained by the proposed construction algorithm, and equation (15) is used to obtain the total cost of the solution (i.e., $TC(\mathcal{S}_0)$). This solution and its cost are defined as the best solution and cost (i.e., set $best_sol = \mathcal{S}_0$ and $best_cost = TC(\mathcal{S}_0)$). A neighboring solution \mathcal{S} is generated randomly using either a drop/add or pairwise exchange operation on the solution \mathcal{S}_0 . The details of these operations are given below. Next, constraints (16) of the COP model is used to check the feasibility of the neighboring solution \mathcal{S} . If the neighboring solution \mathcal{S} is infeasible, the solution \mathcal{S}_0 remains as the current solution for the next iteration. Else, the cost of the neighboring solution, $TC(\mathcal{S})$, is obtained using equation (15), and it is compared with cost of initial solution, $TC(\mathcal{S}_0)$, by calculating ΔTC , where $\Delta TC = TC(\mathcal{S}_0) - TC(\mathcal{S})$. If the cost of neighboring solution \mathcal{S} is better than the cost of the initial solution \mathcal{S}_0 (i.e., $TC(\mathcal{S}) < TC(\mathcal{S}_0)$ or $\Delta TC > 0$), the neighboring solution \mathcal{S} becomes the current solution and is the starting solution at the next iteration (i.e., set $\mathcal{S}_0 = \mathcal{S}$). If the cost of the neighboring solution \mathcal{S} is worse than or equal to the cost of the current solution \mathcal{S}_0 (i.e., $TC(\mathcal{S}) \geq TC(\mathcal{S}_0)$ or $\Delta TC \leq 0$), then the neighboring solution \mathcal{S} is selected as the current solution \mathcal{S}_0 (i.e., set $\mathcal{S}_0 = \mathcal{S}$) for next iteration with respect to an acceptance probability. Otherwise, the current solution \mathcal{S}_0 does not change. This process continues until a stopping criterion is met. The details of the acceptance probability and of the stopping criterion are given below, but first the operations for obtaining a neighboring solution is defined.

In the proposed SA heuristic, there are two types of operations used to obtain a neighboring solution \mathcal{S} from the current solution \mathcal{S}_0 : drop/add and pairwise exchange. The drop/add operation removes one location assigned to a facility and reassigns a different location to it in one of the periods. However, the pairwise exchange operation interchanges the locations of two facilities (assigned to different locations) in one of the periods. For example, consider the solution $\mathcal{S}_0 = \{(2, 2, 3, 3, 3, 1), (1, 1, 3, 3, 3, 2)\}$ obtained from the proposed construction algorithm discussed earlier. The proposed SA heuristic randomly selects an operation, say pairwise exchange. Next, a period is randomly selected, say period 2, and two facilities

assigned to different locations are selected, say facilities 2 and 6. As a result, a neighboring solution \mathcal{S} is obtained as follows by interchanging the locations of facilities 2 and 6 in period 2, and constraint (16) of the COP model is used to check the feasibility of the new solution \mathcal{S} .

$$\mathcal{S}_0 = \{(2, 2, 3, 3, 3, 1), (1, \underline{1}, 3, 3, 3, \underline{2})\} \quad \rightarrow \quad \mathcal{S} = \{(2, 2, 3, 3, 3, 1), (1, \underline{2}, 3, 3, 3, \underline{1})\}$$

As mentioned earlier, if the solution \mathcal{S} is not feasible, the solution \mathcal{S}_0 remains the current solution at the next iteration. Else, the total cost of the solution \mathcal{S} (i.e., $TC(\mathcal{S})$) is obtained, and either \mathcal{S}_0 remains the current solution at the next iteration or \mathcal{S} is selected as the current solution (i.e., set $\mathcal{S}_0 = \mathcal{S}$) if either $\Delta TC > 0$ or $\Delta TC \leq 0$ and the acceptance probability is more than a randomly generated number between zero and one (i.e., $\text{rand}(0, 1)$), which will be discussed below. In contrast, if the drop/add operation is selected randomly as well as a period, say period 1, then a facility is randomly selected, say facility 4 (assigned to location 3) and a different location is randomly selected between location 1 or 2, say 1. Therefore, a neighboring solution \mathcal{S} is obtained as follows by replacing location 3 with location 1 for facility 4 in period 1, and constraint (16) of the COP model is used to check the feasibility of the new solution \mathcal{S} , as discussed earlier.

$$\mathcal{S}_0 = \{(2, 2, 3, \underline{3}, 3, 1), (1, 1, 3, 3, 3, 2)\} \quad \rightarrow \quad \mathcal{S} = \{(2, 2, 3, \underline{1}, 3, 1), (1, 1, 3, 3, 3, 2)\}$$

The acceptance probability is defined as the probability of accepting a non-improving neighboring solution \mathcal{S} as the current solution for the next iteration. It is defined as follows.

$$P(\Delta TC) = \exp(-\Delta TC/Temp)$$

where $Temp$ is the current temperature and $Temp = Temp_0 \alpha^{r-1}$ for $r = 1, 2, \dots, R$. $Temp_0$ represents the initial temperature, $r - 1$ is the number of temperature reductions, and α is called the cooling ratio and is usually set at 0.90 or higher as stated in **McKendall et al. (2005)**. If $\Delta TC \leq 0$ and a randomly generated number between 0 and 1 (i.e., $\text{rand}(0, 1)$) is less than the acceptance probability (i.e., $\text{rand}(0, 1) < P(\Delta TC)$), then the non-improving solution \mathcal{S} is selected as the current solution (i.e., set $\mathcal{S}_0 = \mathcal{S}$). Otherwise, keep \mathcal{S}_0 as the current solution. At the initial temperature $Temp_0$, the probability of accepting non-improving solutions is high. This allows the heuristic to search the solution space without quickly converging to a poor local optimum. After a number of iterations, N_{Temp} , at the current temperature $Temp$, the temperature is reduced (i.e., set $Temp = Temp * \alpha$). As the temperature $Temp$ reduces, the probability of accepting non-improving solutions is lower, allowing the heuristic to possibly converge to a good local optimum. The SA heuristic terminates when the temperature $Temp$ reduces to a certain value, min_Temp . In other words, the heuristic terminates when $Temp \leq min_Temp$. The flow chart of the SA heuristic is given below in figure 3.

Steepest Descent Heuristic

It is important to note that sometimes the SA heuristic may not converge to a local optimum. That is, the best solution obtained from the SA heuristic (i.e., $best_sol$) may not be a local optimum. In other words, there is a neighboring solution \mathcal{S} , in the neighborhood of $best_sol$, that gives a lower total cost (i.e., $TC(\mathcal{S}) < TC(best_sol) = best_cost$). As a result, after the SA heuristic terminates, the following steepest descent heuristic is implemented to ensure that the $best_sol$ is a local optimum.

Step 1: Obtain $best_sol$ and $best_cost$ from SA heuristic.

Step 2: Find all feasible neighboring solutions by considering all possible drop/add and pairwise exchange operations on $best_sol$.

Step 3: Pick the best feasible neighboring solution, \mathcal{S} , with respect to total cost, $TC(\mathcal{S})$. If $TC(\mathcal{S}) < best_cost$, set $best_sol = \mathcal{S}$, $best_cost = TC(\mathcal{S})$, and go to step 2. Else, terminate heuristic and display the solution $best_sol$ and its cost $best_cost$.

As stated previously, the proposed improvement algorithm, which consists of the SA heuristic and the steepest descent heuristic presented above, is given in figure 3.

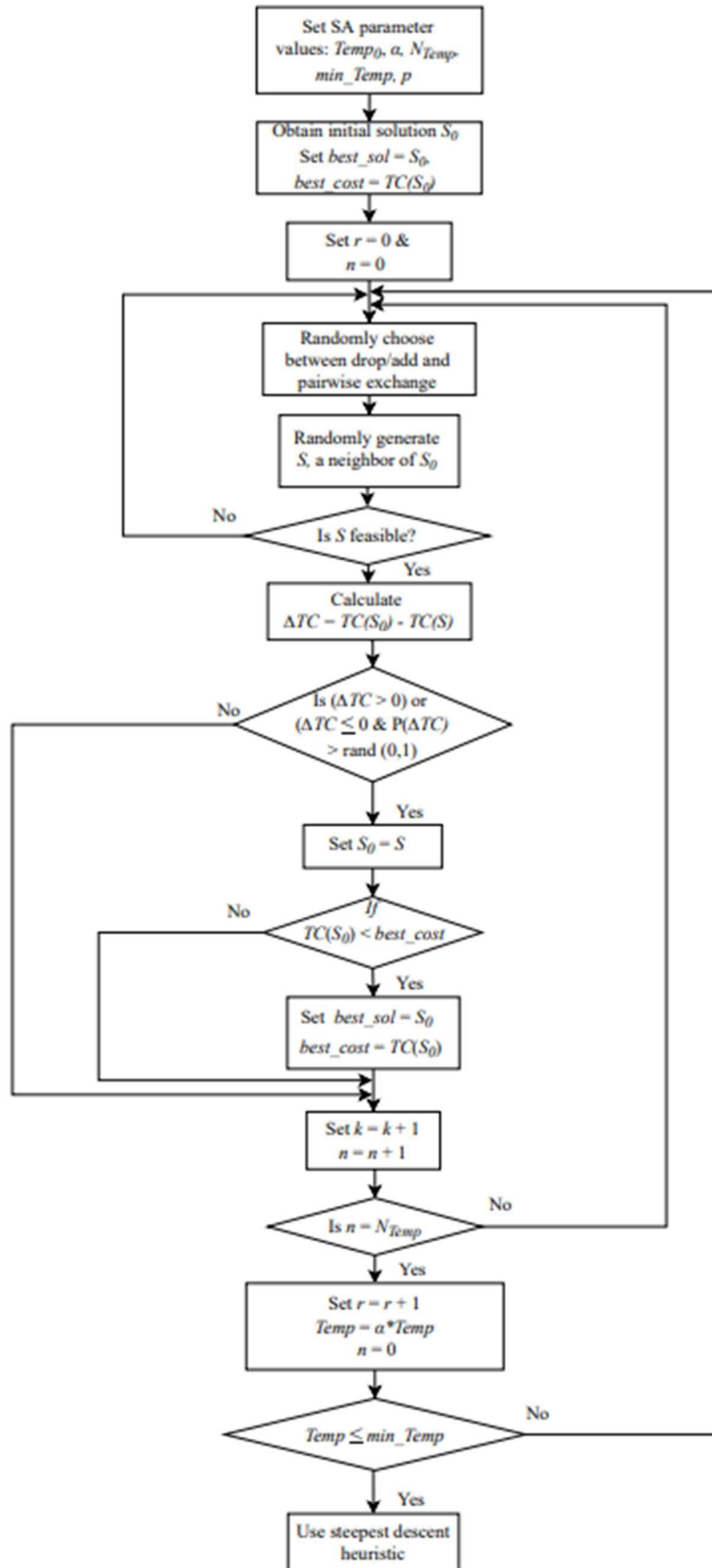


Figure 3. Flow chart of SA heuristic for DGQAP.

COMPUTATIONAL RESULTS

This section provides the results obtained from preliminary computational experiments performed in order to test the performance of the proposed SA heuristics against the results obtained from the MILP model and CPLEX 12.4. Also, in all experiments, a PC (equipped with Microsoft Windows 10, an Intel Core processor i7 with a CPU speed of 2.90 GHz and 16 GB of RAM) was used to solve the test problems, and the proposed SA heuristic was coded using Matlab.

Six test problems were developed for the DGQAP to test the performance of the SA heuristic. The test problems are generated following the procedure available in **Cordeau et al. (2006)** for the GQAP and modified for the DGQAP. The authors labeled the test problems using the notation M-N-U where M = number of facilities, N = number of locations, and U = total percent of location space utilized by the facilities (a value between 1 and 100 used to control the tightness of the capacity constraints). Since the DGQAP has more than one period in the planning horizon, in this paper U = average percent of location space utilized considering all periods. As a result, in this paper the test problems are labeled using the notation T-M-N-U where T = number of periods in the planning horizon. For instance, the small DGQAP instance given in table 1 is labeled as 2-6-3-92. Furthermore, the input data are generated for given values for T , M , N , and U as follows.

a_{tik} is generated according to a discrete uniform distribution in $[1, \dots, 10^4N]$.

f_{ij} and d_{kl} are generated according to discrete uniform distribution in $[1, \dots, 100]$.

r_{ii} is generated according to a discrete uniform distribution in $[1, \dots, 100]$; as per the application, the r_{ii} remains the same for each instance for all periods.

C_{tk} is generated according to a discrete uniform distribution in $[1, \dots, \sum_{t \in T} \sum_{i \in N} \frac{r_{ti}}{U}]$

The six test problems are generated as mentioned above where the space utilization (U) and the distance matrices are the same for each period (i.e., $d_{1kl} = d_{2kl} = \dots = d_{Tkl}$). Also, the amount of space required for each facility i is the same for each period (i.e., $r_{1i} = r_{2i} = \dots = r_{Ti}$). Note, the small DGQAP instance given in table 1, labeled as 2-6-3-92, does not consider the last restriction. That is, the amount of space required for a facility may change from one period to another (e.g., $r_{11} = 2$ but $r_{21} = 3$).

Recall, the SA parameters are the initial temperature $Temp_0$, the cooling ratio α , number of iterations performed at each temperature $Temp$, N_{Temp} , p , the probability of accepting a non-improving solution S at the initial temperature $Temp_0$, and the minimum allowable temperature before terminating heuristic, min_Temp . The SA parameter settings were obtained experimentally and are $\alpha = 0.99$, $p = 0.7$, $min_Temp = 0.0001$, and $N_{Temp} = \lceil .40(T * M(N - 1) + T * M(M - 1)/2) \rceil$ (i.e., N_{Temp} is 40% of the maximum size of the neighborhood of S_0 , rounded above to the nearest integer, where the size of the drop/add neighborhood is $T * M(N - 1)$ and the size of the pairwise exchange neighborhood is $T * M(M - 1)/2$). Last, set the initial temperature $Temp_0 = -(.10)TC(S_0)/\ln(p)$ where $TC(S_0)$ = cost of the initial solution obtained from the construction algorithm, $p = 0.7$ = probability of accepting a non-improving solution S at the initial temperature $Temp_0$, and \ln = natural logarithm.

The results of the computational experiments are given in table 2 below. Notice the small DGQAP instance given in table 1 (i.e., 2-6-3-92) is listed first followed by the six test problems randomly generated as discussed above. Each test problem was solved 20 times, since the SA heuristic is stochastic, and the outcome may be different for different runs. The maximum (Max), average (Avg), and minimum (Min) total cost of the best solution (Best Total Cost) and computation time in seconds are given for each problem. Furthermore, the optimal solutions with run times were obtained for some of the problems using the commercial solver CPLEX 12.4 (using the default settings) and the proposed MILP model presented earlier. Notice the optimal solutions were obtained for four of the seven problems (i.e., 2-6-3-92, 3-10-5-75, 3-9-4-55, and 4-12-5-35). However, the other three problems were unable to obtain the optimal solution, since

the CPLEX solver stopped due to insufficient memory (see Opt TC column with asterisks). In other words, the branch-and-bound search tree became very large and used up most of the RAM, and terminated before verifying optimality. Notice these problems ran for at least 10,916 seconds (or 3.03 hours). The bolded values represent the best total cost obtained from either the proposed SA heuristic or the CPLEX solver. Last, the percent deviation the best total cost obtained from the SA heuristic is from the best total cost obtained from the CPLEX solver is given in the last column for each problem. For instance, considering problem 3-15-4-85, the CPLEX solver obtain its best solution where its total cost is 1872699, and the proposed SA heuristic obtained a solution with its best total cost of 1652317, which is 11.8% below the total cost obtained from the CPLEX solver. However, the SA heuristic obtained a total cost which was 2.3% above the total cost obtained from the CPLEX solver. This is the only problem where the CPLEX solver obtained a better solution than the SA heuristic, but notice the run time is a lot longer for the CPLEX solver on average (i.e., $19,674 > 158 = 7.9(20 \text{ runs})$). As a result, the SA heuristic out-performed the CPLEX solver with respect to solution quality and computation time.

Problem	SA (20 runs)						CPLEX Solver		
	Best Total Cost			Computation Time (sec)			Opt TC	Time (sec)	% Dev
	Max	Avg	Min	Max	Avg	Min			
2-6-3-92	322	309	308	2.9219	0.952349	0.79688	308	0.05	0
2-15-4-85	1254504	1225066	1204837	9.0469	6.10236	5.7344	1248242*	19,644	-3.5
3-10-5-75	782141	751625.8	710036	6.8906	5.999235	5.2188	710036	10,494	0
3-15-4-85	1777081	1710304	1652317	9.9375	9.140635	8.5469	1872699*	10,916	-11.8
3-9-4-55	654715	637032.9	630095	2.7344	2.643765	2.5469	630095	661	0
4-10-5-75	967746	905294.8	842120	9.1875	7.893755	6.3906	822861*	19,674	2.3
4-12-5-35	489900	333098.6	266907	5.9063	5.58516	5.4375	266907	24.84	0

*Ran out of memory (did not verify optimality).

Table 2. Computational results for set of test problems.

CONCLUSIONS

In this paper, a new problem is presented called the DGQAP. Mathematical models as well as a construction algorithm and an improvement algorithm were developed and presented for the problem. The improvement algorithm consists of a SA and a steepest descent heuristic. Although some computational experiments were conducted on a small data set, generated randomly, and showed promising results, more computational experiments need to be performed to show the effectiveness of the proposed SA heuristic. For example, for one of the problems the SA heuristic did not perform as well as the CPLEX solver based on solution quality. It is believed that the SA heuristic did not perform well because of its randomness, and its inability to change locations of either one or two facilities in multiple periods simultaneously, especially for tightly constrained problems ($U > 70$). More specifically, for tightly constrained problems where rearrangement cost is relatively high, changing the location of either one or two facilities in a period (i.e., performing either a drop/add or pairwise exchange operation during one iteration) may require changing the location of one or two of those facilities in either preceding or succeeding periods (i.e., at the next several consecutive iterations) to keep total cost low. However, due to the randomness of the SA heuristic, the chances of changing the locations of one or both of those facilities in the necessary preceding or succeeding periods in

the next several consecutive iterations is very low. As a result, for future research, one can add a look-ahead and look-back strategy, as presented in **McKendall et al. (2005)** and **McKendall et al. (2006)**, to the proposed SA heuristic, which would allow changing the locations of one or two facilities in multiple periods, if it gives a better total cost. This strategy can also be added to the proposed construction algorithm. It is believed that the SA heuristic with a look-ahead and look-back strategy would work well for problems with high assignment and reassignment cost relative to transportation cost, and the proposed SA heuristic would work well for problems with low assignment and reassignment cost relative to transportation cost.

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AN EXPLORATORY STUDY OF AUTONOMOUS RIDE SERVICES (ARS) FOR PEOPLE WITH DISABILITIES

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ABSTRACT

Autonomous vehicles are continuing to be designed by car manufacturers announcing anticipated if not actual benefits for consumers. Autonomous ride services are also continuing to be designed by the manufacturers announcing benefits of the vehicles. In this paper, the authors explore autonomous ride services (ARS) as to how the vehicles might be better designed for accessibility for people with disabilities. Manufacturers might not be focused on these people that may be helped by the benefits of autonomous ride services vehicles. This paper contributes a foundational model for autonomous ride services vehicles for those with disabilities.

Keywords: Automated Driving, Automated Driving Levels, Autonomous Ride Services (ARS), Autonomous Vehicles (AV), Micro-Transit, People with Disabilities, Ride Sharing Services, Robo-Buses, Robo-Taxis

BACKGROUND

Automated cars are computer-controlled conceptual vehicles that drive without consumer interaction (Hussain, & Zeadally, 2019). Automation of autonomous vehicles are categorized as no automation, driver assistance automation, partial automation, conditional automation, high automation and full automation driving levels, by the Society for Automotive Engineering (Glon, & Edelstein, 2020). Alternately, autonomous cars are categorized as semi-autonomous, sufficiently-autonomous and fully-autonomous driving levels (McGrath, 2020), benefiting especially from camera-based, laser detection (LIDAR) map sensor and connected vehicle (V2V) systems. Autonomous driving is characterized as adaptive cruise control (ACC), automatic emergency braking (AEBS), avoidance of collision and object (CAS), control of lane and recognition of signs on street technology. Autonomous ride services (ARS), as circular micro-

transit, last-mile ride or paratransit sufficiently-autonomous vehicles for disadvantaged people, are anticipated to be the first application for autonomous (driverless) robo-bus or robo-taxi vehicles, in geo-fenced metropolitan regions (Dovey, 2017, & Knapp, 2019), by network transporters akin to Lyft and Uber. The accessibility benefits of autonomous vehicles, and especially of autonomous ride services vehicles, are considered astounding in the literature (McGrath, 2020).

Costs of owning vehicles are anticipated to decline with autonomous transportation vehicles to a high of 80% annually (McGrath, 2020). Autonomous vehicles are anticipated to have less accidents and life savings to a high of 90% of accidents and 40,000 lives annually (McGrath, 2020). Autonomous ride services are anticipated to be a “land” of mobility opportunities for communities of color, disabled and elderly people without ride sharing services, with the costing of autonomous ride services considered to be 50% less than ride sharing services (McGrath, 2020). Both autonomous vehicles and autonomous ride services vehicles are considered opportunities for decreasing congestion of metropolitan traffic and increasing productivity time to a high of 300 hours annually (McGrath, 2020). Estimates for autonomous vehicles are an exceptional \$42 billion in 2025 to \$77 billion, and 12 million autonomous and autonomous ride services vehicles, in 2035 (Davies, 2021), but the forecasts may be concurrently hype as autonomous vehicles are impacted by issues.

Autonomous vehicles are considered safe by manufacturers but not enough safe by others (Ford, 2021, Metz, 2022, & Stilgoe, 2021). Continued articles on accidents and on deaths from autonomous vehicles are in the literature (Boudette, 2021, Pietsch, 2021, Smiley, 2022, & The New York Times, 2022b). Designs of both autonomous and autonomous ride services vehicles may not be perfect for performance, reliability and safety (The New York Times, 2022a), contradicting the hype for the vehicles. Critically, for the authors, accessibility designs of the technology may not be attuned to disability organizations, and to especially people with cognitive and non-cognitive disabilities (Schwartz, 2018) – 25% of people have a disability (Li, Greene, Purwar, & Rhau, 2020), to be helped by autonomous ride services vehicles – the people that are more reliant on public transportation than people without disabilities (Shinkle, 2020). In this paper the authors consider how autonomous ride services vehicles might be better designed for people with disabilities, a marginalized niche population that might benefit the most from this technology.

INTRODUCTION

The authors of the Seidenberg School of Computer Science and Information Systems of Pace University consider how autonomous ride services (ARS) might be designed for differently enabled people. Not enough evidence of designing autonomous ride services for people with disabilities is in the literature (Reardon, 2021). Estimates of 15 million, including 6 million people with disabilities, having accessibility issues with non-autonomous public transportation (Motional, 2021) are a driver of this paper. People with disabilities face more obstacles with the transportation than people without disabilities. The American Disabilities Act (ADA) and the Telecommunications Act are not beneficial enough for the exceptions and forms of obstacles faced by people with disabilities from non-autonomous ride services.

The authors of this paper explore autonomous ride services from accessibility considerations from the Center for Universal Design at North Carolina State University for all consumers, including people with disabilities (Motional, 2021). The authors especially explore encounters of engaging the vehicles, entering the vehicles, experiencing riding in the vehicles, experiencing the safety of the vehicles and exiting the vehicles, hypothetically, as informed by products introduced for people with disabilities. The features of autonomous ride services vehicles are “out of the norm” for these people (Shinkle, 2020). Few of the car manufacturers engage disability organizations of how the vehicles might be designed for experiences considered inclusive by and for people with disabilities, and few of the manufacturers involve people with disabilities in the design process (Herriotts, 2020). Not involving people with disabilities in designing this option of paratransit transportation impacts educational, employment and health opportunities to a high of \$19 billion (The Ruderman Family Foundation, 2022).

The authors explore findings formed from an AutoNme paper on autonomous ride services by former disability studies and information systems students of Pace University. The findings of the former students found in their paper (Li, Greene, Purwar, & Rhau, 2020) were presented as a project of a dream team that is improved in this paper. The foundation for this paper is informed by interactions of the authors with disability non-profit organizations partnered on projects of technology with the university. This paper is further informed by issues of people with disabilities in the metropolitan sections of New York City. The findings of this exploratory paper is in a design model for autonomous ride services vehicles for those with disabilities that might be helpful to manufacturers and to non-profit organizations.

FOCUS OF PAPER

“People with disabilities stand to benefit the most from [autonomous ride services], but [manufacturers] are not making accessibility enough of a priority.” – Haben Girma, Disability Justice Lawyer

The essence of this paper is to explore how autonomous ride services might be better designed for accessibility for people with disabilities. How might the driverless features of autonomous ride services be designed effectively for people with disabilities? How might the features of autonomous ride services be designed for empowering people with disabilities with a feasible option for transportation? The features of the manufacturers are integrated into a design model, but further functionality is integrated into the model, such as from the AutoNme paper (Li, Greene, Purwar, & Rhau, 2020) and from other papers, in a preliminary phase preparatory to a final phase of study. The focus of this paper is to formulate the importance of the inclusiveness of this technology (Gray, 2017) for those with disabilities.

METHODOLOGY

This paper is a project by the first author – professor of disability studies and information systems in the Seidenberg School of Computer Science and Information Systems of Pace University.

In a preliminary study, professor engaged the second author, a graduate student of information technologies, to descriptively explore in January – May 2022 the features of the manufacturer products of autonomous ride services (ARS), from best-in-class data literature. Particularly the professor engaged the student on the project to explore the products as to their inclusiveness for people with disabilities, in engaging the vehicles, entering the vehicles, experiencing riding in the vehicles, experiencing the safety of the vehicles and exiting the vehicles, hypothetically. The student was concurrently engaged with people with disabilities in another program of technology at the university, which increased her knowledge of the population and of the technology tailored to those with disabilities. The exploration was also helped by findings of the AutoNme paper (Li, Greene, Purwar, & Rhau, 2020) of the former undergraduate students. The second author was also helped by generic indices of the Center for Universal Design at North Carolina State University. The best-of-class features of autonomous ride services found and integrated by the second author were interpreted into a design model by the first author in May – July 2022, in the next section of this preliminary study.

In the final study, the first author – professor will empirically evaluate in fall 2022 – spring 2023 the feasibility of the autonomous ride services model with a disability organization and its disability population in New York City sections, not hypothetically as in the preliminary study, and if the model is proven practical by a pilot of the population the professor will explore funding partnerships for the technology (Disability Scoop, 2021) with the City of New York and the United States Department of Transportation.

ANALYSIS

The analysis derives from current autonomous ride services data literature.

Autonomous ride services are currently in the first or second generation of driver, but not driverless, small vehicles. Autonomous ride services are also currently circular, curb-to-curb, defined, geo-fenced and fixed but navigable vehicles. Though not the third generation of driverless, door-to-door and fully-autonomous vehicles (Anderson, 2020), the first or second generation is considered in the literature (McGrath, 2020) as sufficiently-autonomous vehicles. The criticality of the design of the first or second generation of smaller autonomous ride services is appropriate by the authors for the development of the larger third to fifth generation of the potentially larger vehicles.

The authors present the design features for driver sufficiently-autonomous ride services in a design model for the vehicles.

The design model assumes an application (app) of audio (for deafness) and haptic (for blindness) design, off-board and on-board, for all of the below encounters for the features for people with disabilities (i.e. cognitive and non-cognitive disabilities) desiring a first or second generation curb-to-curb geo-fenced smaller vehicle; the app as multi-lingual; the app as agnostic as to disability and to skills (i.e. web content accessibility standards [www.w3.org]); the driver (human) apart from the people with disabilities in the vehicle but physically in the sufficiently-autonomous

vehicle; and with dispatch and the driver functioning from a centralized maneuverable and redundant safety system.

Autonomous Ride Services

Design Model for People with Disabilities

Sufficiently-Autonomous Model

Engaging the Vehicle

- *(App for)*
- *Booking Destination*
(Audio and Haptic for Engaging the Vehicle)
- *Concierge and Dispatch for Help **
- *Digital Fare (if Not Free) **
- *Directions to Destination Location*
- *Estimates to Destination Location*
- *Honking of Vehicle Prior to Entering Vehicle **

Entering the Vehicle

- *(App for) for*
- *Door Opening of Vehicle (Automatic and Manual)*
- *Door Closing of Vehicle (Automatic and Manual)*
(Audio and Haptic for Entering the Vehicle)
- *Concierge and Dispatch for Help **
- *Directions to Empty Seats in Vehicle*
- *Door Handles Easy to Find*
- *Facility for Animal Helpers Joining the Vehicle **
- *Facility for Equipment to Be Stored on Vehicle (e.g., Wheelchair) **
- *Facility (Automatic or Manual) for Down Ramp and Retracting*
- *Facility (Automatic or Manual) for Height of Ramp to Street*
- *Facility (Automatic or Manual) for Up Ramp and Retracting*

Experiencing Riding in the Vehicle

- *(App for)*
- *Display of Features for Riding*
(Audio and Haptic for Experiencing Riding in Vehicle)
- *Concierge and Dispatch for Help **
- *Destination Location and Route*
- *Door Handles Easy to Find in Vehicle*
- *Facility for Incident Management in Vehicle **
- *Facility for Interior Lighting in Vehicle*
- *Facility for New Destination Location (with Driver) While in Vehicle*
- *Facility for Language in Sign**
- *Facility for Opening and Closing Vehicle Windows*
- *Landmark Narrative on Route **
- *Music Option in Vehicle **
- *Narratives for Next Route Stops and Timings **
- *News Option in Vehicle **
- *Option for News on Route Weather **
- *Reminder on Seat Belts*

Experiencing the Safety of the Vehicle

- *(App for)*
- *Display of Features for Safety*
(Audio and Haptic for Experiencing Safety in Vehicle)
- *Concierge and Dispatch for Help **
- *Door Handles Easy to Find*
- *Facility for Incident Management in Vehicle **
- *Facility for Interior Lighting in Vehicle*
- *Facility for New Destination Location (with Driver) While in Vehicle **
- *Facility for Opening and Closing Vehicle Windows*
- *Facility for Physical Restraints of Storage (e.g., Wheelchair)*
- *Movement of Vehicle Only Upon Interior Systems*

Exiting the Vehicle

- *(App for)*
- *Announcing Destination Location*
- *Door Opening of Vehicle (Automatic and Manual)*
- *Door Closing of Vehicle (Automatic and Manual)*
(Audio and Haptic for Exiting Vehicle)
- *Concierge and Dispatch for Help **
- *Door Handles Easy to Find*
- *Facility (Automatic or Manual) for Down Ramp and Retracting*
- *Facility (Automatic or Manual) for Height of Ramp to Street*
- *Facility (Automatic or Manual) for Up Ramp and Retracting*

*Honking of Vehicle Prior to Exiting the Vehicle **

*AutoNme Paper (Li, Greene, Purwar, & Rhau, 2020)

The design model assumes adaptive cruise control (ACC), automatic emergency braking (AEBS), avoidance of collision and object (CAS), camera-based, control of lane and recognition of signs on streets, laser detection (LIDAR) map sensor and connected vehicle (V2V) systems of autonomous vehicles, especially in experiencing riding in the vehicles and experiencing the safety of the vehicles.

Note: Facilities in the model are features for people with disabilities and are not features that might be generic necessarily to autonomous ride services technologies.

The car manufacturers engaged in the features of generic products of autonomous ride services that might be integrated into the design model include the following:

- Apple “AR5”;
- Aptiv Hyundai;
- BMW (with Daimler Mercedes);
- Ford “ArgoAI” (and with Lyft);
- General Motors “Cruise Anywhere”;
- Google (Waymo) Chrysler Pacifica “Waymo One”;
- Mercedes “Robo-Taxi” (with BMW);
- Merlin “Mobility”;
- Renault “EZ-GO” Robo-Taxi;
- Testla “Tesla Network”;
- Toyota (with May Mobility);
- Uber “UberAV”;
- Volkswagen “Sedric” (with Ford); and
- Volvo (with Uber).

Importantly, a few of the manufacturers are involved in partnerships that are prominent with disability organizations, on the autonomous ride services technologies (Reardon, 2021, & Wiggers, 2020):

- General Motors (National Federation of the Blind and Lighthouse for the Blind);
- Volkswagen (Disability Rights Education and Defense Fund, National Federation for the Blind and National Association of the Deaf - Inclusive Mobility Initiative); and
- Waymo (Foundation for Blind Children and Foundation for Senior Living).

Progress in the inclusiveness of the technologies in the vehicles is nevertheless perceived as slow to people with disabilities (Wiggers, 2020).

As the authors are informed more of the mobility needs of the people with disabilities, from the disability non-profit organizations and from the people with disabilities in the final study, the design model of this paper will be modified for the new services then.

PRELIMINARY IMPLICATIONS OF PAPER

“There will be more change in [transportation] in ... five to ten years than ... in the last fifty years.” (Mary Barra, Chief Executive Officer, General Motors)

Autonomous vehicles are continuing to be designed by car manufacturers. Autonomous ride services (ARS) are continuing to be designed faster however by manufacturers and by organizations for ride sharing, such as Lyft and Uber, and autonomous ride services are expected to be the first sufficiently-autonomous market in the vehicles in metropolitan sections (McGrath, 2020). The immediate implication is that as advocates disability organizations might be engaged more in the design of autonomous ride services with the manufacturers and with the organizations for ride sharing, so that as consumers disadvantaged people might benefit from first mover services.

Disability organizations are critical in the development of autonomous ride services. Diversity is important in the inclusion of people with disabilities that might benefit the most from ride sharing systems (Alexiou, 2021). Manufacturers, and even organizations for ride sharing, might learn more about people with disabilities if disability organizations are included more in the inputs into the nuances of the technology. If not, the products of the technology might not benefit people with disabilities (BraunAbility, 2022). The implication is that disability non-profit organizations might be included more in the development of autonomous ride services, so that people with disabilities might benefit effectively from the technology.

Disability organizations are crucial in enhancements of the technology. Consulting in the direction of the evolution of the features of engaging the vehicles, entering the vehicles, experiencing the riding of the vehicles, experiencing the safety of the vehicles and exiting the vehicles, from the

design model for those with disabilities, sooner in the stages of the systems is important as a accessibility principle for this technology (Motional, 2021, & Riggs, & Pande, 2021). The implication is that the evolution of autonomous ride services for those with disabilities might be a proactive process of including the disability organizations and those with disabilities in the practicality of this technology.

Disability non-profit organizations might be enablers of autonomous ride services for people with disabilities by engaging in governmental partnerships. Municipalities might be interested in partnerships with the non-profit organizations in pilot programs of autonomous ride services. The United States Access Board and the United States Department of Transportation might be interested in piloting Inclusive Design Challenge and Inclusive Mobility Initiative (IMI) programs for driver-less systems with the manufacturers and the non-profit organizations. Importantly, the disability organizations might be partnering with the Department of Transportation on proposing regulations on the technology, as manufacturers and the regulators struggle with this (Alexiou, 2021). The implication is that non-profit organizations for those with disabilities might inquire of governmental partnerships proactively, so that they might benefit from the programs.

Finally, the project is benefiting the second author – student engaged in this preliminary study in the Seidenberg School of Pace University. The student is involved in learning of a neglected population that might benefit from accessible autonomous ride services technology – a paradigm-shifting technology (Mankoff, & Wobbrock, 2022), if not learning of autonomous vehicles for those without disabilities. This implication is that STEM students might be more involved on studies of technologies that might be helping disadvantaged people in society.

LIMITATIONS AND OPPORTUNITIES

The descriptive findings of this paper, and on autonomous ride services vehicles not autonomous vehicles, are clear limitations of this paper. The findings are from the preliminary study, not from fruitfully hopeful impacts that might be from the final study involving the people with disabilities as subjects. Also, the forecasts for autonomous ride services can be considered not exact and hype (Kane, Phillips, Copulsky, & Andrus, 2019) that is not infrequent in the media of autonomous vehicles. However, this paper contributes a design model that is a foundation for further study of the future of this technology. Hypothetically, this paper initiates a journey on this topic.

CONCLUSION

The advent of autonomous ride services (ARS) is a benefit for people with disabilities. Barriers in current mobility of people with disabilities are alleviated in the conceptions of autonomous ride services. Disability organizations, and especially people with disabilities, are critical however in how autonomous ride services vehicles might be better designed for accessibility for disadvantaged people. The authors explored the manufacturer products of the technology that might be better designed in a foundational model to help the metropolitan mobility needs of this population. Overall, the authors of this study posit the potential of autonomous ride services vehicles for those with disabilities in our society.

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APPENDIX

Autonomous Vehicle Taxi, www.google.com, May 2022

<https://vimeo.com/manage/videos/747779130>

ANALYZING FINANCIAL LITERACY USING EXPECTANCY THEORY

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ABSTRACT

Being a financially literate consumer is more than simply knowing about personal financial concepts and strategies. In order to truly meet the definition of financial literacy, one must choose to engage in financially literate behavior. It has been determined that many consumers know how to make sound financial choices, but simply do not choose to make the sacrifice. In this study, we use the expectancy theory of motivation to analyze the choice between using one's money to purchase some desired item or making a long-term investment. Results suggest that positive and negative reinforcement, through the use of a budgeting app, may influence consumers to make the sound financial choice, and choose the investment.

INTRODUCTION

Being a financially literate consumer is becoming more and more important (Lusardi, 2009). Perhaps the most overarching influence on the need to make smart financial choices is the fact that social programs designed to aid consumers as they age, like Social Security and Medicare, are woefully underfunded and facing uncertain futures. Even the most optimistic forecasts suggest these programs may only be able to provide about three-quarters of the benefits that they provide to current retirees (Rosen, 2021). And while many Americans depend on these benefits to fund their retirements, Social Security was only ever meant to be an income supplement, not the sole source of retirement income (SSA.gov).

Adding to the need to be financially literate is the increasing level of complexity associated with personal financial planning concepts, strategies and products. Very few consumers truly understand popular financial instruments like cryptocurrencies, SPACs, and NFTs. Even market professionals have difficulty understanding and properly utilizing these assets. In addition, the economy itself has become more complex. Many of today's consumers have never experienced inflation over three percent and a tightening monetary policy. Furthermore, none of today's consumers have ever had to make financial decisions in the midst of a global pandemic. And lastly, consumers relying on their employers to look out for their financial well-being are likely to be disappointed. Gone are the days of defined benefit plans (with just a few lucky exceptions) to fund consumer retirement lifestyles. These plans have been replaced with defined contribution plans that require attention, understanding, sacrifice, and strategy from their participants. Unfortunately, it seems that as the need to become financially literate becomes more important, it has arguably never been more difficult to make smart financial choices for oneself and one's family.

The need to educate consumers has become a popular topic. Policymakers and educators have been working to improve America's understanding of personal finance for many years (Crain, 2013). Unfortunately, efforts to increase the financial literacy of American consumers have met with mixed results. Several studies have suggested, that despite the dedicated attempts, Americans maintain an alarming lack of general personal financial planning knowledge (Lusardi & Mitchell, 2007; Bucks & Pence, 2008; Lusardi, Mitchell & Curto, 2010).

Perhaps; however, in some cases, it is not "knowledge" that Americans lack, but motivation. Some studies have suggested that while an understanding of the basics of financial planning are potentially helpful, this knowledge alone does not necessarily motivate consumers to change their financial behaviors to those that they know to be more financially sound (Mandell & Klein, 2007, 2009). Just like an understanding of health and human performance does not necessarily help an individual to become physically fit, an understanding of personal finance concepts and strategies does not necessarily help one to become wealthy. Unfortunately, for personal finance educators and policy-makers, teaching students about financial planning is likely much less complicated than actually motivating these same consumers to change their poor financial behaviors. Something more may be needed.

Expectancy Theory as it Relates to Financial Literacy

Several theories analyze the factors that can lead to motivation. One popular theory for analyzing motivation is Victor Vroom's expectancy theory (Vroom, 2015). Expectancy theory suggests that a person will act in a certain way because they are motivated to select a specific behavior over others due to what they expect the result of the selected behavior will be – the desirability of the outcome. However, the outcome (itself) is not the sole determining factor in deciding how to behave. The decision is based on the expectancy (E), instrumentality (I), and valence (V) of the action.

$$E \times I \times V = \textit{Motivation}$$

- E = Expectancy – the belief that an effort will be successful (influenced by the possession of knowledge, information or the appropriate skill). Valued between 0 and 1.
 - As it relates to financial literacy, expectancy is having financial knowledge – knowing what the right financial decision is likely to be. This variable would be largely dictated by knowledge of financial products, services, and strategies.
 - *For example:* If a consumer knows that saving into a 401(k) is a good strategy to reach their retirement goals, then (E) will be close to one (100%). If the consumer has no idea how to plan for retirement, then (E) will be close to zero as it relates to the decision to save into a 401(k).
- I = Instrumentality – faith in the result (clarity in the relationship between performance and outcome). Valued between 0 and 1.
 - As it relates to financial literacy, instrumentality is the belief that if one is to engage in the behavior (investing), that one's goal will be met (successful retirement). This variable is also mostly dictated by knowledge of financial products, services, and strategies.
 - *For example:* If a consumer is confident that saving into a 401(k) will lead to the desired retirement goal, then (I) will be close to one (100%). If the consumer believes that saving into a 401(k) will provide no measurable benefit in meeting retirement goals, then (I) will be close to zero.

- V = Valence – expected satisfaction that relates to reaching the goal (the significance of the expected outcome). Valued between -1 and 1.
 - As it relates to financial literacy, valence has little to do with knowledge of financial products/strategies. Valence (in most cases) involves the sacrifice of something desired today for something less tangible to be obtained in the future.
 - If a consumer understands the urgency of saving for retirement (now) and the importance of having assets to fund a future retirement goal, then (V) will be positive. If the consumer cannot appreciate the importance of such an intangible goal (such as having a dedicated retirement fund available in the future) then allocating dollars to a 401(k) may be close to zero. Further, if the consumer has other more tangible needs or wants (a new phone for example), then saving dollars into a 401(k) may actually be negative.

According to the theory, E , I , and V must all be close to one for the decision-maker to be motivated to act, and thus engage in the desired behavior. Therefore, educating consumers on financial products and strategies is important as it is likely to raise both expectancy (E) and instrumentality (I). However, if the value of any of one of these variables remains close to zero, then motivation will also be close to zero, with no desire to change behaviors. While education can certainly influence valence (V) to a certain degree, one still has to see value in the result. If consumers do not appreciate the importance of the financially literate behavior, knowledge alone will not motivate the consumer to act.

For many educators, a financially literate consumer is a consumer who knows about personal finance. Knowledge is definitely important as it is a significant factor for both (E) and (I) of the expectancy theory equation. However, if a consumer has knowledge of sound personal financial strategies, but does not behave as if they have this knowledge, can we truly consider that consumer to be financially literate? There is a strong argument that the failure to address (V) in the expectancy theory equation is why financial literacy efforts do not seem to be having the desired impact on society (Mandell, 2006). “Knowing” may be two-thirds of the equation, but it is not the whole equation. Consumers must be motivated to act on what they know.

So, as financial literacy educators, how do we increase the valence of the expectancy equation? One option may be to provide an increased level of positive reinforcement for good behaviors and negative reinforcement for the lack of good behaviors. Providing additional positive reinforcement for making good choices and negative reinforcement for failing to make good choices could potentially alter the perceived valence of the expectancy equation. Regular positive reinforcement is its own incentive if consumers feel they are making progress toward their financial goals. But in addition, regular negative reinforcement could introduce fear and/or guilt as a potential incentive, and possibly help motivate a wise financial choice.

Both the positive and negative reinforcements described could come from numerous sources. Parents, employers, spouses, or even a personal financial advisor could readily provide these types of inducements. However, for the purposes of this study, we wanted to look at the efficacy of financial technology to help motivate financially literate behaviors. For instance, if properly utilized, budgeting apps can alert consumers if they are spending too much in one area or another. They can also recognize good behaviors and readily praise consumers for making smart financial choices (Frost, Gambacorta, Huang, Shin, & Zbinden, 2019). Could these budgeting apps, and both the positive and negative reinforcements they provide, increase the valence of the expectancy equation, and motivate consumers to make smart financial choices?

METHODOLOGY

For the purposes of this experiment, a survey was designed that attempted to test if the use of positive reinforcement for making a financially wise decision, and the threat of regular negative reinforcement for making a poor choice, might motivate respondents to choose a long-term investment strategy over a more short-term desire. In particular, a survey was designed that attempted to control for both expectancy (E), and instrumentality (I) so that the valence (V) of the two different decision-making scenarios could be measured. For the purposes of this particular survey, both the positive and the negative reinforcement was to be regularly delivered by an unspecified “phone app”.

We surveyed sixty-eight college students who were enrolled in various finance and accounting courses at Roanoke College in the spring term of 2022. Having taken business courses in accounting/finance, students had been exposed to the basic concepts of investing and the time-value-of-money. Ages for the survey group ranged from 18 to 23, with an average age of approximately 20 years old.

The survey consisted of three scenarios. The first scenario asked students the following:

Scenario One – Take a moment and think of several things that you would like to buy. These “things” can be anything other than savings, investments, or debt repayments. Possible items might include electronics, vacations, apparel, etc. Now assume that you have just been given \$2,000 to purchase (or apply toward) these items. On a scale of 1 – 100, please rate your level of happiness from obtaining your item (1 is not very happy at all and 100 is as happy as you can imagine).

Scenario Two – You have just been given \$2,000 with the following stipulation. You will need to invest this \$2,000 into an account and may not access it for twenty-five years. However, after the necessary time has elapsed, your \$2,000 is guaranteed to be worth \$30,000. On a scale of 1 – 100, please rate your level of happiness from this investment (1 is not very happy at all and 100 is as happy as you can imagine).

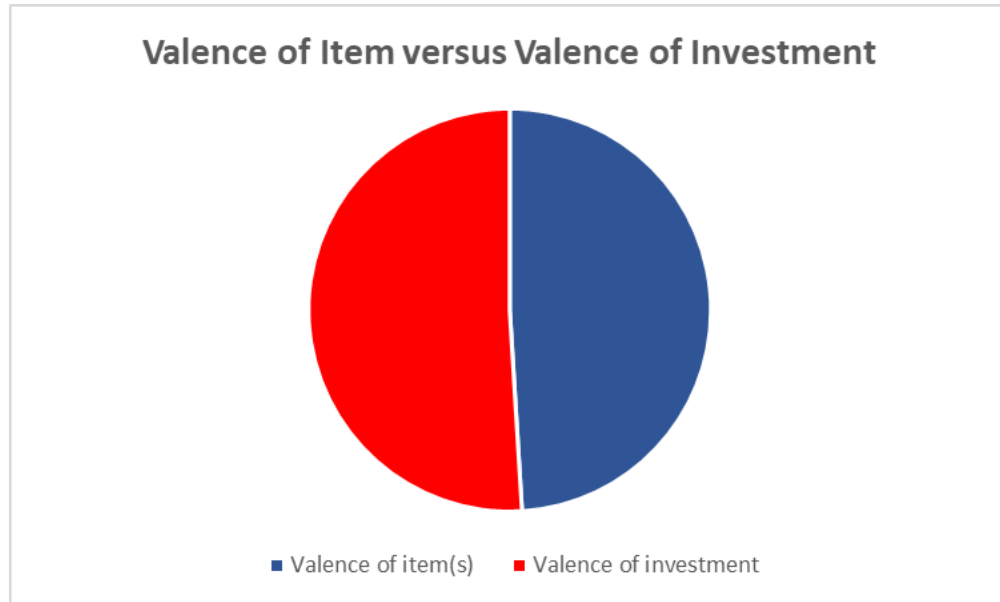
Scenario Three – You have been given the choice of using the \$2,000 toward your desired items from Scenario One or investing the \$2,000 in the account described in Scenario Two. However, if you choose your desired items, you will be required to check an app on your phone at least twice per year (for the next 25 years) that will show you what your \$2,000 would have grown to over the time period. If you, instead, choose to invest the \$2,000, you will have the same app and may check it whenever you like to see the growth of your invested money. Which one will you choose – your most desired items or the investment?

Note that both scenario one and two attempt to control for the expectancy and instrumentality of the equation. By “giving” the money and then “guaranteeing” the growth of the investment, expectancy (E) and instrumentality (I) for both scenarios should be close to one. Then, by asking students to rate their happiness on a scale of 1-100, we are only measuring the valence of each of the two scenarios – the value the student places on the respective behavior.

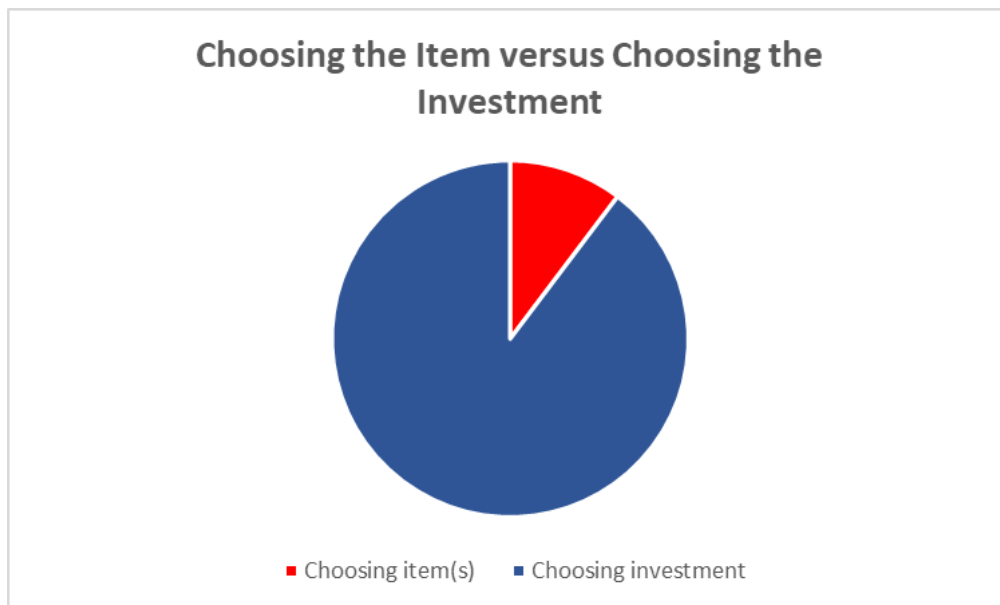
The goal of scenario three is then, to determine the survey-taker’s actual intended behavior. Assuming that students value “things” and “experiences” as much, or more than, “investing”, a decision to choose the investment might likely be due to the influence of the positive and negative reinforcement described in the scenario. Would the positive or negative feedback associated with the app influence survey-takers to choose the long-term investment over the shorter-term desire?

RESULTS

While it was hypothesized that students would demonstrate a higher valence for the shorter-term desires over the long-term investment, the students in this group valued both equally. The mean valence of the item(s)/experience(s) was 80.00 and the mean valence of the investment was 83.16. A paired t-test was run on the data and the hypothesis that the two means were different was rejected ($p = .177$). The means are equal.



However, when students were then asked which of the two options they would choose, given the positive and negative reinforcement associated with the phone app, students demonstrated a dramatic preference for the investment with 89.7% (61 out of the 68 students) choosing the investment over the item(s)/experience(s).



DISCUSSION

As educators, it is nice to be able to lecture on a topic, assign readings, and then test students on what they have learned. Success can simply be measured by the retention of knowledge. But when it comes to the effort to create a more financially literate society, knowledge retention alone, is not enough. Educators must find ways to actually motivate changes in behavior.

In this effort, more research designed to improve a decision-maker's valence appears to be warranted. It would be interesting to compare the results of this survey with a similar survey that does not utilize the positive and negative reinforcement associated with the phone app. Would survey-takers still choose the investment? What if both expectancy (E) and instrumentality (I) were not controlled (as in most real-world scenarios)? What impact would this have on efforts to reinforce valence and change behavior? Could other behavioral theories of motivation be utilized to determine even better or more simplistic methods of influencing changes in behavior?

While changing behavior is not easy, the findings of this study suggest that financial technology may provide some needed aid in this area. Something as simple as the regular use of a budgeting app may provide the push that consumers need to make the sacrifice and choose long-term needs over short-term desires. Be it fintech or some other strategy, hopefully educators will continue to attempt to influence financially literate behaviors in their students, because knowing is only half of the battle.

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APPLYING A MOBILE APP TO ADDRESS HOUSEHOLD FOOD WASTE

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ABSTRACT

Food waste is a highly relevant social issue that is impacting our planet. This particularly impacts household food waste and has many implications for our health and future. The measures that are being taken to prevent this issue from worsening should include mobile applications. Through mobile applications, millions of people can be reached at once. This power should be used to help in the fight to prevent food waste and is exactly what the mobile application (app) of this paper is attempting to do in a dissertation project. This mobile application will prevent household food waste by creating a facility for households to have an inventory of the food that is in their homes.

Keywords: Disposal of Food, Household Waste, Mobile Computing, Sustainability, Waste

BACKGROUND

“There’s an app (application) for that” is a slogan that has had a stable existence in our vernacular since its conception. Made infamous by Apple as part of an advertising campaign in 2009, it has not become any less relevant in the 13 years since it was introduced by Apple. In fact, it may be even more relevant now than it was when Apple was first using it to promote its wide assortment of mobile applications in the App Store.

Mobile technology has had consistent and positive growth, with new applications arriving daily. There are now mobile applications for things that no one had even thought to imagine in 2009, like Nurx, a birth control subscription service. Critically, it is not only mobile applications that have had constant upward growth but their user base as well. In 2009 there were 170 million smartphone sales, while in 2015 that number had grown to 1.4 billion (Gartner Group, 2018); this number is constantly rising and showing no signs of slowing down. With the kind of outreach that mobile applications have it would be foolish to not utilize them for social issues that are dependent on outreach to make a change.

Household food waste is a significant global issue. In the United States alone, food waste accounts for 30 to 40 percent of the food supply, which corresponds to about 133 billion pounds and \$161 billion worth of food (Gerber, 2018). This approximation for pounds and monetary value of food waste is for one year only. It paints a grim picture to think that every year these numbers grow exponentially. Food waste is an issue that is not going to disappear on its own. It is complicated and far-reaching.

Food waste in domestic households is exactly the kind of social issue that should be making use of mobile applications. They should utilize mobile applications because household food waste is directly connected to the actions of the people that make up the households; therefore reaching them is integral to the cause. There is no better way to reach households in this country than through their smartphones.

There are existing mobile applications that were created for the purpose of preventing food waste. The mobile application in this paper, “Fridge on the Go”, designed for a dissertation project, is developed as an approach to preventing food waste. This mobile application is targeting household food waste that arises from the groceries that are brought into the home and are not properly utilized there.

This mobile application will allow the user to keep an inventory of the groceries they purchase. The products will be organized in a way that encourages a full usage of them. There are mobile applications on the market with similar concepts. What makes the mobile application of this paper stand apart is that it has been specifically developed with the purpose of preventing food waste. It is not simply an inventory, but an inventory that is being collected with the purpose of encouraging the user to utilize all their resources, with minimal waste.

INTRODUCTION

Food waste is a significant issue that has deep ramifications on our climate, economy, and food supply. It is an issue that has a wide reach and needs to be combated on multiple levels, “governmental, industry, and individual” (Hanson, & Ahmadi, 2021). Domestic food waste in our homes, the individual level of food waste, is deeply problematic. Food waste makes up 40% to 60% of a household’s total annual garbage (Hayley, 2008), not an insignificant number. Mentioning this aspect of food waste is not done with the intention of simplifying this issue but by implying that it solely falls onto the individual to end it. However, the individual and her / his impacts should not be seen as an unimportant aspect of the combat against food waste. Individual behavior is still a valuable aspect of the long-term fight against food waste because it is something that is in the control of average individuals, unlike the governmental and industrial levels.

Due to the constant evolution of technology, most of the research that has been made on the role of mobile applications against food waste does not span a large timeframe and is instead from more recent years. This does not mean that the existing literature is not credible but instead suggests that there will be more advancements to come - advancements that will make technology an even more effective tool.

Technology has made it possible to reach millions of people via mobile applications, a strong option for anyone attempting to combat any sort of societal injustice. They are “one of the major features of our society” (Makuochi, et.al., 2021), and therefore an extremely valuable tool that has to be utilized in order to effectively combat food waste on an individual level. Mobile applications “support users to perform target behaviors” (Makuochi, et.al., 2021), which is exactly what makes them so effective in preventing food waste- targeting individual behaviors.

There are many different ways to utilize mobile applications to prevent food waste. What many applications are doing in order to impact their user’s individual behavior is employing persuasive strategies.

In the paper, “Persuasive Apps for Sustainable Waste Management: A Comparative Systematic Evaluation of Behavior Change Strategies and State-of-the-Art” by Makuochi, et.al. (2021), identified “reduction strategies” as the most effective persuasion technique for mobile applications. This strategy has the goal of user-friendliness in mind, striving to make the user have a straightforward experience with the mobile application. Reduction strategies implement “easier avenues to carry out target behaviors” as this will “motivate users to engage with and continue with the behaviors” (Makuochi, et.al., 2021). The paper gives examples of how the implementation of this strategy looks, such as a mobile application showing the “nearest public waste bucket” (Makuochi, et.al., 2021) This strategy is as simple to include in a mobile application, as it is for the user to digest.

Another paper, “Socially-Oriented Persuasive Strategies and Sustainable Behavior Change: Implications for Designing for Environmental Sustainability” by Makuochi, et.al. (2020), identifies “social facilitation” as the most effective persuasive technique. This technique aims to “detect other users who are performing target behavior” (Makuochi, et.al., 2020). This strategy is implemented through chat features and other communal aspects that are tied to user performance. This strategy focuses on allowing users to gain motivation to perform certain behaviors based on the behaviors they see other users perform. Users will be more motivated to perform the behaviors that the mobile application wants them to perform in the process. In this case, these behaviors are actions that prevent food waste.

There is “a significant relationship between the number of persuasive strategies and apps effectiveness, as indicated by user ratings” (Makuochi, et.al., 2020), including a combination of persuasive techniques that will make for a more effective and powerful mobile application.

The existing research that has been made into the utilization of mobile applications for combating food waste has identified some key features that are effective in a facility.

Having an up-to-date inventory of the food that is present in the household was found to be the “most effective design [feature for] improving food supply knowledge.” (Jeremy, et.al., 2014). This feature does have its drawbacks as the separation of the food location and inventory can cause issues to arise. That is why having a “co-located device with food storage” (Jeremy, et.al., 2014) would be the most effective utilization of this feature.

Another beneficial feature that was identified is having a recipe suggestion feature. This feature was found to be a “likely contributor to a reduction in food waste” (Jeremy, et.al., 2014). It goes

the extra step of not only ensuring that a user is knowledgeable about their inventory, but that he / she effectively utilizes it all.

A final feature that seems to be the most common method for mobile applications to combat food waste is the promotion of food sharing. Most of the successful mobile applications that prevent food waste are applications that assist users in finding leftovers from local restaurants. While an effective way to ensure that no food goes to waste, this feature can be seen as controversial because of “concern of trust and comfort” of the users (Geremy, et.al., 2014).

Mobile applications have proven to be effective in impacting individual user behavior and preventing food waste.

The paper, “Food Talks Back: Exploring the Role of Mobile Applications in Reducing Domestic Food Wastage” by Geremy, et.al., (2014), found that the mobile applications studied that were created with the purpose of preventing food waste had “a positive impact on raising consumer awareness of their food supply, location, and literacy”. Raising consumer awareness is a pivotal task for preventing food waste. Improving the awareness of individual consumers will in turn impact their actions, which is the only method that domestic food waste can be combated. It is all in the actions of the individual in her / his household.

The use of social-based persuasion techniques in mobile applications that attempt to prevent food waste has found the apps to be “effective at promoting sustainable and pro-environmental behaviors” (Makuochi, et.al., 2020). Once again, targeting individual behavior in a mobile application has proven to be effective. Developers in fact include specific features in their mobile applications that they know will encourage a specific response from their users.

Clearly, the utilization of mobile applications in the battle against food wastage is a route that has merit and should continue to be explored.

METHODOLOGY

The “Fridge on the Go” app in this paper was designed by the first author-student, and advised by the second author-professor, in a dissertation project at Pace University, using Android Studio. Options were relatively limited considering “99.6% of smartphones [run] on either iOS or Android” (Hanson, & Ahmadi, 2021), but it was still an easy decision of the first author to choose Android over iOS. The app is a native Android application because of its ease of use. It is not a cross-platform application because of the time constraints for this project in the one semester of spring 2022.

The reason that Android Studio was the best environment to develop this mobile application is because of the tools that it offers developers – it has its “own ecosystem of tools to support it” (Gerber, 2018). Having this kind of in-house support was ideal for a more effective mobile app development. It saved time, and the process of this project was simple.

There are two main programming languages used with Android Studio: Java and Kotlin. Java was used for this mobile application, as the first author was already experienced in the language. This

familiarity, and the memory management that is afforded by Java, were the factors for including the language. Android Studio is also a “memory-managed programming environment” (Gerber, 2018), so the combination of the two was convenient for this project.

There are two sides to the mobile application. There is the front end, which is what users of the app are interacting with, and is the app itself. Then there is the back end, which is controlled by the developer and in this case is Firebase. The application of Fridge on the Go is illustrated in the next section of this paper.

DESIGN EXPERIMENT

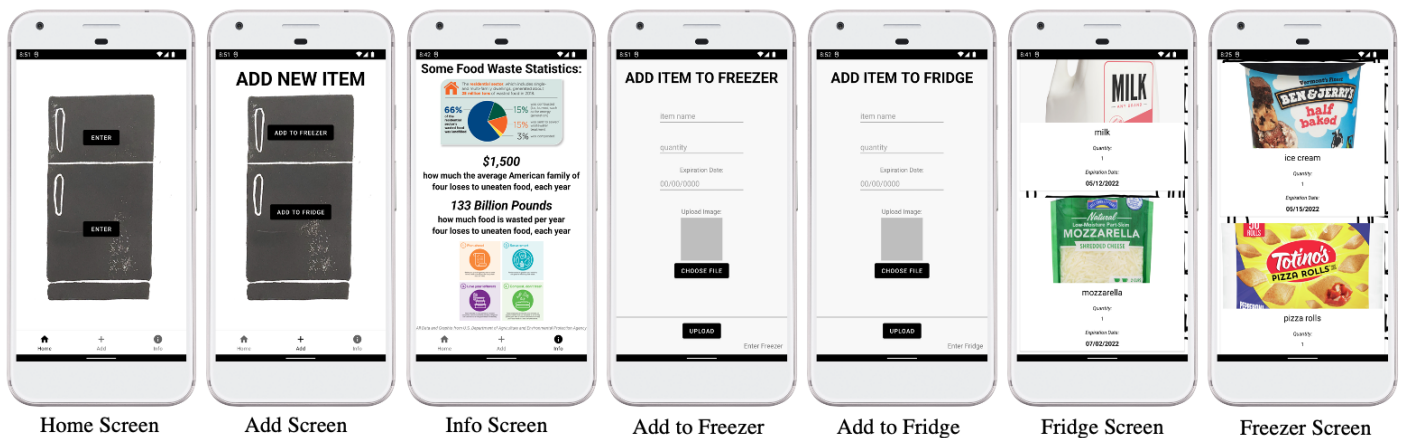


Figure 1: Fridge on the Go Screens

Splash Screen

The first page that users will encounter when they open the application. This page is a brief flash on the screen when the application is first opened. It includes a picture of the application logo and white background.

Home Screen

The home screen of the application is the main screen that will load when users open this application. There will be two options for the users here: To enter the fridge; To enter the freezer.

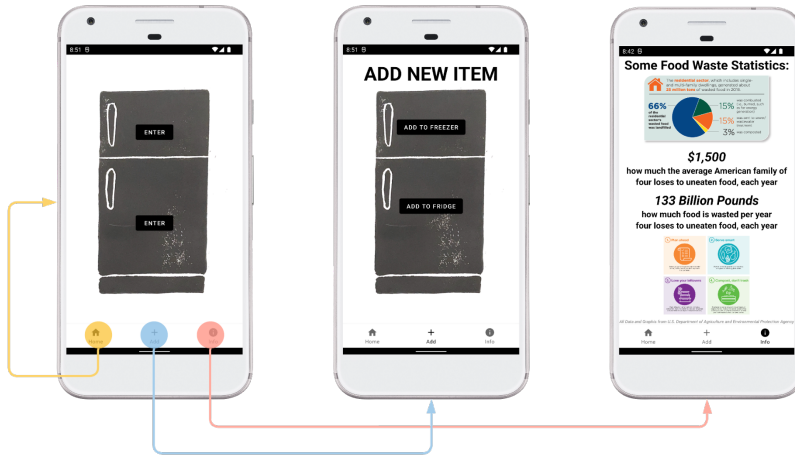


Figure 2: Home Screen Functions

Add Item Screen

The add item screen is where users will be able to select whether they want to add items to the freezer or to the fridge. They will enter the add item to the freezer screen or the add item to fridge screen.

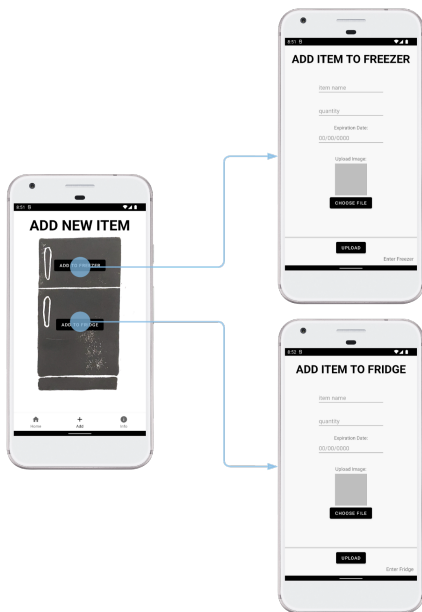


Figure 3: Add Item Screen Function

Add to Freezer / Fridge

These two screens are the specific add item pages for the fridge and the freezer. The users will be able to add the name of the item, the quantity, the expiration date, and upload a picture from their camera roll.



Figure 4: Example of Adding Item to Fridge
Fridge Screen and Freezer Screen

The fridge screen is where all of the users' fridge entries will appear. These items will be sorted by expiration date, prioritizing what will expire first. Users are able to delete items.

The freezer screen will contain all of the users' freezer entries. These items will be sorted the same way as the fridge screen, with soon-to-expire items at the top. Users will be able again to delete entries.



Figure 5: Freezer Screen with Example Inventory

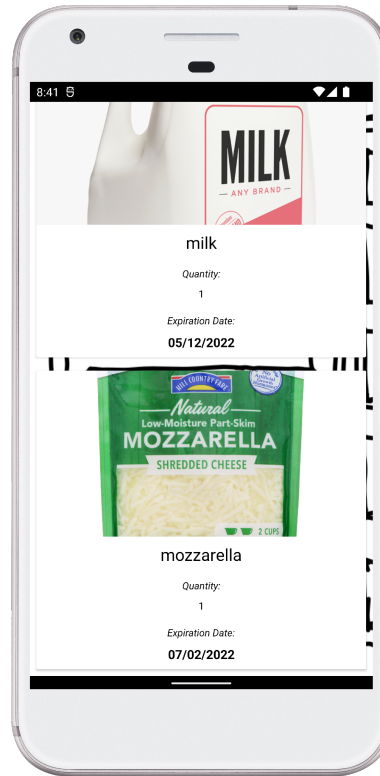


Figure 6: Fridge Screen with Example Inventory

Information Screen

This screen is purely informational. The goal is to make users learn new information about food waste, and understand the deep impact that it has on the world.

The functionality of this application is dependent on Firebase Database and Firebase Storage. The Android Studio environment is extremely compatible with Firebase.

The Firebase database feature is used to store all user entries made in the Add to Freezer and Add to Fridge screens. Each time a user enters a new item in the Add to Fridge/Freezer screen, there is an entry created into the firebase database with a unique id. If the user entered the entry in the Add to Freezer screen, her / his entry is nested under the “freezer” node in the database. If the user entered the entry in the Add to Fridge screen, it is nested in the “fridge” node.

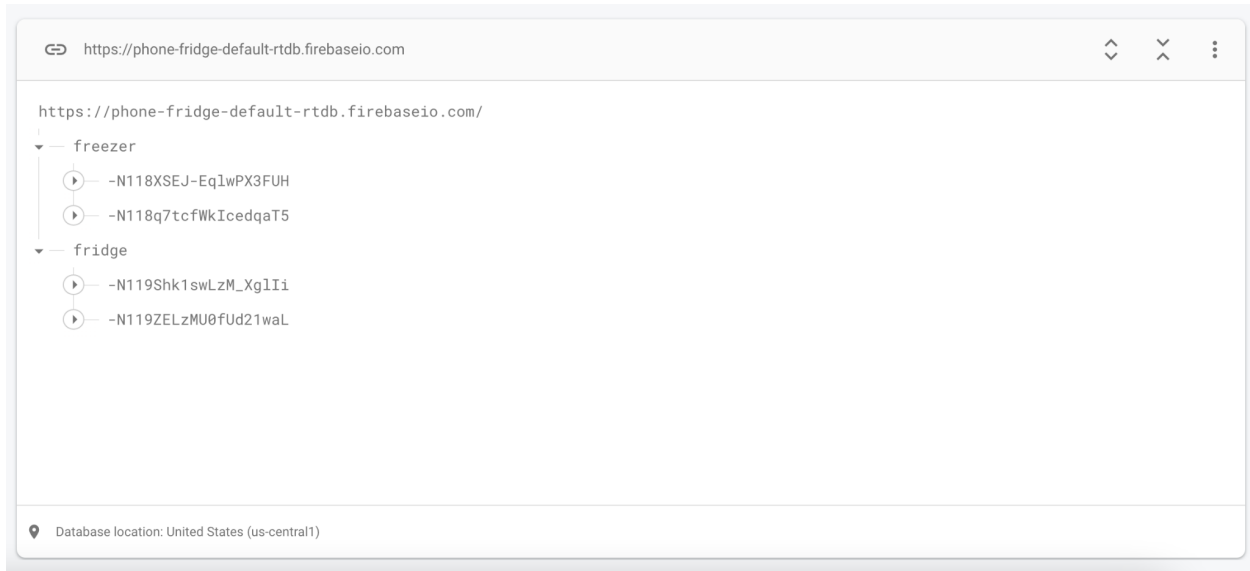


Figure 7: Firebase Database with Example Entries

Each entry in the database has a set of attributes that are populated by the user-inputted entries. These attributes are the name of the item, the quantity, the expiration date, and an image that the users can upload from their camera roll. These attributes were chosen because they are the most pertinent for the users to know about their food items.

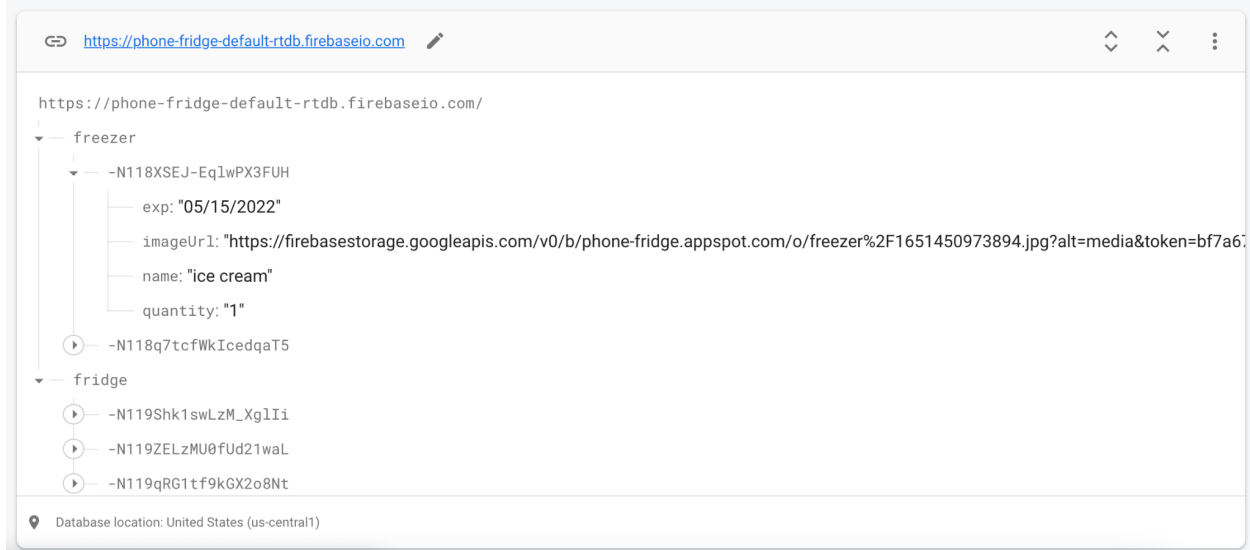


Figure 8: Freezer Item Entry Example with Attributes

Ease of use for the users was prioritized in the design. The users just have to navigate only to the screen of their choice, fridge or freezer, and enter the information of their item. Their entry will be inputted into the right place. This was done by specifying a pathway for the database in the java classes for the Fridge Screen and Freezer Screen.

```
mStorage = FirebaseStorage.getInstance();  
mDatabaseRef = FirebaseDatabase.getInstance().getReference("fridge");
```

Figure 9: InsideFridge.Java Snippet

```
mStorage = FirebaseStorage.getInstance();  
mDatabaseRef = FirebaseDatabase.getInstance().getReference("freezer");
```

Figure 10: InsideFreezer.Java Snippet

Firestore was used to handle the user image uploads that come with every item entry. Like the database, there is a specified pathway for the user entries depending on whether they are in the Add to Freezer or Add to Fridge screen.

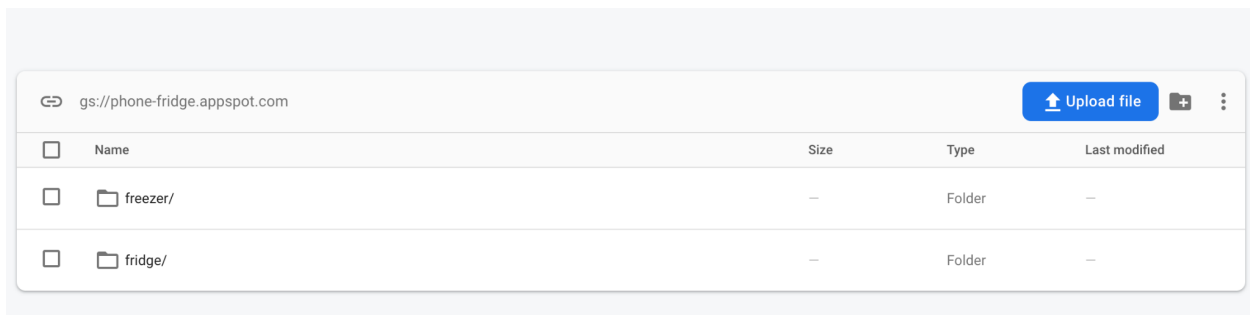


Figure 11: Firebase Storage with Separate Folders for Freezer and Fridge Entries

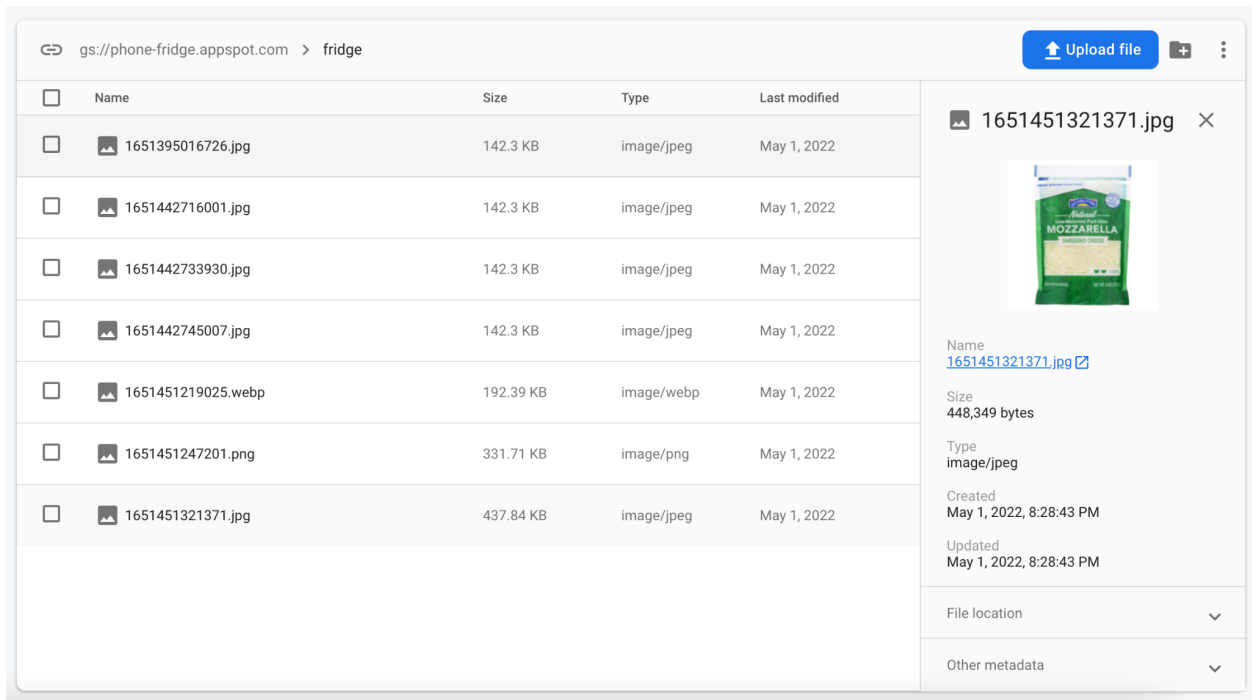


Figure 12: Example Fridge Item Entries in Firebase Storage

IMPACTS

Given the limitations of resources and semester timings, the mobile application, Fridge on the Go, has accomplished fundamental objectives. This application creates an inventory of the food products that users bring into their homes, while also educating users on why food waste is a significant issue. Having access to a visible inventory that the users can add to and edit at the touch of their fingertips will impact the behavior of the users of this app in a manner that will combat food waste.

Fridge on the Go will impact users even if they are not in their homes. If the users are at the grocery store and unsure about how much of an item to buy, or whether they still have anything left of another item, they can use Fridge on the Go. Users can easily check the Fridge Screen and Freezer Screen to see what they have at home. This will prevent users from overbuying items that they will not use, preventing food waste.

Another Fridge on the Go feature that will impact users is the sorting of Fridge and Freezer items. The items on these screens are sorted by the expiration date. Items that will expire soonest are at the top of the page and the first thing users will see then. Reminding users that these items exist, and making it clear that they will soon go bad will encourage them to consume these products. This behavior will impact food waste by preventing the wastage of items that are not used before their expiration dates.

LIMITATIONS AND OPPORTUNITIES

There are features of Fridge on the Go that could be improved upon. Currently, if the users want to change one of the attributes of an item after it has been entered, they must delete the entire entry and make a new one. It would be much more effective and user-friendly if the users were able to edit entries after they are made. Moreover, users are not able to sort items in the Fridge and Freezer by themselves, as the items are automatically sorted by expiration date. It would be an enhanced feature to allow the users to select how they want their items sorted by Fridge on the Go.

Other features include a screen that suggests recipes for users based on the items that they have in their fridge and barcode scans to add items to their inventory.

CONCLUSION

There are alternate approaches in designing a mobile application focused on the prevention of food waste. Food waste is a broad issue that can be narrowed into diverse specifics. When focusing on household food waste, there are more approaches in feature specifics that can be developed by students engaging mobile computing technology. The mobile application in this paper was developed to focus on the behaviors of household users. With more resources and more semester timings at the university, this mobile application can become a greater if not perfected system to fight food waste. In conclusion, even in limitations, this mobile application is fundamentally a helpful tool for preventing household food waste.

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Beyond COVID-19: Assessment of Learning Loss on Human Capital

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ABSTRACT

The unprepared shift of primary school students to remote learning in response to the COVID-19 pandemic during the 2020-2021 academic year has created learning losses in PreK-12 that will disadvantage human capital development. The loss will be more felt in low-income counties, like Clayton County, Georgia, already disadvantaged by a digital divide. During the early months of the pandemic, national data showed that 20 percent of students in low-income households without reliable internet access did not log on to attend class meetings and/or complete class work. Demographics of the county most vulnerable to the long-run economic consequences of learning loss will be households with elementary school children and without access to the internet and broadband subscriptions. This research aims to ascertain the degree of learning loss damage to the county's human capital base and if such damage and its long-term consequences are reversible now.

KEYWORDS: COVID-19, Digital Divide, Economic Consequences, Georgia, Human Capital, Learning Loss, Remote Learning

1. Introduction

Many researchers agree that the decision of many schools in the United States and world-wide to move to virtual learning environment in response to the COVID-19 pandemic during the 2020-2021 academic year has resulted in a large learning loss in PreK-12 education that will disrupt human capital development for many years to come unless the education systems could create and execute a plan to counter those educational losses. The sooner those interventions are implemented, the better the results. The loss would be more felt in low-income areas, especially those suffering from the more significant digital divide, such as lower access to computers and/or high-speed internet. During the early months of the pandemic, national data showed that 20 percent of students in low-income households without reliable internet access did not log on to attend class meetings and/or complete class work (McKinsey, 2020). Among those most

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vulnerable to the long-run economic consequences of learning loss would be households with elementary school children and those without access to computers and/or broadband internet subscriptions. The goal of this research is to determine the degree of learning loss damage to the Clayton county's human capital base and to see if such damage and its long-term consequences are reversible. In the next section, we briefly review the available literature on the effect of COVID-19 pandemic on human capital development. In Section 3, we give a summary of the main results, and in Section 4, we will share our thoughts on how we could further improve future research.

2. Literature Review

The COVID-19 pandemic caused an unexpected shift during the 2020-2021 academic year as students transitioned from in-person to remote learning formats. This shift led to significant learning loss in grades PreK-12 that could potentially disadvantage human capital development. Additionally, learning loss can create permanent, negative implications unless schools can identify and target critical areas of need and develop strategies that surpass prior performance levels (Burgess & Sievertsen, 2020; Hanushek & Woessman, 2020).

Skills and competencies learned in school are vital to workforce success long-term (Bowen & Shume, 2020; Hanushek & Woessman, 2020). According to Delano and Hutton (2020), “workforce and economic development is increasingly a K-12 issue and trained human capital must be developed through a complex educational system” (p. 47). Over the past several decades, research has highlighted a national decline in workforce competencies (Reider, Knestis, & Malyn-Smith, 2016). In response, US educational systems began implementing curricula designed to develop soft skills such as critical thinking, comprehension, and communication, as well as proficiency in the STEM subjects of science, technology, engineering, and math (Casey, 2012; Hanushek, 2014; Reider, Knestis, & Malyn-Smith, 2016). In 2020, the COVID-19 pandemic halted and complicated these efforts and, in some cases, created further disparities within the educational system and future workforce development initiatives. Researchers see the most significant impact in learning deficiencies in cognitive and skill development, math and reading comprehension, communication, social, emotional, and motivational development (Hanushek & Woessman, 2020). These critical skill deficiencies are vital components of economic development.

Existing research highlights the connection between school attendance and learning outcomes. A 2020 study by Hanushek and Woessmann suggests that a loss of nearly one-third of a school year through ineffective learning could potentially lower a country's gross domestic product (GDP) by an average of 1.5 percent over the remainder of that century (3). Economies with a lower-skilled workforce threaten to lower economic growth, and a lack of effective learning can negatively affect students' immediate and long-term opportunities (Dorn, Hancock, et al., 2020, Oster & Halloran, 2021).

School closures during the COVID-19 pandemic impacted the efficacy of the learning process, which suffered a substantial decline (Goulas & Megalokonomou, 2020; Weathers, Hollett, et al., 2021). For example, the critical development window for early childhood education was disrupted, leaving opportunities for consequences regarding the socio-emotional and motivational development of students due to a lack of contact with teachers and peers and the psychological effects of isolation and lack of engagement (Hanushek, 2014; Oster, Halloran, et al., 2021).

Implications from learning loss were exacerbated among students from vulnerable communities and socio-economic backgrounds (Helland & Holt, 2022). This includes students in areas disadvantaged by a digital divide, such as households with limited access to reliable internet and broadband subscriptions (Graves, Abshire, et al., 2021). Existing research shows that students in households less able to support out-of-school learning faced more considerable learning loss than more advantaged peers (Hanushek & Woessman, 2020). If unaddressed, deficiencies acquired during the pandemic can translate into a more profound loss of lifetime earnings (Dorn, Hancock, et al., 2020).

3. Main Results

For the longest time, physical attendance at an institution of learning was synonymous with education. The internet was the backchannel one could use to obtain additional educational resources outside of a physical location. Then the pandemic hit, and the immediate and unprepared shift to remote learning immediately made internet access synonymous with educational access. We have used publicly available data from the Georgia Department of Education and focused on Clayton County, Georgia, one of the most populous counties in the State of Georgia (among the top five), and the two neighboring counties, Fayette and Henry Counties, for comparison purposes. Clayton State University is located within Clayton County, GA.

Looking at the enrollment data before and after the COVID-19 pandemic (Figures 1-3), it is evident that with only a few exceptions for most of the grade levels, across the three counties mentioned above, the enrollment either remained almost the same or increased after the COVID-19 pandemic occurred. Possible contributing factors can include a family's decision to withdraw from school and homeschool their children due to fear of COVID-19 infection. It is important to note that for more than one year after the onset of the pandemic in the United States, there was no vaccine available, especially for young children. Data indicates that this adverse effect on enrollment is much more robust and pronounced for grades K-5. The literature also substantiates that the same group was the most vulnerable in the transition to online and virtual learning due to a lack of experience and immaturity. We will later examine the students' Mathematics and Language Arts Assessment performance at different grade levels to look for such adverse effects. Indeed, the assessment data shows a decline in assessment results after the pandemic.

Figure 1: Primary school enrollment immediately before and after COVID Pandemic

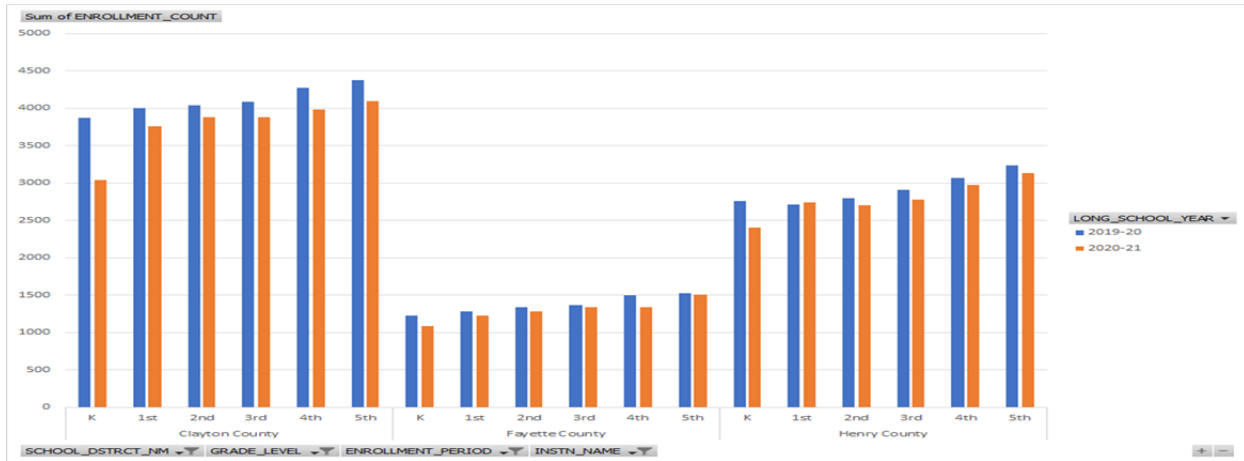


Figure 2: Middle school enrollment immediately before and after COVID Pandemic

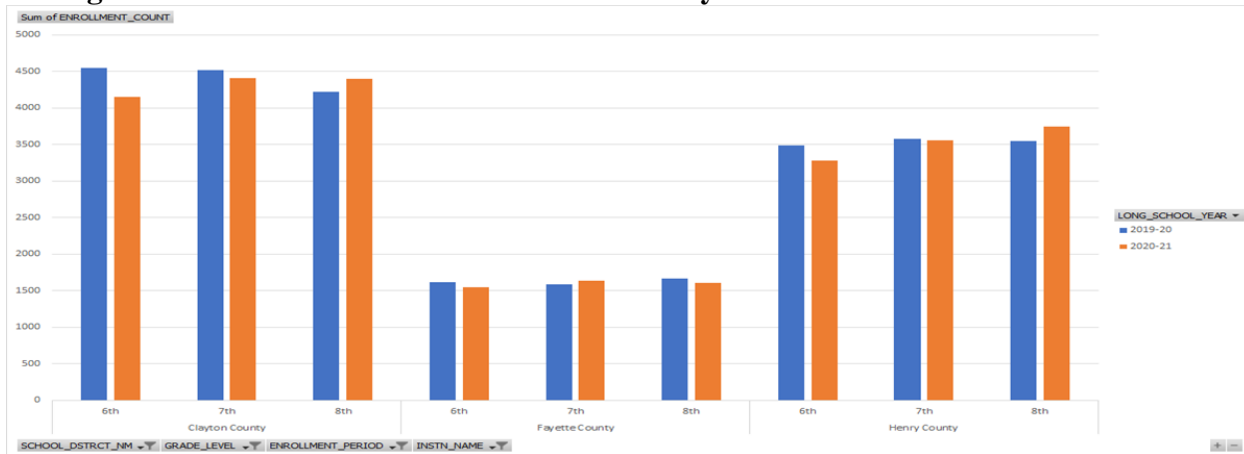
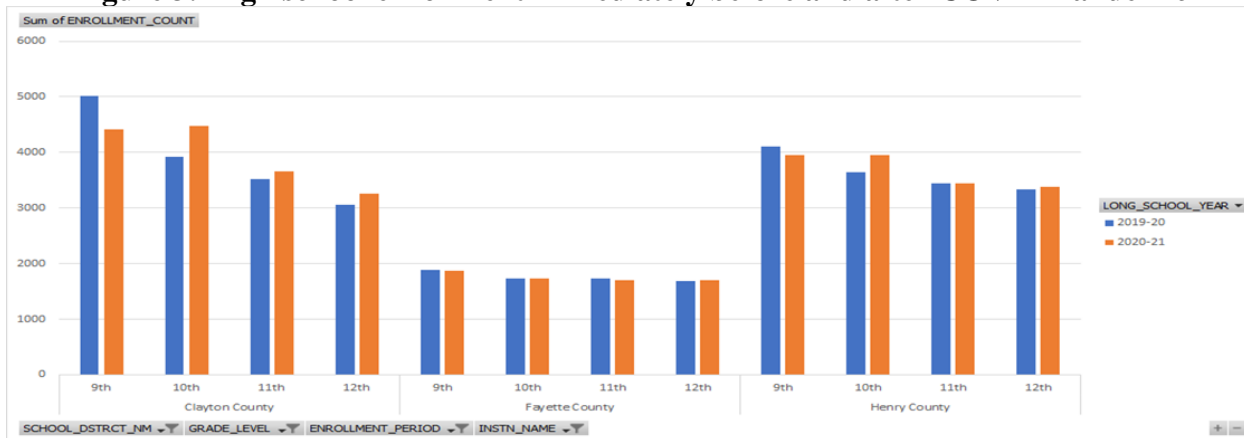


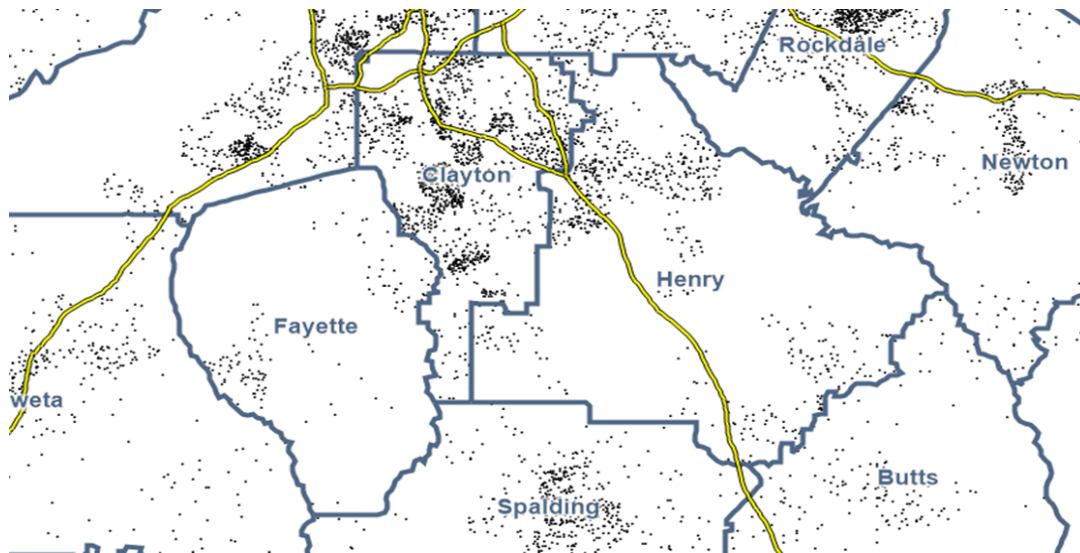
Figure 3: High school enrollment immediately before and after COVID Pandemic



Pre-pandemic data on internet access by geographical area in the State of Georgia, provided by the American Community Survey and Atlanta Regional Commission, paints a vivid illustration of where students resided who were without an internet subscription or an internet-capable device. Lack of reliable internet access increased students’ vulnerabilities to educational loss during the pandemic. The following map, provided by the Atlanta Regional Commission, shows

the density of households with students lacking an internet subscription or an internet-capable device in 2020. High-poverty areas in Southwest Atlanta, South Fulton, and Clayton County regions showed clusters of student populations without an internet subscription. Also included were additional urban areas within suburban counties like Cobb, Cherokee, and Rockdale.

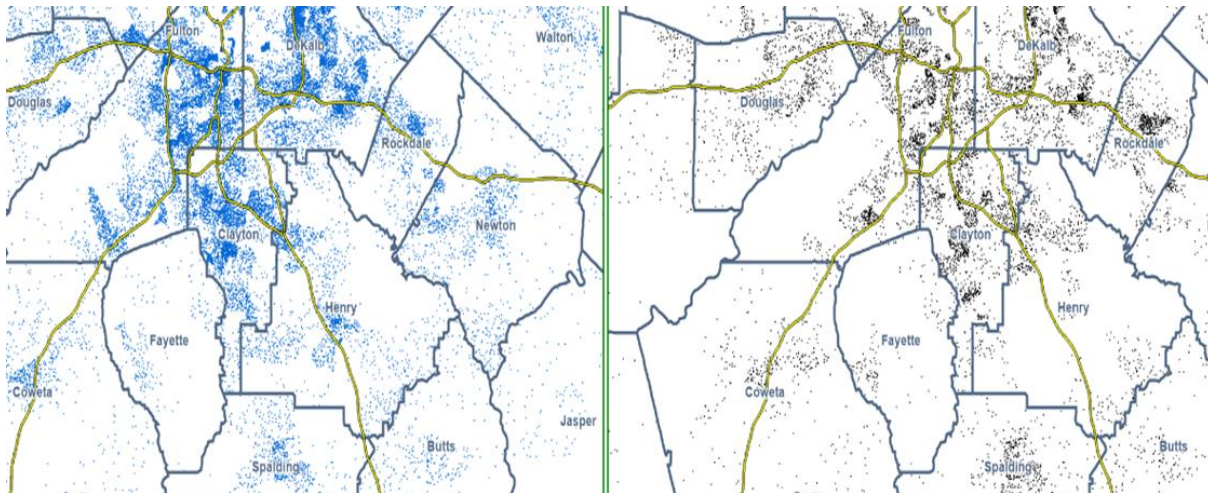
Figure 4: Concentrations of Households with Children Lacking Internet Access



Source: 33°N, Atlanta Regional Commission, 2020 American Community Survey 5-Year Estimate

While only considering a student's access to an internet subscription or an internet-mobile device, the Atlanta Regional Commission reported there to be only a moderate correlation ($r=0.35$) between the percentage of students living below the poverty line and percentages of students without an internet subscription or internet-mobile device. The following 2020 map, providing a spatial comparison between poverty and student areas without internet access, aligns with this correlation.

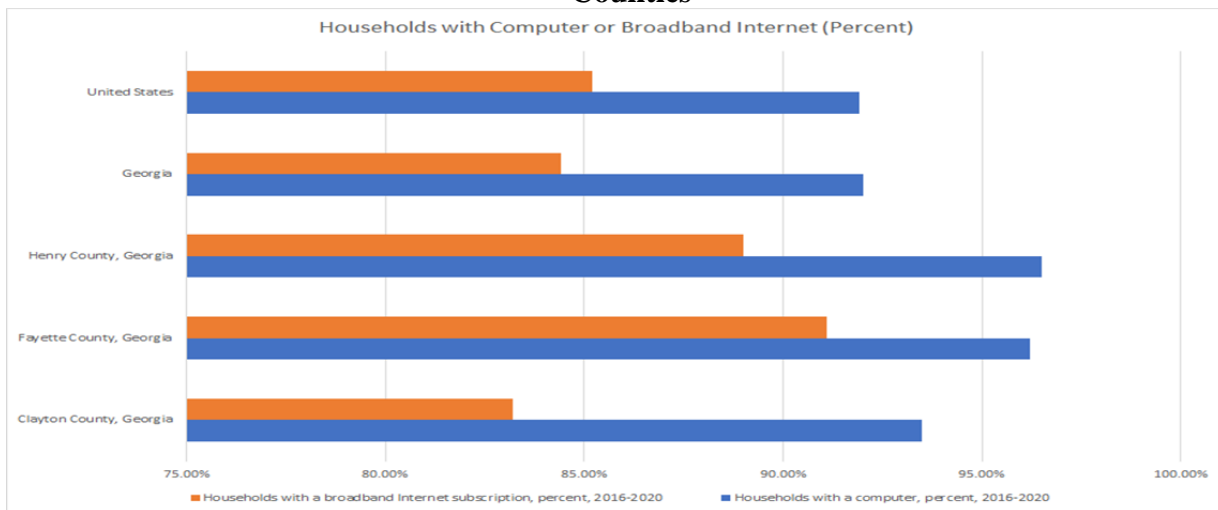
Figure 5: Spatial Correlation between Child Poverty (left) and Internet Access (right)



Source: 33°N, Atlanta Regional Commission; 2020 American Community Survey 5-Year Estimate

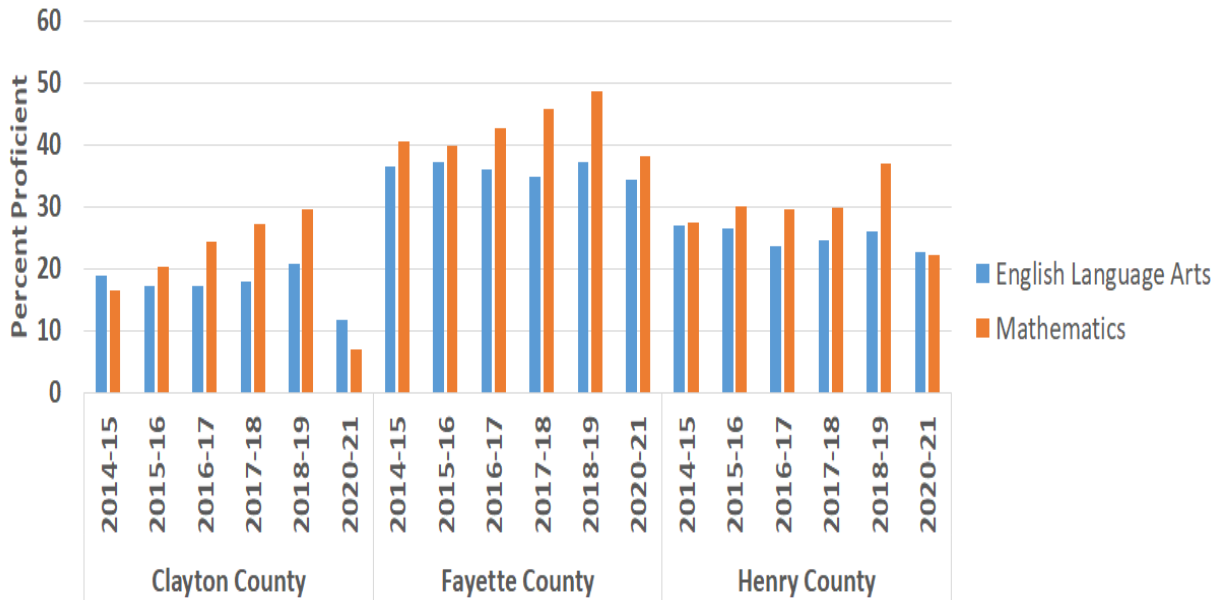
On the one hand, a side-by-side comparison shows that the area northeast of the intersection of I-20 and I-75/85 has a dense population of children living below the poverty line but no corresponding concentration of children without internet access. On the other hand, the southeastern portion of DeKalb County has fewer children below the poverty line but a high density of children with no internet access. Clayton County, the county of interest for this study, shows high-density levels of children living below the poverty line with high representative density levels of children without internet access in the same area. We believe the correlation to be higher if internet service availability and quality of service provided (i.e., signal strength, bandwidth, frequency of disruptions) from an available internet service provider(s) were considered. Figure 6 shows that the internet access percentage in Clayton County is lower than the US and GA average. Access to computers is higher than in both the US and GA; however, Clayton County trails behind compared to Fayette and Henry counties.

Figure 6: Comparison of Household’s Access to Internet & Computers across Three GA Counties



Evidence of educational loss resulting from vulnerable access to internet services is likely reflected in the end-of-grade proficiency exams in language arts and mathematics. Assuming younger students have less online learning and computer experience than older peers, the following table shows that 3rd-grade level proficiency in language arts and mathematics declined more significantly for Clayton County—a high-poverty county--than its low-poverty neighboring counties, Fayette and Henry.

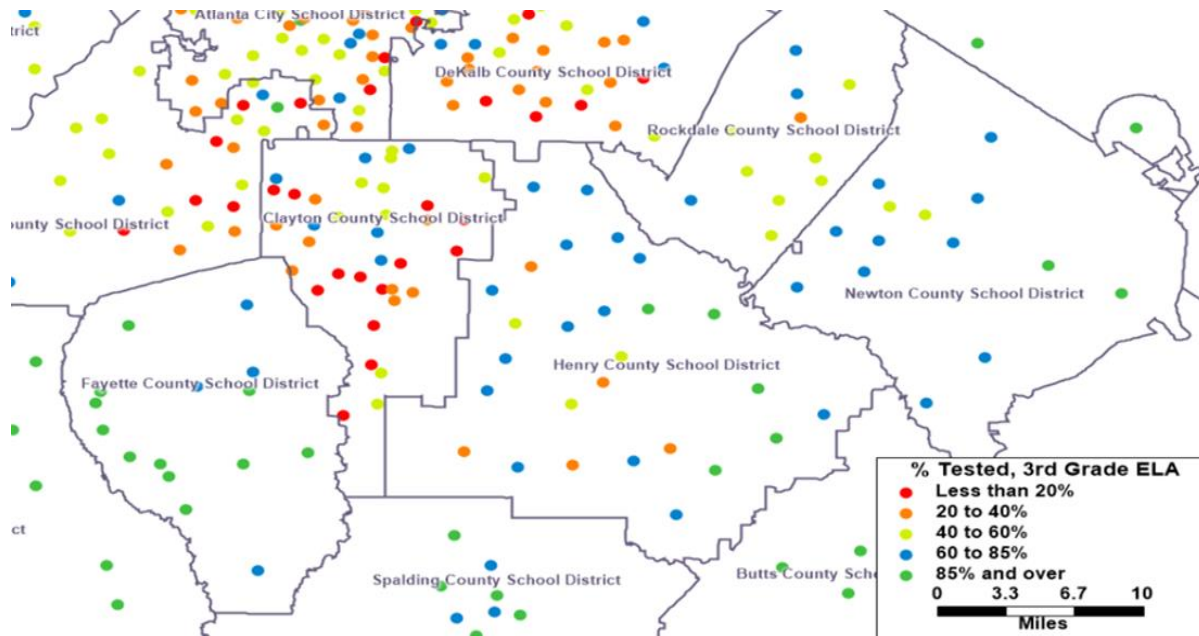
Figure 7: Percent of 3rd Graders Proficient in Language Arts and Mathematics (2015-2021)



Source: *Georgie Governor’s Office of Student Achievement*

It is also important to note that in 2021, with the return to primary schooling in a hybrid format of online learning and in-class instruction, the 3rd-grade student population in Clayton County had the lowest participation rate in the 3rd grade English Language Arts Assessment for that year.

Figure 8: Participation Rates in 2021 3rd Grade- English Language Arts Assessment



Source: 33°N, Atlanta Regional Commission

4. Future Directions

The authors are determining various next steps for future research in this area including possibly working with the Clayton County Public Schools System to disseminate, collect, and analyze surveys. Survey results will help identify the best ways to:

- 1) Assess deficiencies in learning as consequences of the digital divide,
- 2) Identify target areas of need for students, teachers, and families,
- and 3) Develop strategies to decrease the digital divide.

When initial research was conducted, some of the 2021 and most 2022 data were not yet released by the Georgia Department of Education. As more data becomes available, the authors will collect and analyze it for future extensions of this work.

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BROKEN FAMILY COURTS: TRAUMA EDUCATION AND A REASON FOR HOPE

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ABSTRACT

Increasing attention to the trauma histories of students has become a regular part of higher education. To better understand the impact of trauma on students, many colleges and universities are encouraging faculty and staff to attend ‘trauma training’ sessions. Trauma has wide-spread consequences, affecting more than just the current generation of college students. Adverse childhood events (ACE) result in long-term physical and psychological consequences, affect productivity, the workplace environment, and have significant economic consequences. Since the early 2000’s, an increasing number of freshmen begin college with a mental health disorder; statistics indicate that more than one in three freshmen arrive on campus with signs of a mental health disorder (Sears, 2018). The question then becomes, is there anything that colleges can do to help students avoid an ACE before they arrive on campus? One of the primary enablers/perpetrators of childhood trauma is our broken family court custody system. In many cases, traumatic childhood events could have been avoided if the family court had been aware of the most recent domestic violence research and best practices for protecting children. Using the now debunked theory of ‘parental alienation syndrome’, family court judges punish the ‘safe parent’ for being protective. Empirical studies have documented the harsh and damaging consequences for children when they are forced by family courts to be with abusers over the objections of either the child or the protective parent (Silberg, 2019). It seems as if the abuser’s parental rights are protected at the expense of the child’s safety, emotional, and psychological well-being. The latest domestic violence research and changes to the law are discussed. Specific suggestions are made for domestic violence topics and research to be included in current course content. These changes could have widespread positive effects on the paradigm of future judges, lawyers, social workers, psychologists, human resource managers, custody evaluators, teachers, clergy, counselors, nurses, healthcare workers, law enforcement, and parents. In brief, through changes to curriculum, higher education could proactively reduce the number of traumatic events that a child experiences before arriving as a student on campus.

Introduction

Much of the trauma that students experience before they arrive as freshmen occurs in the home. Adverse events include experiencing or witnessing ‘coerce and control’ domestic abuse that often includes physical, sexual, emotional, psychological, verbal, or financial abuse and other traumatic events. The rise of narcissism has been described as an epidemic (Twenge, 2009). Narcissism and domestic violence frequently go hand in hand as the narcissist lacks empathy, bullies others, dominates, and is drawn to chaos and danger. The importance of understanding narcissistic personality disorder and the ‘dark triad’, the far-reaching effects of domestic violence, and the use of ‘parental alienation’ to punish protective parents and harm children are discussed.

Higher education can play an important role in protecting students from trauma by increasing awareness of the latest research through changes to pre-law, pre-med, business, sociology, psychology, criminal justice, and nursing curriculum. Suggestions for changes to the curriculum for these programs are outlined and

include: The ACE Study; The Saunders Study; Narcissism and the “Dark Triad” of personality disorders; and The Family Court Outcomes Study as well as additional ground-breaking research of Joan Meier of George Washington University. Although significant reforms are needed at the state level, there reason for hope given the Congressional reauthorization of the Violence Against Women’s Act, a law that now includes “Kayden’s Law”.

A recent trend in collegiate communities across the country is to offer trauma training for professors and staff. Undoubtedly, professors who have been active in the academe over the past two decades have observed first-hand, a significant increase in the number of students with anxiety, depression, and a trauma-related disorders. These anecdotal observations have now been corroborated by a peer-reviewed research. The findings from a comprehensive study using two large national datasets from 2008-2018, “demonstrate a broad worsening of mental health among U.S. college students over the past decade, a concerning result meriting further attention and intervention.” (Duffy, 2018) Specifically, this study found that “rates of depression, anxiety, non-suicidal self-injury, suicidal ideation, and suicide attempts markedly increased over the assessed years, with rates doubling over the period in many cases. Anger, low flourishing, and suicide plans, each assessed in only one dataset, also exhibited upward trends.” (Duffy, 2018) Research published by the American Psychological Association indicates that greater than 1 in 3 college freshmen show symptoms of mental health related disorders (Sears, 2018).

Perhaps many of these students were harmed by a broken family court system and child protective agencies that promote parental rights over the right of a child to be safe from abuse. While colleges and universities cannot immediately ‘fix’ the court system and provide services to children before they arrive on campus, schools can modify course content and change the curriculum for psychology, social work, teacher preparation, nursing, pre-med. pre-law, criminal justice, business management, criminal justice, and political science.

The Broken Family Court

“Most people, including court professionals, are unaware that custody courts are having severe problems trying to respond to cases involving domestic violence or child abuse” (Goldstein and York, 2022). The Center for Judicial Excellence has been keeping track of tragic outcomes. Since 2008, 864 children have been murdered by a divorcing/separating parent and in 117 these horrific events, the death of these children could have been prevented if the family court had listened to the warnings of the ‘protective parent’ (Center for Judicial Excellence, 2022). Since the 1990’s, family courts across the country have shown a distinct preference for joint custody and assume that children naturally fare better with two parents intimately involved in their lives, even in the most contentious divorce and custody cases. This has been shown to be a false assumption when one parent is abusive, as the pattern of abuse will more than likely be replicated with the child.

For years, there was anecdotal evidence from protective parents reporting that the family courts had punished them for alleging abuse and/or trying to protect their children from abuse. “Protective parents and domestic violence professionals have long asserted that courts dealing with child custody and their affiliated professionals frequently deny true claims of adult partner or child abuse and instead punish parents (usually mothers) who allege domestic violence, child physical or sexual abuse, or seek to limit the other parent’s child access for any reason” (Meier, 2020). The Family Court Outcomes Study is the first empirical study of ten years of U.S. cases involving allegations of abuse and claims of ‘parental alienation’ and the mistreatment of these allegations in family court (Meier, 2020).

Congressional Response

The prevention of domestic violence and the protection of children from abuse has received national attention. On March 11, 2022, President Biden signed into law the reauthorization of the federal Violence Against Women's Act (VAWA). A provision of VAWA is 'Kayden's Law', a law that was named after a child killed by an abusive father exercising parental rights granted by a Pennsylvania family court judge. Kayden's Law provides funding to states with the following custody laws and standards:

- Expert testimony is limited to those with demonstrated expertise and clinical experience working with victims of domestic violence.
- Past child abuse or domestic violence must be considered in custody disputes.
- Contact with the safe parent must not be restricted to improve a bad relationship with the abuser.
- Reunification treatment will not be ordered unless it is scientifically valid.
- All court personnel must complete 20 hours of initial training and 15 hours of additional training every five years.

Is Kayden's Law the law of the land? Not yet. All states to adopt Kayden's Law so the above recommendations can be enforced in the family courts. The VAWA provides financial incentives for states to adopt the standards found in Kayden's Law. It is also important for every state to pass a Safe Child Act (Goldstein, 2022) requiring family courts to have an early evidentiary hearing when there are signs of domestic violence or child abuse; and that the abuser have supervised visitation if evidence of abuse is found to be present. It is also critical for the health and safety of the child to be the top priority in determining custody.

Changes to Courses and Curriculum

Domestic violence and child abuse and the accompanying adverse outcomes in Family Court have garnered the attention of law makers on the national level; however, significant progress at the state level is sorely lacking. Colleges and universities are in a unique position of educating future child service providers, and court personnel. The following are some of the changes to course offerings that would complement the recommended body of knowledge that court personnel, judges, psychologists, custody evaluators, *guardians ad litem*, healthcare workers, law enforcement, teachers, and social workers would be expected to know if Kayden's Law and the Safe Child Act were adopted at the state level:

- *Saunders Study* -- The Saunders Study is peer reviewed research sponsored by the Department of Justice. Saunders found that mothers alleging abuse only made false reports 1.3% of the time and that fathers are sixteen times more likely than mothers to fabricate allegations of child abuse (Saunders et al., 2012). This report also concluded that court professionals need knowledge of specific subjects to adequately screen for domestic violence and to understand the impact of domestic violence on children. "Professionals without this knowledge tend to focus on the myth that mothers frequently make false reports and unscientific alienation theories." (Goldstein and York, 2022) Unfortunately, very few court professionals have never heard of the Saunders Study.
- *Malignant Narcissists and the 'Dark Triad'* – Dangerous personality disorders should be studied by all psychology, sociology, nursing, pre-med, pre-law, criminal justice, religion, and as well as business management students. A quick Internet search using the terms "divorce", "custody" and "malignant narcissist" will reveal a plethora of articles and web sites chronicling remarkably similar and horrific experiences. Narcissistic Personality Disorder (NPD) is characterized by a lack of empathy, an inability to love another person, amoral and risky behavior, treating a partner/spouse and children as possessions, blame shifting, gaslighting, revenge for perceived wrongs and slights, and dichotomous thinking – you are either with the narcissist or against him. Life for the narcissist

is a game that must be won and the best interests of those in his path are ignored. Worst of all, narcissists don't believe that anything is wrong with them. Treating NPD is not effective.

- *Parental Alienation Syndrome (PAS)* – This theory is used to convince the courts that the ‘safe parent’ is not protecting her child; instead, her efforts to limit access to the child are intended to alienate the child from the abuser. PAS was concocted by Richard Gardiner, a disgraced psychologist who was well known for being ‘pedophile friendly’. He is quoted as saying, “Older children may be helped to appreciate that sexual encounters between an adult and a child are not universally considered to be reprehensible act.” Gardiner’s work was based on personal observations and was never peer-reviewed. Although PAS has been rejected by the APA, the AMA, and the WHO, it has been repackaged as ‘parental alienation’ and used by abusers, their lawyers, custody evaluators and family court judges to limit the protective parent’s access to their child.
- *The Family Court Outcomes Study* (Meier, 2020) – This was the first empirical study that included national data describing the outcomes in family courts in the U.S.. This study examined the family courts’ reaction to abuse and claims of ‘alienation’ and found that women who allege abuse are losing custody of children they are trying to protect. Family courts unfamiliar with “The Saunders Study” are lending credence to spurious allegations of ‘alienation’; children are being harmed and protective mothers are being punished. “The data support the widespread critiques of family court proceedings sending children into the care of destructive and dangerous parents. The gender disparity in how much more powerfully alienation claims work for fathers as opposed to mothers also reinforces claims that, *in abuse cases*, alienation is little different from PAS, operating in an illegitimate, gender-biased manner.” (Meier, 2020)
- *Adverse Childhood Events (ACE)* -- The CDC and Kaiser Permanente studied adverse childhood events from 1995-1997. Over 17,000 patients receiving physical exams from their HMO providers answered anonymous surveys in two waves of data collection in this seminal study. (CDC) What are the consequences of experiencing an ACE? This peer-reviewed medical research concluded that children exposed to domestic violence, child abuse, and other traumas detailed below will suffer adverse mental and physical health consequences. These innocent victims of trauma face a lifetime of health problems including pre-mature death and heart disease. “Most of the harm is not from any immediate physical injuries, but from living with the fear and stress abusers cause. Clearly, this goes to the essence of the well-being of children” (Goldstein and York, 2022). By definition, an adverse childhood event takes place before a person’s 18th birthday and includes the following:
 - **“Emotional abuse:** A parent, stepparent, or adult living in your home swore at you, insulted you, put you down, or acted in a way that made you afraid that you might be physically hurt.
 - **Physical abuse:** A parent, stepparent, or adult living in your home pushed, grabbed, slapped, threw something at you, or hit you so hard that you had marks or were injured.
 - **Sexual abuse:** An adult, relative, family friend, or stranger who was at least 5 years older than you ever touched or fondled your body in a sexual way, made you touch his/her body in a sexual way, attempted to have any type of sexual intercourse with you.
- Household Challenges
 - **Mother treated violently:** Your mother or stepmother was pushed, grabbed, slapped, had something thrown at her, kicked, bitten, hit with a fist, hit with something hard, repeatedly hit for over at least a few minutes, or ever threatened or hurt by a knife or gun by your father (or stepfather) or mother’s boyfriend.
 - **Substance abuse in the household:** A household member was a problem drinker or alcoholic or a household member used street drugs.

- **Mental illness in the household:** A household member was depressed or mentally ill or a household member attempted suicide.
- **Parental separation or divorce:** Your parents were ever separated or divorced.
- **Incarcerated household member:** A household member went to prison.
- Neglect
 - **Emotional neglect:** Someone in your family never or rarely helped you feel important or special, you never or rarely felt loved, people in your family never or rarely looked out for each other and felt close to each other, or your family was never or rarely a source of strength and support.
 - **Physical neglect:** There was never or rarely someone to take care of you, protect you, or take you to the doctor if you needed it², you didn't have enough to eat, your parents were too drunk or too high to take care of you, or you had to wear dirty clothes.” (CDC)

Conclusion

Narcissism is on the rise and family court judges and professionals entrusted with the safety of children need to have an in-depth understanding of personality disorders, including but not limited to narcissism and the ‘dark triad’. Colleges and universities are in the unique position to include the latest domestic violence research in their curriculum and have a positive impact on future students and the community. Without knowledge of ACE, custody evaluators, social workers, and family courts, minimize domestic violence and child abuse. The Saunders Study is equally important because without it, courts rely on the wrong experts and make life altering decisions that harm children. The Saunders Study tells us that reports of abused children and the survivors of domestic violence should be believed and not ignored. The ACE Study revealed the enormous price paid by the victim and by extension, the community, when there is an adverse childhood event. The groundbreaking research of Joan Meier demonstrates that in custody disputes where there is domestic violence and a protective parent, that in a majority of cases, the abuser is granted sole or joint custody; thus, placing the child’s safety and well-being in jeopardy. The death of children recklessly entrusted for abusers to exercise their parental rights has garnered the attention of lawmakers and Kayden’s Law has now become part of the Violence Against Women’s Act. It is time for Kayden’s Law and the Safe Child Act to be adopted by every state. Through a change in the curriculum, universities have the unique opportunity to positively impact the mental and physical well-being of future students and by extension, the community at large.

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Cyber RADaR: Cybersecurity Rapid Asymmetric Discovery and Reporting via AI-driven Social Media Crowdsourcing

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Abstract

Small businesses are especially vulnerable to asymmetric, zero-day cybersecurity attacks because most do not have the experienced staff required to monitor, defend, and remediate these dangerous, active vulnerabilities.

Log4j is a recent asymmetric vulnerability that severely impacted the global internet. New aspects of the vulnerability were being discovered weeks and months later, and it may take years to fully remediate. To bring awareness to the deep and widespread nature of log4j, government and industry leaders immediately began messaging via social media. Technology and cybersecurity professionals also used these platforms as a primary means to both share and consume the latest log4j information with a particular focus on remediating the zero-day threat. Circumstantial evidence of the log4j response indicates a shift towards social media as the primary source for threat awareness and remediation, and away from proprietary vendors and partners who have traditionally acted in that capacity.

This paper describes an active research project to automate the use of social media to support zero-day cyber threat awareness and mitigation via a managed security service (MSS) using AI and ML concepts to automate real-time global crowdsourcing and analysis of social media content to proactively deliver an organization-specific, asymmetric cybersecurity threats “Insights Dashboard.” This approach seeks to automate collection of diverse thinking and innovative problem-solving data, rapidly understand individual zero-day cyber threats and paths to remediation, provide problem-centric feedback, and increase situational awareness. Automated collection of widespread content will be especially valuable for small to medium sized companies.

Introduction

Asymmetric cybersecurity attacks use unconventional methods and entry points to attack electronic and technology-based systems. An asymmetric attack results in an asymmetric threat to others who may have similar architectures or infrastructure components. An example of a recent asymmetric attack and resulting threat is log4j where a common log file, used by most internet-based technologies, was used to gain access to computing systems. By their nature, asymmetric threats fall into the category of the “unknown unknowns” making them practically impossible to proactively guard against. Zero-day threats represent the period from when a cybersecurity threat has been identified until a standard remediation approach has been made available. Zero-day and asymmetric threats are closely associated with a zero-day threat generally directly resulting from the identification of an asymmetric threat. Until a patch or other standard remediation is available,

interim approaches to combat asymmetric cyber threats can be particularly complex for any technology professional. This is particularly true for small businesses that represent 99.9% of all businesses in the United States with most having ten employees or less. It is especially challenging for small businesses to be aware of emerging threats and the scope of the threat. Additionally, once aware, most small businesses lack the required skills, tools, and bandwidth to understand what interim approaches to take against an asymmetric threat and how to implement those approaches.

The aforementioned log4j asymmetric threat severely impacted the global internet. New aspects of the vulnerability were discovered weeks to months later and it may take years to fully remediate the threat. To bring awareness to the deep and widespread nature of log4j, government and industry leaders immediately began messaging via social media, even before proprietary vendors publicly identified the issue. Technology and cybersecurity professionals continued to use these platforms as a primary means to both share and consume the latest log4j information with a particular focus on approaches to interim remediation of the zero-day threat [1]. Although the use of social media in this capacity is not new, circumstantial evidence of the log4j response does indicate a continuing shift towards social media as the primary source for threat remediation, and away from proprietary vendors and partners who have traditionally acted in that capacity.

Manually processing “crowdsourced” data increases the vulnerability of small businesses that do not have experienced security professionals to monitor threats on a complex, distributed medium. As the use of “crowdsourcing” of social media and other publicly available data increases, it is imperative that this approach be optimized to increase awareness, understanding, and remediation of threats to better support the small businesses that represent a large portion of our economy while also being the most vulnerable to asymmetric and zero-day threats.

Problem Scope

The need for effective cybersecurity solutions continues to grow at an unprecedented rate to meet the ever-expanding threats. Figures 1 and 2 illustrate the escalating number of breaches and the rising investment in cybersecurity.

By 2025, the global cybersecurity market is estimated to be \$276 billion [2] and the number of IoT (internet of things) installed devices will surge to seventy-five billion [3] representing massive opportunities for attacks. Detection and response continue to be a priority with 82% of organizations increasing cybersecurity budgets in 2021 [4]. Yet breaches continued to rise in 2021 costing organizations over \$1 million more per incident than in 2020.

The shortage of cybersecurity professionals inhibits organizations’ ability to address cyberthreats and attacks. ISC(2) projects the cybersecurity workforce gap at 3.5 million for 2022, almost double their prior estimate. The shortage of trained professionals has already negatively impacted small businesses’ ability to respond to cybersecurity threats, and the growing resource gap exacerbates the hiring challenges for small businesses as well-funded employers amass the limited number of skilled cybersecurity professionals.

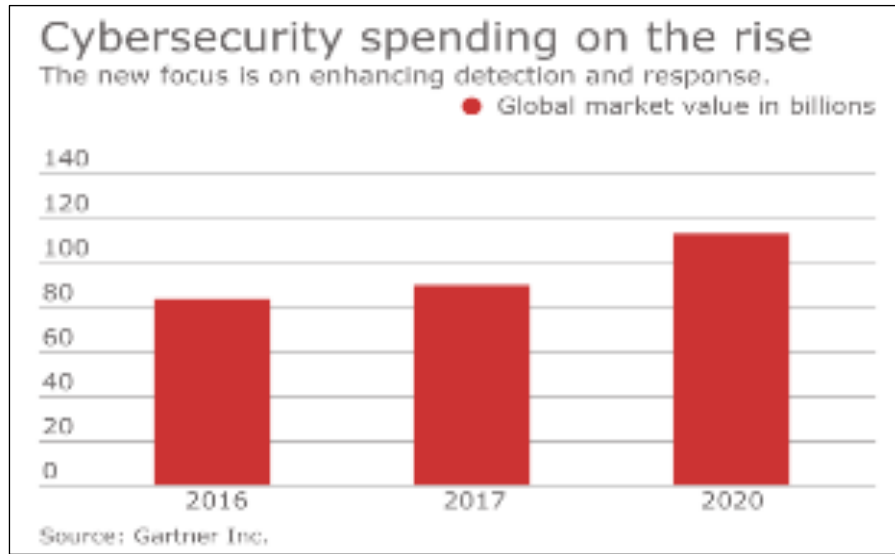


Figure 1: Security Spending Trends

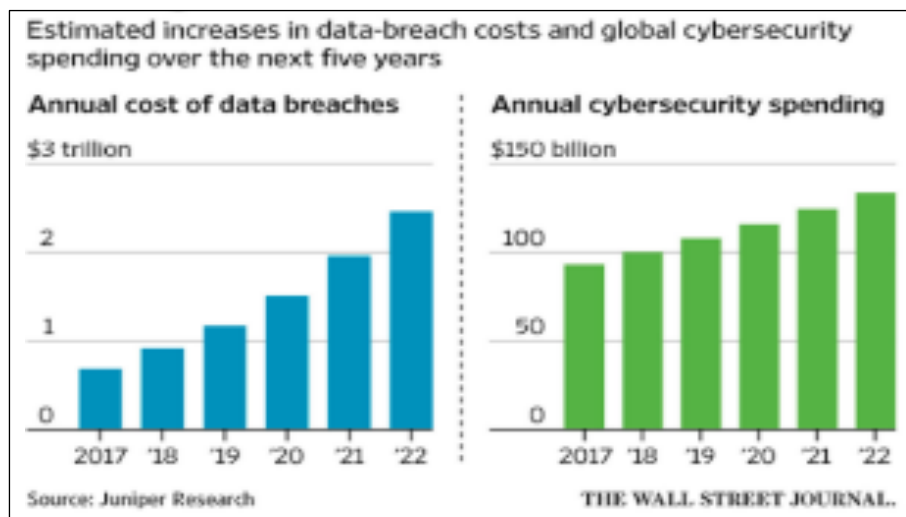


Figure 2: Trends in security breaches and cost

The Cyber RADaR service improves organizational threat detection and response while addressing the workforce shortage via a social media ‘crowd’ approach. Using AI and ML, Cyber RADaR will track active threats and provide the professionals, who are in place, interactive dashboards with real-time crowdsourced intelligence about the geo-social location of threat mitigation and remediation.

Background

To address the critical need for cyber research, innovation, and workforce development, the state of Virginia established the Commonwealth Cyber Initiative (CCI). In July 2018, the Virginia General Assembly passed legislation establishing the Commonwealth Cyber Initiative to “serve as an engine for research, innovation, and commercialization of cybersecurity technologies, and

address the Commonwealth’s need for growth of advanced and professional degrees within the cyber workforce.” Four CCI Nodes: Southwest, Coastal, North, and Central; were certified by the Virginia Research Investment Committee in June 2019, establishing the statewide CCI Network. The authors received generous support for Cyber RADaR and other cybersecurity-related projects from various CCI nodes with Cyber RADaR receiving targeted support from the Southwest Virginia CCI node (SWCCI) [5]. As part of these efforts, the authors have collaborated with multiple public and private entities as well as higher education institutions including Old Dominion University, Virginia Commonwealth University, the University of Virginia at Wise, Virginia Tech, and numerous community colleges.

Project Objectives and Deliverables

As illustrated in Figure 3, the project team seeks to automate the use of social media and other publicly available data to address asymmetric and zero-day cyber threats via the development of the Cybersecurity Rapid Asymmetric Discovery and Reporting (Cyber RADaR) managed security service (MSS). Cyber RADaR will use advanced analytics and machine learning (ML) methods to automate real-time global crowdsourcing and analysis of social media content to proactively deliver an organization-specific “Insights Dashboard” for asymmetric cybersecurity threats and their remediation.

Benefits to Cyber RADaR automation of cybersecurity threats:

- Automated collection of diverse thinking and innovative problem-solving data
- Quicker understanding of individual zero-day cyber threats and paths to remediation
- Objective, problem-centric feedback independent of personal or provider issues/agendas
- An overall situational awareness for both individual and collective cyber threats

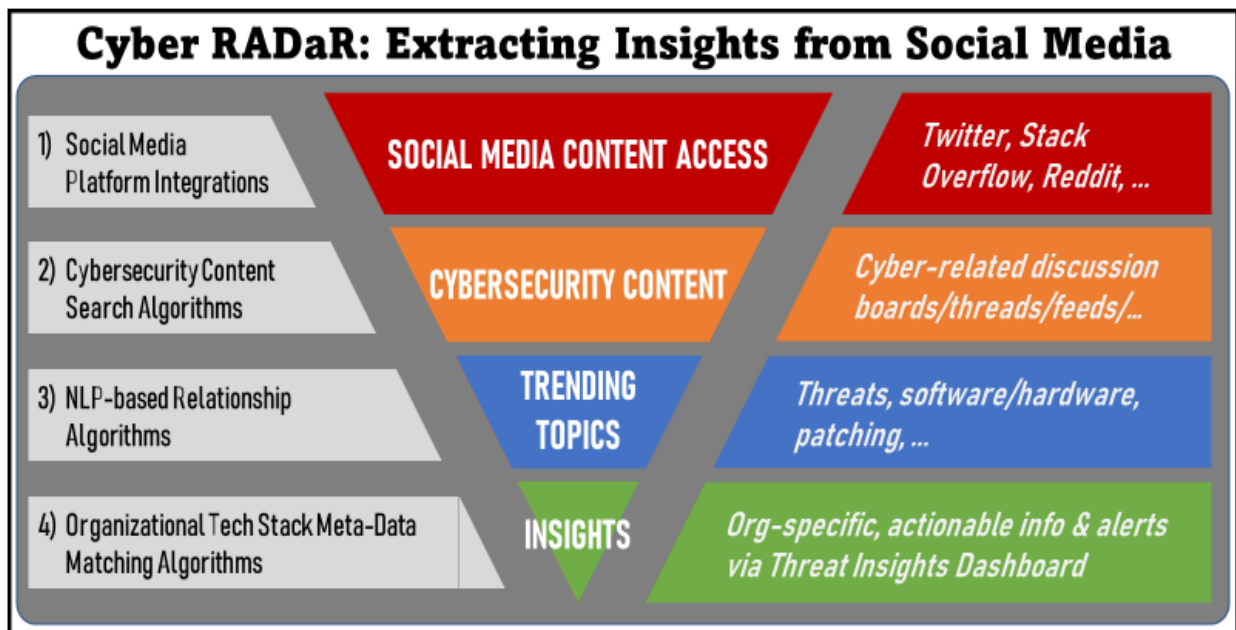


Figure 3: Extracting insight from social media

The Cyber RADaR project will develop a prototype of the interactive threat-insights dashboard with the following capabilities:

- At least one integration with a major social platform
- Integration of base-level natural language processing (NLP) AI algorithms supporting cybersecurity content identification and trend analysis
- Individual organization tech-stack metadata capture mechanism
- Base AI-driven relationship algorithms to align trends to organizational metadata
- An outline for implementation of ML algorithms for continual improvement of the model

Successful prototype implementation will use social media to locate one or more existing, verifiable threats and the geo-social location of the associated remediation data based on the metadata of a specific organization. This outcome will provide a solid foundation for more social media platform integrations, tuning of the model and algorithms, and implementation of ML concepts.

Preliminary Results

Preliminary findings suggest the log4j/log4shell vulnerability announcement made in November 2021 had an immediate ripple effect across technical social streams, with continuous viral impact still indicating as recent as September 2022 (IT people are still discussing the impact and learning of the threat for the first time). The resulting research from the next phase intends to analyze the trend pattern and isolate signals that can be indexed for future beaconing of known threats, as the behavioral patterns representing the “Voice of the Developer” are early-warning indicators of an exploit taking hold in an environment.

Results are initially focused on defining the data sources to target social active listening for keyword topic tokens relevant to the asymmetric threats experienced from the log4j and log4shell events. The team created a defined topic token keyword list with a total of 73 matching topic tokens to use in active listening for known threats. Our focus in data collection starts in January 1, 2021 through to the current date, for English speaking audiences.

Sources Targeted

Twitter API | 7-Day Window Frames from Twitter API [Academic API Needed for full history]

Reddit API | Targeting 10 sub-reddit as well as a full topic token match across all subs

StackExchange / StackOverflow APY | Limited data

Google Search Trends | Long-tail interest in log4j topic - rests at 1% popularity (>0)

Online News Articles | Article Topic Token Aggregation

Current findings demonstrate ongoing conversational awareness of known threats, such as the log4j/log4shell vulnerability, with a long-tail topic stream. The signals at the early stages of the vulnerability announcements are of critical interest to the next phase of our research.

Conclusion

Cybersecurity is a massive concern that continues to grow in unprecedented ways. While overall spending reflects that larger organizations are enhancing their capabilities, smaller businesses lack sufficient resources: tools and people; necessary to address the growing concern. Cyber RADaR seeks to support and improve small businesses' ability to better secure their operations by automating the crowdsourcing of social media and other publicly available data to increase awareness of active threats and identify methods being applied to mitigate vulnerabilities.

The Cyber RADaR pilot project ends in December 2022. The team will seek additional funding during and after the project to further enhance Cyber RADaR capabilities. Additionally, the team will work with appropriate organizations to share Cyber RADaR capabilities and provide access to the service for small businesses and other constrained organizations such as localities.

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Cybersecurity Issues in Current Mobile Banking

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Abstract— Mobile banking fraud entails deliberate, and intentional activities perpetrated by criminals with a focus on venturing in mobile financial services and looting funds. The financial institutions, in the recent past, launched programs where they formed money transfer apps that are uploaded and installed in smartphones. The initiative was developed after it was realized that most people especially in developed countries own a smartphone. Besides, banks were experiencing long queues as their customers were seeking services to check account balances, withdraw, or deposit money. The need to smoothen banking services where the community members can have full control of their bank accounts and finances led to the mobile banking apps. An array of factors has contributed to the increase in mobile financial services fraud. First are lenient regulations; banks and other financial regulatory bodies are unable to closely monitor the mobile money systems. Besides, the regulators fail to offer stringent guidelines to all stakeholders involved in financial services. This has created a loophole that is aggravating cases of fraud in mobile banking. Another factor is the maturity of mobile banking; fraudsters are targeting different stages of mobile banking. This could mean targeting the mobile money transfers during the transaction process or in new deployments where fake registrations are made. There are also non-standardized or weak processes that give room to fraud. Leniency, especially in markets that are yet to be severely saturated by fraudsters create an avenue for fraudsters to target. There are still many parts of the world where cultural groups are not aware of the strategies that are used by fraudsters to gain access to their finances.

Keywords—mobile banking fraud, financial services, cybercrimes, money transfers apps, cybersecurity

I. INTRODUCTION

Because of its ease of use and accessibility, as well as the flexibility of being able to transfer payments and manage accounts while on the road, mobile banking is becoming increasingly popular. Mobile banking, on the other hand, is new, imperfect, and subject to the usage of technology and services that are not related to the financial sector [1]. As a result, as technology advances, the risks change, and with such a diverse range of services, organizations, and financial platforms, it becomes even more difficult to not just choose the right service, but also one that is secure. Cybercriminals are becoming more sophisticated, and mobile devices are now more vulnerable than ever.

Each of the 35 installed apps on the average smartphone is a possible entry point for a hacker. According to mobile banking statistics, a rogue mobile app is responsible for around one out of every twenty fraud attempts [2]. Fraudsters can

publish a fake program to one of the major app stores and hope that it will be downloaded by unsuspecting customers. Unfortunately, determining whether a program is from a genuine seller, or a cleverly disguised piece of malware can be quite difficult. Fraudsters have the technology to track money and spread malware that steals payment information, login credentials, and ultimately monies from victims' bank accounts

This sort of malware has progressed; statistics from the first half of 2019 show a 50% rise in attacks compared to the first half of 2018. Triade is the most extensively disseminated mobile bank malware, accounting for roughly 30% of all banking malware infections [3]. It gives hackers super-user capabilities, allowing them to take complete control of users' devices. According to mobile banking and security data, the majority of these mobile malware apps use cutting-edge evasion strategies. By employing transparent icons with empty program labels, they can avoid sandboxes. As a result, nearly no software is resistant to such an attack [4].

The mail research question which this paper explores is: what are the security issues in current mobile banking? In order to answer this question, I will use the following hypotheses:

H01: Lack of proper authentication method is not a key security issue in the current mobile banking sector.

H02: Awareness of the known security threats is not a key security issue in the current mobile banking sector.

H03: Awareness of the unknown security threats is not a key security issue in the current mobile banking sector.

H04: Privacy risk is not the key security issue in the current mobile banking sector.

HA1: Lack of proper authentication method is a key security issue in the current mobile banking sector.

HA2: Awareness of the known security threats is a key security issue in the current mobile banking sector.

HA3: Awareness of the unknown security threats is a key security issue in the current mobile banking sector.

HA4: Privacy risk is a key security issue in the current mobile banking sector.

The rest of the paper is structured as follows: In section 2, reviews related work on mobile banking fraud while in Section 3, I discuss the methodology which I used to conduct the research in this paper. In Section 4, I present the analysis of my findings while Section 5 provides my conclusions.

II. RELATED WORK

The researchers in this case study were tasked with developing a mobile banking solution for the company's enormous customer base. Their focus was ensuring that clients could safely transact using their mobile application. The researchers completed a Mobile Application Security Process utilizing their own in-house built Expert Driven Integrated Testing Engine (E.D.I.T.E) framework. During their initial assessment, they discovered that the architecture consisted of a mobile app with a simple user interface and a backend server that funneled data to its users [5]. The researchers installed a traveling application from a user onto one of the test Blackberry phones and ran early scans on it to fully comprehend the program's operation.

The key findings in this research included the following:

- To better understand the interactions between the application layer and the server, reverse engineer the iOS and Android mobile applications.
- Vulnerabilities were discovered and exploited to go around current security measures.
- Understanding of the inner workings of the application.
- Exploiting the above findings to gain access to the backend server.
- The testing revealed numerous critical security flaws on the server, including one that might have resulted in a denial of service for users attempting to authenticate with the app.

The financial institution was able to uncover potential threats/vulnerabilities that could have compromised their network and systems thanks to the researcher's penetration test. The information that is lacking from this literature is whether penetration testing fixing the vulnerabilities in the mobile banking app. The case study explained how doing the penetration test help them identify the vulnerabilities within the mobile banking application. My study will provide financial institutions with a framework to use when creating a mobile application that will decrease the vulnerabilities, and changes that need to be made analyzing the security/privacy within the mobile application [5].

According to a recent analysis from LexisNexis Risk Solutions, banks experienced higher monthly fraud attacks in 2021 compared to the previous year. The survey indicated that between 2020 and 2019, the average number of monthly fraud assaults for banks with yearly revenues of more than \$10 million rose from 1,977 to 2,320 [6]. The cost of fraud also kept increasing. Financial services companies in the United States spent \$4.00 for every dollar of fraud lost in 2021, compared to \$3.64 in 2020 prior to the epidemic. The transaction face value for which the firms are held responsible, fees and interest accrued, fines and legal fees, labor and investigative costs, and external recovery costs are included in those charges [6].

The cost of fraud to American banks increased from 26% in 2020 to 33% in 2021 as a result of online banking, while costs associated with mobile transactions increased from 20% to

29% in the same period. In 2021, 21 percent of fraud costs were attributable to in-person fraud, down from 29 percent in 2020 [6]. The survey also discovered that losses due to fraud occur at all points in the customer experience, including when a new account is opened, when a consumer logs into their account, and when money is distributed from a bank account, an investment account, or a loan. The step of the customer journey most vulnerable to fraud, according to respondents from U.S. banks, is the distribution of funds stage, followed by account login. At every point of the customer journey, identity verification was identified by banks as a major barrier for online and mobile channels.

In the summer of 2020, when mobile banking activity increased in reaction to COVID-19 and the ensuing lockdowns, the FBI issued a warning about an increase in hostile behavior aimed at exploiting vulnerabilities in mobile financial services. At the end of December, an "evil emulation farm" that imitated victims' mobile devices to defraud bank account users in the U.S. and Europe of millions of dollars was discovered, putting that warning into action [7]. According to researchers, this operation differs from earlier instances of mobile fraud because of its size and speed. By using automation and a network of roughly 20 emulators that imitated 16,000 mobile devices, the attackers were able to steal millions of dollars from bank accounts in just a few days. A mobile emulator is a fictitious mobile device that replicates the features of actual mobile devices and simulates user interaction. Emulators were first created to provide automated software testing on a variety of devices.

The victims' existing devices were imitated by the fraudsters in certain instances. In other instances, the scammers impersonated the victim accessing their bank account using a fresh device. The researchers don't know exactly how the banking credentials were compromised, but it's conceivable that they were taken by malware, gathered through phishing campaigns, or discovered on the dark web. It's unclear exactly how device identifiers were gathered, although it makes sense that mobile malware that was installed on victims' devices would have collected this information [7]. To identify online fraud, researchers have proposed a system with five layers of prevention: endpoint-centric, navigation- and network-centric, user- and entity-centric, cross-channel user- and entity-centric, and big data user and entity analytics. The employment of an emulator by the fraudsters allowed them to get around some parts of the initial line of defense. More and more often, clever fraudsters are able to impersonate client-side information such as the client's device, location, and time of day [7].

III. METHODOLOGY

The research methodology is quantitative because this study builds accurate and reliable measurements that allow statistical analysis. In addition, this study focuses on collecting and analyzing data that is structured and can be represented numerically. The designated data collection techniques include 22 quantitative survey questions with bank executives and third-party vendors for those financial institutions. The survey questions with the bank executives will allow me to get statistics and information on the institution about their mobile banking app security and privacy. Financial institutions

increasingly rely on third-party vendors to help them achieve their growth and efficiency initiatives, so the third-party vendors give me more information and a different perspective on the mobile banking app.

IV. RESULTS AND ANALYSIS

Null Hypothesis 1 is that lack of proper authentication method, awareness of the known security threats, awareness of the unknown security threats, and privacy risk are not the key security issues in the current mobile banking sector. Frequency analyses and binomial tests were performed to address this hypothesis. The results revealed that 77.4% of the participants believed that customer perception of security in mobile banking is affected by the authentication method used. The results from the binomial test indicated that this percentage was significantly higher than 0 ($p < .001$), suggesting that a lack of proper authentication method could be a key security issue in the current mobile banking sector. Furthermore, all the respondents believed that both awareness of the known security threats and awareness of the unknown security threats have a direct relationship with perceptions of trust in mobile banking.

In addition, a majority of the participants (77.4%) stated that privacy risk is a key security threat in mobile banking. The results from the binomial test indicated that this proportion was significantly higher than 0 ($p < .001$), suggesting that privacy risk is a key security issue in the current mobile banking sector. Overall, these results provided strong support to reject Null Hypothesis 1 indicating that lack of proper authentication method, awareness of the known security threats, awareness of the unknown security threats, and privacy risk are among the key security issues in the current mobile banking sector.

The actual data collection was conducted using quantitative survey questions. Quantitative surveys with the closed-ended format were employed to obtain verbal nominal data ("yes", "no", or "don't know/don't have knowledge of the answer.") of the perceptions of banks executives and third-party vendors concerning mobile banking app security and privacy. There were seven independent variables in this study, including the awareness of the known security threats, awareness of the unknown security threats, customer trust level, authentication method, security, privacy risk, and satisfaction level while the dependent variable is mobile banking fraud.

A total of 209 participants conducted surveys: 155 bank executives and 54 third-party vendors. The data collected in the pilot study were merged with the data collected in the main study as there were no changes in the survey questions and the same participant selection method was followed in both phases of the study. Thus, the final sample included 221 participants, 161 bank executives, and 60 third-party vendors.

Frequency analysis was conducted to characterize the sample. These results showed that all respondents believed that security issues cause mistrust of mobile banking transactions and services among customers, awareness of the known security threats has a direct relationship with perceptions of trust in mobile banking, awareness of the unknown security threats has a direct relationship with perceptions of trust in mobile banking, security is an antecedent of customer trust in

mobile banking, secure mobile banking services can enhance trust between consumers and sellers, and the assurance of safety and security helps in developing trust in mobile banking users. A majority (91%) agreed that security improves customer trust in mobile banking. More than half of the respondents (54.3%) indicated that security is a highly rated concern in the trust of mobile banking users. ID fraud and ID theft were reported by 22.6% of the respondents to be major security threats in mobile banking. A majority (77.4%) stated that privacy risk is a key security threat in mobile banking.

Customer perception of security in mobile banking was deemed to be affected by the authentication method used by 77.4% of the respondents. More than half of the respondents (54.3%) believed that the biometric method can improve the security level in mobile banking more than the conventional use of usernames and passwords. The participants generally agreed (77.4%) that the fingerprint mechanism is the most appropriate biometric authentication approach for a customer of mobile banking services. The respondents were more likely to agree (54.3%) that the fingerprint mechanism is more suitable for authentication as compared to other biometric mechanisms such as voice recognition and facial recognition. All the respondents reported that the adoption of the fingerprint biometric mechanism will increase/enhance the security level in mobile banking, fingerprint biometric mechanism for mobile banking is easy and accessible for bank services from anywhere, and the risk level will be reduced when the fingerprint biometric mechanism is implemented in mobile banking. A majority (77.4%) stated that the implementation of the fingerprint biometric mechanism in mobile banking will help to reduce fraud in this sector.

In addition, 45.2% agreed that customer satisfaction is high when fingerprint biometric mechanism is used in mobile banking when compared to other biometric techniques. All the participants stated that the implementation of the fingerprint biometric mechanism leads to a high customer trust level. Transaction of money was deemed to be safe when fingerprint biometric mechanism is used in mobile banking by 45.2% of the respondents. More than half (63.8%) reported that age affects customer perceptions of security, trust, and authentication in mobile banking.

V. FUTURE WORK AND CONCLUSION

As mobile banking continues to grow as a sector of the banking industry, it prompts questions about perceptions of threats as well as the utility of different authentication measures to meet those threats. This paper examined the opinions of industry leaders in their understanding of public perceptions of risk, trust, and cybersecurity as well as investigated their opinions on the most effective biometric authentication methods.

This research identifies several variables that weigh heavily in the decision-making calculus of both vendors and customers of mobile banking apps. The most important variables were authentication methods, security threats, privacy, and risk calculations. Biometric solutions to security questions also bore out through the research, including a recommendation for fingerprint authentication for both security and trust building among clients.

Cyber security represents a large and growing focus of academic literature, as it permeates industries that were, until recent decades, wholly offline. Banking is a high-risk industry, carrying sensitive information that mobile banking users trust will be kept confidential. Breaches in bank security can be devastating to individuals' financial situation, and even if caught and fixed, can carry a heavy cost in terms of time and energy spent. The banking industry, like many others, must continue to dedicate resources towards investigating the costs and opportunities of cybersecurity.

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Defining a New Business Core Curriculum

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Defining a New Business Core Curriculum

Abstract

The future is changing faster than we humans can adapt. As we look to the future, we can no longer predict what our students will need to know. The knowledge base of most current curriculums is based on the business practices that evolved over the past 100 years. Today, AI, BI, Data Analytics are driving business in new directions the old model no longer support. This paper attempts to identify knowledge areas that students will need to develop to thrive in the future.

Introduction

Curriculum development is an assortment of actions whose outcome is changes in curriculum, according to Marsh and Willis (2007). Ornstein and Hunkins (2009) define curriculum development as procedures that enable schools and other stakeholders to achieve set objectives. Ornstein and Hunkins (2009), asserts that an effective curriculum is the one developed with the central aim of nurturing deep understandings, sophisticated skills, suitable attitudes, and socially acceptable values. An effective curriculum provides an environment that enables a participatory mode of learning in which the students are major actors in the learning program.

Starting in the fall of 2020 the College of Business started a review of its core curriculum. As shown in Table 1 very few Curriculum changes occurred in the past 30 years. CS 101 became IT 101 then MIS 200 (Office applications), FIN 207 became LE 207 (legal environment), and MIS 290 (principles of MIS) became a required course.

Table 1. The business core curriculum between 1993 and 2022

1993-1995	2001-2003	2009-2010	2020-2021
ACC 215	ACC 215	ACC 215	ACC 215
ACC 216	ACC 216	ACC 216	ACC 216
CS 101	IT 101	ECN 250	ECN 250
ECN 250	ECN 250	ECN 253	ECN 253
ECN 253	ECN 253	FIN 323	FIN 323
FIN 207	FIN 323	LE 207	LE 207
FIN 307	LE 207	MGT 218	MGT 218
MGT 308	MGT 308	MGT 320	MGT 320
MGT 320	MGT 320	MGT 460	MGT 460
MGT 460	MGT 460	MIS 200	MIS 200
MKT 340	MKT 340	MIS 290	MIS 290
		MKT 340	MKT 340

Beyond the business core, students are required general education courses, major-specific courses, and free electives. A few years ago the total hours required to graduate declined from 128 to the current 120 hours.

The Process of Core Business Curriculum Review

In the fall of 2020, the new Dean Avinandan Mukherjee, created several task forces to review various aspects of the College of business's processes and policies. One of these committees was called the BBA

core task force. The role of Task Force was to review the current BBA Core Curriculum and, if desired, develop, vett, and propose an updated BBA Core Curriculum. With the Long-Term Outcome to create a repeatable process of review and revision so that the BBA Core continues to stay:

1. Aligned with LCOB Mission & AACSB AoL
2. Faculty-Driven
3. Relevant to the Constantly Evolving Business World

12 faculty members or assigned to the task force. The faculty represented the disciplines in the college and the dedicated advising office.

Brad Smith, Marshall alumni and former CEO of intuit corporation made a large donation to build a new business building. Brad additionally brought the intuit design process and taught it to the business faculty. Intuit calls This process design for delight (D4D).

The D4D process has three parts.

Deep Customer Empathy

Get to know your customer by observing them and walking a mile in their shoes.

Go Broad to Go Narrow

Create a daring idea by developing a broad number of potential solutions and then narrowing to one.

Rapid Experiments with Customers

Rapidly build a scrappy prototype of your solution and test it on your customers for their feedback.

The task force used the D4D process.

Step one, Deep Customer Empathy. The task force interviewed every single LCOB (Lewis College of business) faculty member and advisor to determine if a redesign of the BBA core was desired. They interviewed 24 students from all business majors. They interviewed 24 alumni practitioners across all business majors. They reviewed the core curriculum of 24 other business schools.

To interview students and alumni they used a structured interview format, see Figure 1.

Figure 1. Structured Interview form. (Mural.com)

Empathy Interview - Student #1

First Name Only: **Major:**

1. Set the stage (3 minutes)
 "It's great to meet you, and thanks so much for taking the time to meet with us today. Our goal is to understand what **core** business skills you think you need to be prepared for the future of business. Your answers will be confidential so you can be completely honest. We want to know your honest answers so we can best prepare students to be successful in the future."

2. Observe and dig deeper (25 minutes)
 You: "OK, let's get started. What do you think the future of business will look like in 5 or 10 years? (This is warm-up question to get the student comfortable.)"

 You: "Interesting. So what skills and mindsets do you think you'll need to be prepared for that future of business? (Drill down and find out the 1) hard skills, 2) soft skills, and 3) mindsets they think they need.)"

 You: (Screen-share the names of the core business classes with student to remind them of them.) "Thinking back on those classes, what do you think were the most important skills and mindsets you learned for the future business world?"

 You: "Thanks. Thinking back on those classes again, what do you think were the least important skills and mindsets for the future business world?"

 You: "How secure do you feel that you'll be able to find, obtain, and succeed in a great career in the future business world?"

 You: "If you had a magic wand, what's one thing you would immediately change about those core business classes that would make you feel more secure about finding, obtaining, and succeeding in a great career in the future business world? (Feel free to ask for more than one thing they would change.)"

3. Wrap Up (2 minutes)
 "Wow [student's name], we really learned a lot from you today, We'll take this info back to my team and get to work! Thanks!"

From these interviews, they gained multiple insights, and these are organized in figure 2.

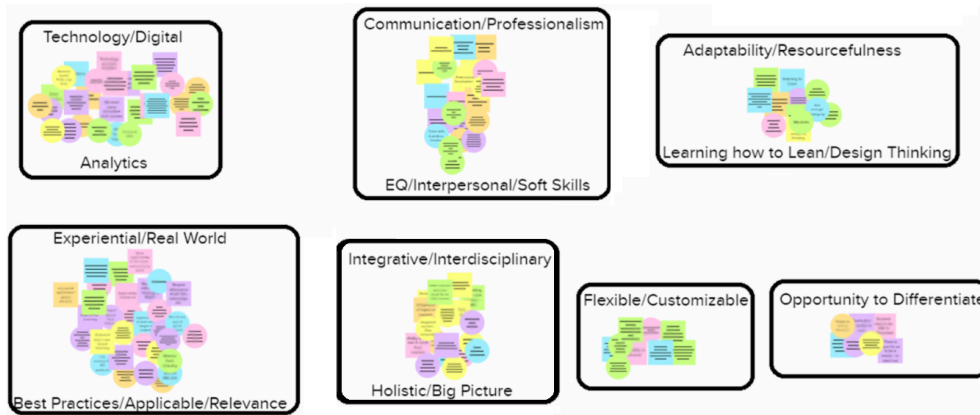
Figure 2. Task Force Insights Organized



These insights were then grouped into eight categories as shown in figure 3.

Figure 3 only shows 7 categories; the 8th category was a desire to understand all the disciplines within business. Since that is the purpose of the core curriculum, it was not included.

Figure 3. Task force insights Grouped



From this in depth look at the customer a problem statement and an ideal state were created, see figure 4.

Figure 4. Problem Statement and Ideal State.

3. Our Problem Statement

He/She is: an LCOB business student

He/She is trying to: be prepared for success in the future business world

But he/she: doesn't have all 4 student skills listed above

Because: the current curriculum doesn't fulfill all 4 student curriculum needs listed above

Which make him/her feel: insecure about his/her future

4. Our Ideal State

In a perfect world: every LCOB business student has the core business fundamentals, technical skills, soft skills, and growth mindset to help a company thrive

The biggest benefit to him/her is: a secure and rewarding career

Which makes him/her feel: able to make a big impact at his/her company

Step 2, Go Broad to Go Narrow. Create a daring idea by developing a broad number of potential solutions and then narrowing to one. In this step, multiple possible core curricula were developed by members of the task force. See Figure 5.

Figure 5, Going Broad

- Each task force member brainstormed 3 “no limits” core curriculum sketches... giving us a pool of 36 “no limits” core curriculum sketches
- “No limits” means shoot for the moon...pretend there are no restrictions on solving for the student problem statement/ideal student state...not considering feasibility or viability at this point (that comes later)

Next, go narrow. To narrow the 36 curricula to 1 it's like multi part activity. First the 12 members of the task force were divided into four teams. each team reviewed the 36 curricula they had developed individually. Using the “100 point game”, see figure 6.

Figure 6, the “100 point game form”

100 Points - 3 Team “No Limits” Curriculums to 1

Each person in your group has 100 points to allocate across the 3 curriculums. Each person should individually allocate their 100 points across each curriculum based on which one they think best achieves the ideal state. Once each person has allocated all 100 of their points, tally the points for each curriculum. The curriculum with the highest point total is selected.

36 Hour Curriculum #1	36 Hour Curriculum #2	36 Hour Curriculum #3
Team Member 1 Name: <input style="width: 80%;" type="text"/>	Team Member 1 Name: <input style="width: 80%;" type="text"/>	Team Member 1 Name: <input style="width: 80%;" type="text"/>
Team Member 1 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 1 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 1 # Points out of 100: <input style="width: 50%;" type="text"/>
Team Member 2 Name: <input style="width: 80%;" type="text"/>	Team Member 2 Name: <input style="width: 80%;" type="text"/>	Team Member 2 Name: <input style="width: 80%;" type="text"/>
Team Member 2 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 2 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 2 # Points out of 100: <input style="width: 50%;" type="text"/>
Team Member 3 Name: <input style="width: 80%;" type="text"/>	Team Member 3 Name: <input style="width: 80%;" type="text"/>	Team Member 3 Name: <input style="width: 80%;" type="text"/>
Team Member 3 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 3 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 3 # Points out of 100: <input style="width: 50%;" type="text"/>
Team Member 4 Name: <input style="width: 80%;" type="text"/>	Team Member 4 Name: <input style="width: 80%;" type="text"/>	Team Member 4 Name: <input style="width: 80%;" type="text"/>
Team Member 4 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 4 # Points out of 100: <input style="width: 50%;" type="text"/>	Team Member 4 # Points out of 100: <input style="width: 50%;" type="text"/>
Total Team Points Curriculum #1: <input style="width: 50%;" type="text"/>	Total Team Points Curriculum #2: <input style="width: 50%;" type="text"/>	Total Team Points Curriculum #3: <input style="width: 50%;" type="text"/>

Each team then narrowed its choice to 1 curriculum. The task force now had 3 curricula, one from each team.

Step Three, Rapid Experiments with Customers. Rapidly build a scrappy prototype of your solution and test it on your customers for their feedback.

Experiment #1 The task force presented these three curricula to the college faculty for review and their evaluation. The goal was to gain faculty impressions of these three prototypes.

- What did they like about each?
- What would they change about each?
- On a scale of 1-10, how well each prepared students for the future of business

Faculty could develop their preferred prototype, see Figure 7.

Figure 7, Faculty Evaluation Form.

Please Circle Your Choice Below.

If Prototype 1, 2, or 3 ALMOST suits you, indicate what you would change.

If you would like to "Build Your Own," use the fourth column and choose courses from the list provided or write in your own!

Prototype #1	Prototype #2	Prototype #3	Build Your Own
1 ACC 215 Financial Accounting	1 ACC 215 Financial Accounting	3 ACC XXX (combine ACC 215 & 216)	<input type="checkbox"/>
2 ACC 216 Managerial Accounting	2 ACC 216 Managerial Accounting	5 BUSN XX1 (Design your Life/Pers. Dev.)	<input type="checkbox"/>
4 BUSN 100 Intro to Bus. & Des. Think.	4 BUSN 100 Intro to Bus. & Des. Think.	6 BUSN XX2 (Gen. App. Certification)	<input type="checkbox"/>
8 ECN 250 Principles of Microeconomics	8 ECN 250 Principles of Microeconomics	7 BUSN XX3 (Major Specific App. Certific.)	<input type="checkbox"/>
9 ECN 253 Principles of Macroeconomics	9 ECN 253 Principles of Macroeconomics	10 ECN XXX (combine ECN 250 & 253)	<input type="checkbox"/>
12 FIN 323 Principles of Finance	12 FIN 323 Principles of Finance	11 ENT 360 Intro to Entrepreneurship	<input type="checkbox"/>
14 LE 207+ (add ethics)	14 LE 207+ (add ethics)	13 FIN 323+ (add personal finance)	<input type="checkbox"/>
17 MGT 218+ (add focus on analytics)	17 MGT 218+ (add focus on analytics)	14 LE 207+ (add ethics)	<input type="checkbox"/>
19 MGT 3XX Mgmt Techniques for Bus.	18 MGT 320 Principles of Management	17 MGT 218+ (add focus on analytics)	<input type="checkbox"/>
20 MKT 340 Mkt. Concepts & Applications	21 MKT 340+ (add sales)	22 MGT/MKT XXX (combine MKT & MGT)	<input type="checkbox"/>
25 MGT 460+ (add experiential learning)	26 MGT 460+ (add strategic transform.)	24 MGT 460+ (add analytics)	<input type="checkbox"/>
29 MIS 299 (combine MIS 200 & 290)	30 MIS XXX (Emerging Technologies)	31 MIS XXX (Excel)	<input type="checkbox"/>

(Number in the box referred to the course description.)

Results of Experiment #1

- Prototype 1 (rated 6.81 out of 10)
- Prototype 2 (rated 6.4 out of 10)
- Prototype 3 (rated 5.4 out of 10)

A couple faculty built their own, but most just tweaked one of the 3 prototypes.

Experiment #2

- Narrowed to a single prototype, heavily based on Prototype 1
- Dean's Office granted us an extra 3 hours to incorporate more technology (total 39 hours)

The Suggested solution. Bold means a major modification to the existing course or a new course.

BUSINESS BASICS – 12 HOURS

LE 207 - Legal and Ethical Business Issues

MIS 299 - Merge MIS 200 and MIS 290

BUSN 100 - Intro to Business & Design Thinking

ECN 250 - Principles of Microeconomics

QUANTITATIVE REASONING – 15 HOURS

ACC 215 - Financial Accounting

ECN 253 - Principles of Macroeconomics

FIN 323 - Principles of Finance

ACC 216 - Managerial Accounting

MGT 218 - Business Quantitative Methods and Analytics

BUSINESS PROCESSES – 12 HOURS

MGT 320 – Principles of Management

BUSN 4XX – Contemporary Business Topics & Technology

MKT 340 - MKT Concepts and Applications

MGT 460 - Capstone Experience

The results for experiment #2

- Prototype rated 7.0 out of 10
- What Faculty Liked:
 - Groupings
 - Integrated Ethics into Core
 - Broad-Narrow-Broad Approach
 - Design Thinking is an Opportunity to Differentiate
- What Faculty Would Change:
 - Flesh out new courses
 - Need heavier focus on Excel as an analytics tool
 - Could've been more innovative

Nest Steps,

- Flesh out the new courses (syllabi, scheduling/logistics)
- Work towards incorporating Excel as an Analytics tool
- Develop another prototype curriculum
- Experiment prototype curriculum on faculty, students, practitioners
- If experiments are successful, send prototype curriculum for faculty vote
- If faculty vote is successful, send on to Curriculum Committee

These have been submitted to the Deans office for presentation to the college faculty. This presentation has not yet occurred.

Conclusion

The core business curriculum has not required a major change as most areas of business evolution occur in advanced courses within a major. As we have reviewed our business core needs some minor tweaking. Given the constraints of 36 to 39 hours, it is difficult to include everything the ideal undergraduate student would learn from these courses. So the struggle to remain current and differentiate oneself in the 21st century continues.

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Departmental Academic Resilience: Using the Incident Response Methodology Taken from Cybersecurity

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Abstract

Considering the unprecedented circumstances of today's world, each individual department in higher education institutions (HEIs) have to be prepared for the unexpected. Events like COVID-19, the Russia-Ukraine war, gun violence, and cyber threats, to name a few, are forcing all parts of HEIs to develop academic resilience to reduce the incident's negative impact on their programs, faculty, staff, and students. The authors, as technology professors, propose a Departmental Academic Resilience Framework (DARF) to support academic resilience and better response by their department to unexpected incidents. The recommendations follow the National Institutes of Standards and Technology (NIST) Incidence Response Framework as the baseline. Two study cases of academic resilience—the effect of COVID-19 on their academic programs and the impact of the Russia- Ukraine War on a global trip program— have revealed that a formally customized incident response framework in academia could generate better outcomes.

Keywords: Resilience, incident response, NIST, COVID-19, higher education

1. Introduction

We live in an uncertain world today: COVID-19, the Russia-Ukraine war, gun violence, and cybersecurity threats such as ransomware, to name a few. Each of these has had a major impact on our academic institutions and their faculty, staff, and students. Most institutions survived but not without some damage. Others did not, such as Illinois-based Lincoln College of Technology which suffered a double hit: the COVID-19 pandemic and a ransomware attack (Chung, 2022).

However, for survivors the massive effort required to handle these unexpected events has had a negative impact on most academic institutions, large and small. According to Inside Higher Ed's 2022 Survey of College and University Chief Academic Officers, 19% said that faculty are leaving at significantly higher rates than previously and 60% said they were leaving at somewhat higher rates (Flaherty, 2022). We have all witnessed

resignations of faculty and staff at our own institutions because of the impact of COVID-19. This obviously places extra burdens on those of us who chose to stay.

There is little evidence that the uncertain world will stabilize any time soon. And so, it is incumbent on us to consider better coping strategies for whatever comes our way. Some can be done at the institution level, but we believe that individual departments are in a unique position to ensure the viability of our programs in these unknown circumstances.

The authors, as technology professors, looked at their own field to find approaches already in use that might be modified to support their department's academic resilience. Their analysis identified the National Institutes of Standards and Technology (NIST) Incidence Response Framework as the baseline framework, a set of procedures to manage the impact of a cybersecurity attack (Cichonski, et al., 2012). They agreed that this guideline, if applied more generally to any unexpected event, might be of value to increase departmental academic resilience and reduce the incident's negative impact on the program, faculty, staff, and students.

The authors look at two specific incidents at their institution and postulate how the implementation of the NIST framework and other IT methodologies might support their better response to future incidents affecting their academic programs.

2. Background

More than ever, higher education institutions (HEIs) have to be prepared for the unexpected. On the one hand, they have to be ready to respond swiftly and effectively to protect students, faculty, and staff when an incident strikes. On the other hand, a robust set of incident response and handling measures must be established to keep teaching and learning activities from being disrupted.

The authors decided to adopt an incident response and handling framework from the cybersecurity domain by taking account of the following factors. First, cybersecurity has emerged as one of the major risk areas that HEIs need to develop their incident response plans for (Fraser-Krauss, 2021; Sanders, 2020). There has been a huge spike in ransomware attacks against universities (Department for Digital, Culture, Media & Sport, 2022; Sophos, 2022) and it remains a critical issue that HEIs have to face. Furthermore, universities and academic institutions have become lucrative targets for other cyberattacks because they manage large amounts of valuable and private data such as research data and student medical records, which makes them an attractive target for cyber-criminals, espionage, and hacktivists (Bongiovanni, 2019; Joachim & Wangen, 2021). In addition, it is much more difficult for an HEI to get cyber insurance coverage for a data breach without certain proactive measures in place (Snyder, 2022).

Such shifts and new mandates in cyber insurance policies drive the need for improved incident response in an HEI. Even though this paper is not to focus on the aspects of Information Technology (IT) or cybersecurity operations, the authors found that the angles to mitigate risks and the strategic planning elements in the cybersecurity incident response framework are highly analogous to their counterpart of academic operations, particularly at the department level.

Second, the pace of change within higher education also reinforces the need for formal security incident response policies and procedures. For instance, even before the COVID-19 pandemic, a great number of HEIs actively looked to digital innovations such as cloud adoption and remote learning to boost student success (Conlan-Donnelly, 2022). Nearly every technology change can affect incident response planning, which requires a regular report on cybersecurity risks and resilience to the executive board (Fraser-Krauss, 2021). Having a clear governance framework in place is considered a critical success factor in achieving academic operation resilience like curriculum renovation or academic policy updates.

Third, there is no need to reinvent the wheel considering that comprehensive guides providing a variety of information and resources relevant to higher education information security programs already exist. For example, Higher Education Information Security Council (HEISC) created an information security guide consisting of 17 chapters on information security, privacy, identity and access management, governance, risk, and compliance (EDUCAUSE, n.d.). It is mapped to several popular standards, including ISO/IEC 27002:2013, NIST, HIPAA, COBIT, PCI DSS, and the federal cybersecurity framework. One of the guide chapters is focused on Incident Management and Response. In addition, it is useful to see examples of real plans created by other organizations in higher education which have been fine-tuned over time based on their experience. The examples include Carnegie Mellon University Computer Security Incident Response Plan (<https://www.cmu.edu/iso/governance/procedures/docs/incidentresponseplan1.0.pdf>), University at Buffalo Information Security Incident Response Plan (<https://www.buffalo.edu/ubit/policies/guidance-documents/incident-response-plan.html>), and Wright State University Incident Response Plan (<https://www.wright.edu/sites/www.wright.edu/files/page/attachments/incident-response-plan.pdf>). Those guidelines are generic enough that one can adapt them to an academic program setting with proper adjustment.

3. Departmental Academic Resilience Framework (DARF)

Resilience refers to an academic program's ability to respond, withstand, and recover from inevitable risks. An academic program with a high degree of resilience is able to act with agility and continually deliver high-quality curriculum with substantial services and resources available to help students succeed in spite of disruptive incidents. The authors created an academic resilience framework by adopting a cyber-resilience framework proposed by Blum (2020) which integrates the NIST Cybersecurity Framework (CSF) (2018) and Incident Response (IR) Lifecycle (Cichonski et al., 2012). Figure 1 illustrates the DARF.

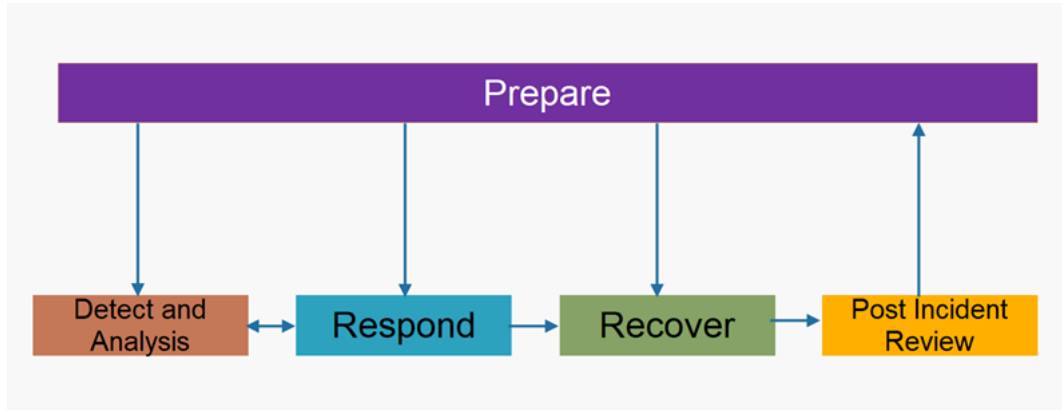


Figure 1. Departmental Academic Resilience Framework (DARF)

An effective DARF includes five basic stages: preparation; detection and analysis; respond; recover; and post-incident review. During this **preparation** stage, the academic program identifies the resources needed for incident response capabilities, ensures that it has faculty or staff who are properly trained and ready to respond to incidents, and develops and communicates the formal detection and reporting processes to others on campus. The **detection and analysis** stage in a departmental academic resilience context means that the academic program needs to develop and implement the appropriate activities to identify the occurrence of an incident. Further, the faculty or staff in the academic program also need to understand the scope of the suspected incident and assess the urgency and impact of the incident. During this stage the academic program will determine whether the suspected incident should be confirmed as an actual incident to which the institution must respond. During the **respond** stage, the academic program needs to take action regarding the incident. It is important to make sure that the response plans and updates include all key stakeholders and external parties if involved. The **recover** component in the framework refers that the academic program needs to maintain plans for resilience and to restore any capabilities or curriculum activities that were compromised due to the incident. The **post-incident review** phase is often overlooked; however, it is very important because this phase is designed for the response team and critical stakeholders to come together

after the incident is closed to identify lessons learned and how to better handle future incidents.

4. Case Studies

This section uses two case studies to showcase how the authors' academic programs handled disruptions caused by Russia-Ukraine war and the COVID-19.

4.1. Ukraine War and the Global Study Course

On February 24, 2022, Russia invaded Ukraine. While the entire world was watching the terrifying news, the authors' school was experiencing a different type of academic incident related to the war.

Several months before the invasion, the authors' school, in partnership with the Global Engagement Office, planned a Special Topics in IT and Cybersecurity course with a Global Trip component in Romania during the scheduled Spring break (March 4 – March 11, 2022). The course was designed to focus on the factors, policies, and practices behind Romania's growing competitive advantage in Eastern Europe in creating and expanding IT and cybersecurity companies. The class content was designed to analyze government policies and business practices promoting increasing global competitiveness of the Romanian high-tech sector. The global trip component considered visits to local and international IT and cybersecurity companies, government entities, nonprofits, and universities located in Bucharest, the capital city of Romania. The objective of the visit was to provide an insight into the technology fields and why US companies select Romanian companies to outsource development and other highly technical projects.

Just a week before the trip, Russia invaded Ukraine. Due to Romania's geographical position in the immediate neighborhood of the war and being the very Eastern NATO border, the country experienced uncertainty and chaos during that time. Due to security reasons, as well as advised by representatives of the US Embassy in Romania, the trip was canceled. Still, the Special Topics in IT and Cybersecurity course was planned to continue until the end of the semester.

During the planning stage of the course, the organizers considered the risk of a new wave of COVID-19 infections, which might have interrupted the trip. Thus, COVID-19 was the main risk concerning a possible trip cancellation. The possibility of war in the region was not foreseen or predicted as a risk. Therefore, it caused a major disturbance and confusion for the students, the instructors, and the staff involved in the trip planning. The student's reaction to the cancellation was a combination of sadness and disappointment, but understanding of the circumstances.

In response to the trip cancellation, curriculum and teaching adjustments were necessary to keep the students engaged until the end of the semester and still fulfill the course's objectives. As soon as the official announcement of the trip cancellation was made, the instructor innovated an alternative: the “global classroom from home.”

The instructor reached out to the local network and partners in Romania and invited them to still participate in a virtual setting. A series of live Zoom meetings were organized with local and European experts from the private sector, government, nonprofits, Romanian universities, European and International organizations, and the legal profession. Despite the 7-hour time difference, we managed to create valuable learning experiences that students appreciated.

As was expected, not all the students were entirely positive about the revised experience, considering that the expectations for the course, with the global trip component, have been set up differently at the beginning of the semester. Handling students' concerns, being agile in re-organizing the course structure, identifying notable guest speakers, providing quality content, and working out logistic details such as busy guest speakers' schedules, different time zones, and cultural differences put a lot of additional pressure on course instructors and organizers. However, the department worked as a team and all the students appreciated the agility of the instructor to reorganize the course structure and still deliver quality.

4.2. Responding to COVID-19

Our department's individual response to the COVID-19 pandemic was largely dictated by the guidance from the federal government, our state (the Commonwealth of Virginia) and the university as a whole but its implementation was the responsibility of individual faculty and staff. We teach technology-related courses and so our faculty were relatively lucky to be equipped to work from home, albeit surrounded by various levels of family, including children and vulnerable older parents. Our own and their health was a major concern.

Also of note was the university's infrastructure. The university had wide spread adoption of the Canvas learning management system, both for a small number of online offerings as well as in support of some face-to-face classes. Zoom had also been in use for a short period of time. Most students had therefore been exposed to these tools.

As most other academic institutions we transferred to the online only platform in the middle of the Spring 2020 semester, with a two-week transition period. Minimal changes were made in those first two weeks, most of the instructional design changes coming

throughout the second half of the semester. As technology teachers we were accustomed to updating our materials constantly as the field is evolving quickly, this laid on an additional need to change the delivery method, particularly for the hands-on portions of our classes. We adopted a few lessons from the “agile methodology” with a sprint time of one week and a team-approach with faculty and staff.

Our students became our major concern, with a great deal of different responses to the “new normal”. Equity became a major concern with quarantined international students far from home, and some of the lower-income students with no computer or wi-fi access from home. Normally, they used school computer labs, or laptops on loan from the library, or their local public library, also now closed. Others shared computing resources with parents and siblings, all now working from home. COVID-19 affected many households differently, including faculty and staff, and we became emotionally drained doing our very best to continue an effective education to all our students, many on an individual basis.

After that first emergency response to the COVID-19 incident, we began to look at the situation from a systems perspective to improve our performance going forward, post COVID, yet recognizing that additional crises might arise. Several business and IT processes came up for discussion including the digital divide, customer (student) relationship management, digital transformation and cybersecurity incident response.

We can say we survived the COVID-19 pandemic but at a cost to faculty, staff and many of our students, leaving thinking there must be a better way. We recognized that a more formal customized to incident response in our academic department was necessary.

5. Discussions

While overall, we can say that we transformed challenging circumstances into opportunities; we admit that the existence of a formal Academic Resilience Framework would have considerably helped manage the unforeseen challenges of the academic programs. For both COVID-19 and the War in Ukraine, an application of the proposed Academic Resilience Framework would have helped manage the crises in a smoother way and minimize somewhat the stress levels.

During the **preparation stage**, the instructors and university staff would identify the resources required for incident response capabilities, ensuring that in case of an unforeseen situation such as a war or a pandemic, the university has the capacity to provide resources for alternative solutions. There was certainly advance notice of both incidents that should have led to more consideration of contingency plans.

In the case of the global trip, in the preparation stage, having an identified local network of partners in advance should have been a priority. To be better prepared we should have also identified upfront trained administrative staff to handle logistical details such as cancelations of plane tickets, hotel reservations, etc. including handling reimbursements, insurance claims, and other trip interruption details. Only COVID-19 was considered a potential risk for the trip interruption, and the possibility of a war in the region was not considered. Even when the media started addressing the region's potential conflict, we did not consider that the potential tensions could affect our program. We should have been better prepared, and prepared our students.

The technology aspects of online teaching were in place for both COVID-19 and the global trip.

During the **detection and analysis stage**, the academic program has to develop and implement suitable activities to identify the incident. For both COVID-19 and the war, the detection and analysis were needed to clearly identify the potential risks.

During the **respond stage**, we need to take action. During this stage, communication is key. Since the beginning of COVID-19, university's leadership, staff and professors have put tremendous efforts to communicate to students, parents and community how the university is addressing all the COVID-19 related challenges.

In the case of the Global course, we announced to the students that the trip was canceled, provided logistical details about cancellations, and announced that the course would continue until the end of the semester. However, at that level, there was no concrete plan of how this course would unfold, which caused a lot of pressure on the course instructor and the students.

In the **recovery stage**, we restored curriculum activities that were compromised and provided alternatives of providing online courses during the pandemic and organizing online events with guest speakers from Romania, in the case of the global course.

And finally, in the **post-incident review stage**, a multi-faced assessment is necessary to gain an insightful understanding of the situation and document the lessons learned for future reference. In the case of COVID-19, a complex assessment process is necessary, since the circumstance was unprecedented and very specific, in addition to the extended period of time. In the case of the global course, since it was a short instance, the instructor allowed students to reflect and express their thoughts in a class setting and individually, including asking their opinion on how this course could have been improved. All that information was collected and used, in part, to create the base of the current research paper. The adoption of the DARF is also an outcome.

6. Conclusion

Today's world faces uncertainties and challenges such as COVID-19, the Russia-Ukraine war, gun violence, economic crises, and cybersecurity threats. These circumstances significantly impact the instructors, staff, and students of HEIs. A comprehensive set of incident response and management methods should be implemented to prevent disruptions to teaching and learning activities caused by unpredictable and uncontrollable circumstances.

In this paper, the authors examined existing models in their own discipline to see if they could be adjusted to support departmental academic resilience. The NIST Incident Response Framework has been identified as the baseline framework that can best strengthen academic resilience within our department and minimize the incident's adverse effects on the institution, its faculty, staff, and students. By adopting a cyber-resilience framework proposed by Blum (2020), the authors proposed an effective DARF that includes five primary stages: preparation; detection and analysis; respond; recover; and post-incident review.

Two case studies on how the authors' school adjusted their curriculum and teaching/learning activities in response to the COVID-19 and the Russia-Ukraine War were presented. The examples show how using the NIST framework and other IT approaches can help academic departments, including themselves, handle such disruptions more effectively and be more agile and resilient in the future.

The authors concluded that each academic department needs a more formal, tailored incident response framework to better support academic resilience during future crises.

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ESTIMATED IMPACT OF UKRAINE WAR ON EXCHANGE RATE RISK OF MULTINATIONAL ENTERPRISES OPERATING IN EMERGING MARKETS

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ABSTRACT

Multinational enterprises (MNE) operating in emerging countries are exposed to various types of risk. Exchange rate risk is an important and anticipated part of MNE's total risk exposure, with a variety of tools available to mitigate that risk. In this study, we focus on transaction exposure of cash flows in eight distinctive emerging market currencies and employ the Modified Value-at-Risk (MVaR) model to estimate the maximum one-period loss during a twelve-month period spanning pre- and post-Ukraine war periods. The predicted losses by MVaR are then compared to the ex-post results, to identify any differences in the pre- and post-Ukraine war periods and to determine the need for adjustments in hedging strategies by MNEs during similar global crises. The motive of this research is to understand the limitations of hedging and what can MNEs do to mitigate transaction exposure risk. The results provide insights on whether MNEs should hedge their currency risk or not. The Ukraine war did impact all firms globally so this study is relevant and pertinent as firms plan their post-war growth.

INTRODUCTION

Multinational Enterprises (MNEs) are business organizations that operate in multiple countries. MNEs engagement in the international arena exposes them to additional types of risk in comparison to domestic corporations. An important risk factor facing MNEs is the exchange rate risk. The exchange rate risk may be particularly significant for MNEs operating primarily in emerging markets.

Since majority of MNEs operate in multiple emerging countries, their currency risk exposure will be subject to the transaction exposure of their currency portfolio (cash inflows as well as outflows in different currencies). The volatility and co-movements of these currencies are known to be instable over time. With the tremendous growth in the foreign exchange transaction volume over the last four decades, as well as the growing volatility of foreign exchange rates in the floating exchange rate era, proper management of currency exchange rate risk is an extremely important part of MNEs overall risk management strategy.

Table 1 illustrates the growth of the foreign exchange market over the last four decades, indicating the growth in the average daily global foreign exchange transaction volume was from \$.14 trillion in 1985 to \$6.6 trillion in 2019. With free trade blocs and pacts between various countries across the world, the just-in-time integration of supply chains across all industries, daily forex trading volumes will continue to increase. Globalization and free movement of goods will spur even more foreign exchange risk management for MNEs.

In order to manage their exchange rate risk, MNEs attempt to quantify the exchange rate risks they face, and implement hedging techniques using a variety of financial market tools to minimize these risks. A widely used method to quantify the transaction risk associated with flexible exchange rates is the traditional

“value-at-risk” (VaR) approach. The VaR approach computes a specific dollar value on the downside risk (i.e., the maximum likely loss) an MNE will face over a specific time period at a particular confidence level. An important deficiency of the VaR model is its assumption that exchange rate movements follow a normal distribution and reliance on historical standard deviation of exchange rate movements in estimating the maximum loss. In this study, we utilize the “modified” value-at-risk, (MVaR) approach, which considers the skewness as well as the excess kurtosis and/or absolute kurtosis of the exchange rate movements, resulting in a more reliable risk estimate.

Table 1: Milestones of Daily Foreign Exchange Transaction Volume Globally

Year	In \$ trillion
1985	\$ 0.14
1995	\$ 1.00
2006	\$ 2.00
2010	\$ 4.00
2014	\$ 5.00
2019	\$ 6.60

Source: Bank of International Settlements (BIS), December 11, 2019

The Ukraine war revealed the chinks in the armor of global trade. With Western sanctions placed on Russia, trade routes shut down due to the conflict, and due to export controls many countries were short of critical energy and agricultural products. Our study is the first to analyze possible changes in MNE’s transaction risk in emerging markets during the pre- and post-Ukraine war periods. The conflict driven disruption to economies might induce greater exchange rate volatility and related co-variances among currencies. This will have a measurable impact on transaction risk. We study the eight major emerging countries’ currencies during the six months before and the six months after Ukraine war using the MVaR approach to quantify predicted losses and then compare these predicted losses with the actual/ex-post results. This study enables MNEs to minimize potential losses by determining which particular currency portfolios (i.e., combinations of currencies) have the least/most transaction risk. The results provide insights on whether MNEs should hedge their currency risk or not. The Ukraine war did impact all firms globally so this study is relevant and pertinent as firms plan their post-conflict growth.

Justification of this study

Globalization, integration of supply chains and numerous inter-country trade pacts have led to an explosive growth in the foreign exchange trading. Table 1 shows how daily forex trading volume has increased over time. This massive trading volume has increased volatility in emerging markets as evident from the multiple currency crises such as Asian economic crisis in 1997, Russian, Mexican, Argentinian and many other countries inflationary currency defaults over the past three decades. MNEs operating in such volatile markets must hedge their currency risks to secure their financial positions. There have been no comprehensive studies of the “modified” value-at-risk (MVaR) measure. Our study compares the maximum expected losses with the actual currency losses over this particular post-Ukraine war crisis period for emerging markets’ currencies. A comparison of these findings with the pre-Ukraine war findings will have significant practical implications for MNEs and even mid-sized US firms that have significant revenues and/or expenditures across different emerging markets’ currencies. The results of this research will provide meaningful insights for MNEs to determine their hedging strategy. Hedging currency risk is quite expensive and firms have to weigh the expected benefits and costs of hedging. Our study will help in making these difficult yet necessary decisions for MNEs. While there are a variety of tools available to

mitigate and/or eliminate the exchange rate risk, there are instances where firms may benefit from the decision not to hedge, if they anticipate exchange rate movements in their favor.

BACKGROUND / LITERATURE REVIEW

Cayton, Mapa and Lising [4] show that VaR has become an increasingly popular way for financial institutions to measure the risk of holding assets in multiple currencies. Mohammadi and Akhtekhane [8] estimate the risk associated with the U.S. dollar/rial exchange rate using VaR. Mabrouk and Aloui [7], Rejeb, Salha and Rejeb [9] and Khazeh and Winder [6] also employ VaR methodology to estimate the exchange rate risk associated with multiple currencies and currency portfolios. Artzner, Delbaen, Eber and Heath [2] were first to explore the concept of conditional VaR. Additional studies on MVaR include Kaut, Wallace and Zenios [5], Basak and Shapiro [3] and Alexander and Baptista [1].

While the previous studies mostly focus on the risk exposure of individual currencies using daily percentage changes, standard deviations, and VAR of the aforementioned currencies, we focus on the MVaR of individual emerging market currencies as well as currency portfolios. In addition, we offer the first study comparing the risk profiles of emerging market currencies in the pre- and post-Ukraine war periods via the MVaR method as well as the actual ex-post results.

DATA

For the pre-war period in this study we select the six-month period preceding the commencement of Russia's invasion of Ukraine (August 23, 2021 - February 23, 2022). The post-war period includes the six months following the commencement of the Ukraine war. (February 24, 2022 - August 23, 2022). Both the pre- and post-war period selected are six months in duration. We use the daily exchange rates data from the Federal Reserve Bank database.

The following eight emerging market currencies were considered in this study. Brazilian real (BRL), Indian rupee (INR), Korean won (KRW), Malaysian ringgit (MYR), Mexican peso (MXN), South African rand (ZAR), Taiwanese dollar (TWD) and the Thai baht (THB). The eight countries constitute a significant portion of emerging market GDPs. China has been excluded from this study as the Chinese yuan is tightly managed to float within a particular price band. This artificial control of the currency makes it less volatile and less relevant to this study.

Figures 1 & 2 provide minimum & maximum daily percentage change for the selected emerging market currencies during pre- and post-Ukraine war periods respectively.

Among the selected emerging market currencies, the Brazilian Real has the greatest range in daily percent change during the six-month pre-Ukraine war period (2.17% to -2.18%). The Mexican Peso and South African Rand also show significant volatility, with ranges of 1.72% to -2.09% and 1.56% to -2.08% respectively. On the other end of the spectrum, the Taiwanese Dollar had the smallest range of these eight different currencies (.54% to -.47%).

During the post Ukraine war period, the same three currencies are the most volatile, with increased range for all three. The Brazilian Real has a range of 2.22% to -3.51%, followed by the South African Rand (2.57% to -2.67%) and the Mexican Peso (1.59% to -2.43%). The Malaysian Ringgit shows the smallest post-war range with 0.43% to -0.80%. The Indian Rupee and Taiwanese Dollar also have relatively narrow post-war ranges of 0.73% to -0.81% and 1.07% to -0.69% respectively.

FIGURE 1: MINIMUM & MAXIMUM DAILY PERCENTAGE CHANGE FOR EMERGING MARKET CURRENCIES (PRE-WAR AUG 2021 – FEB 2022)

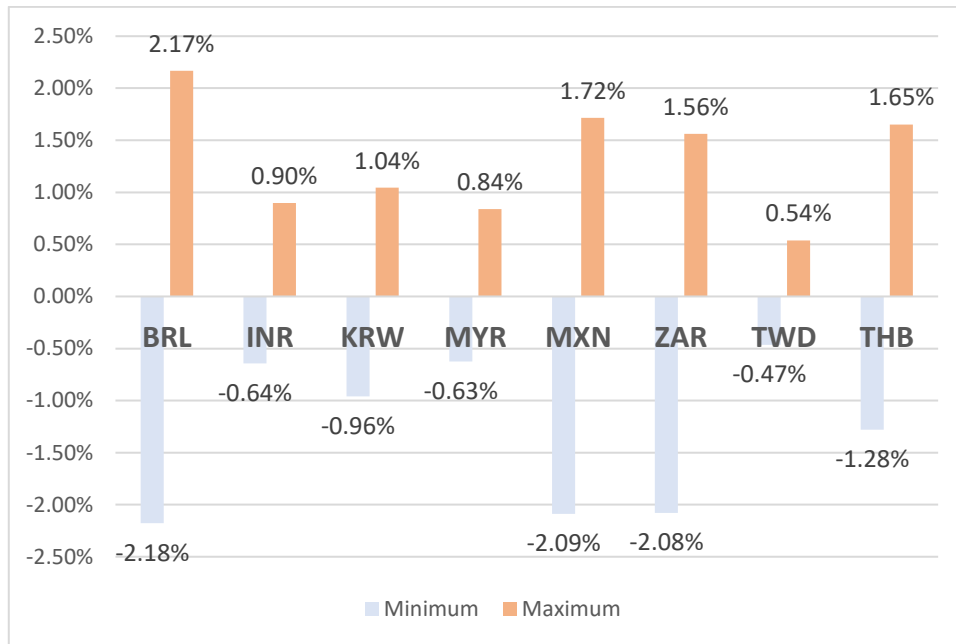
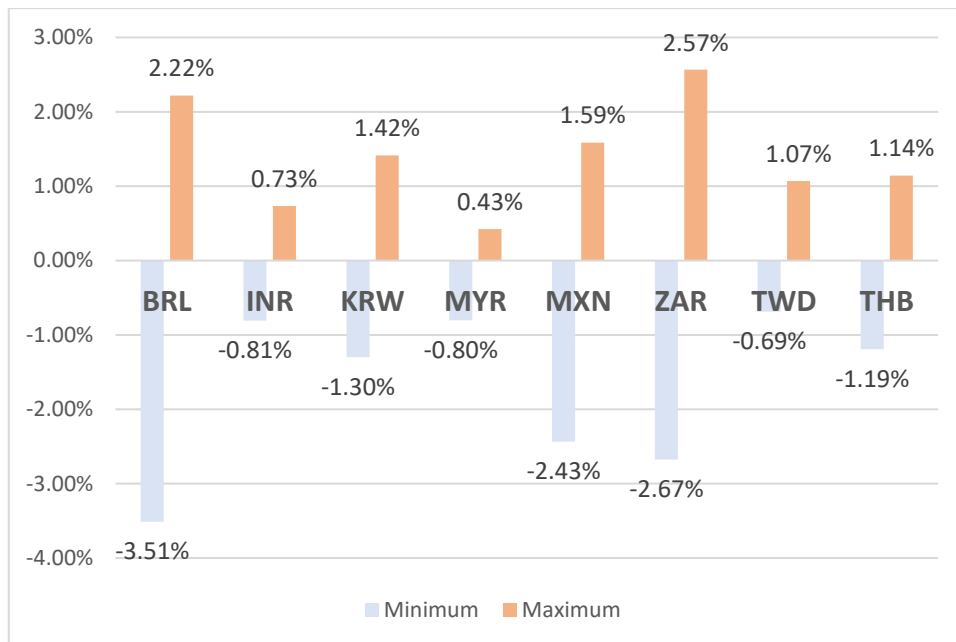


FIGURE 2: MINIMUM & MAXIMUM DAILY PERCENTAGE CHANGE FOR EMERGING MARKET CURRENCIES (POST-WAR FEB 2022 – AUG 2022)



Figures 3 & 4 provide standard deviation of the selected emerging market currencies based on daily percent changes during the pre- and post-war -19 periods.

**FIGURE 3: STANDARD DEVIATION OF EMERGING MARKET CURRENCIES
(PRE-WAR AUG 2021 – FEB 2022)**

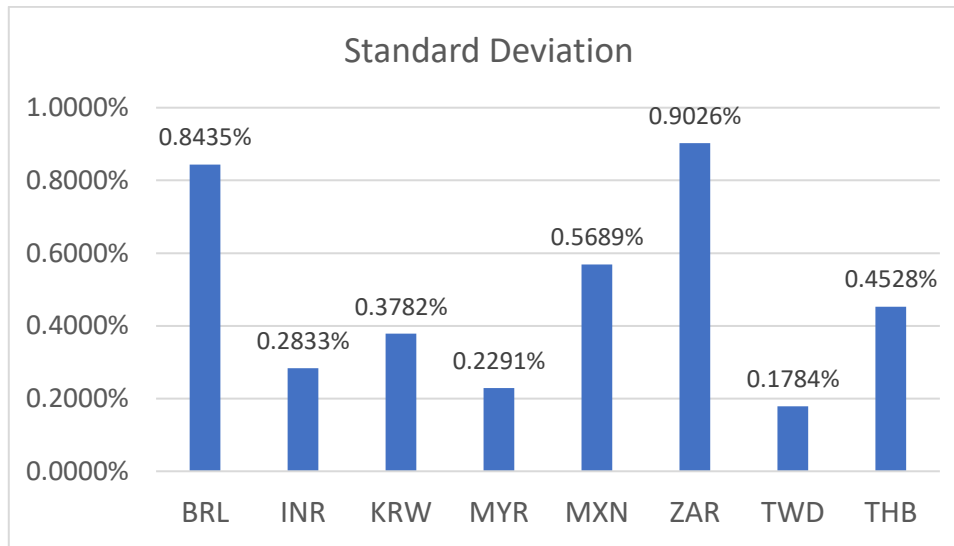
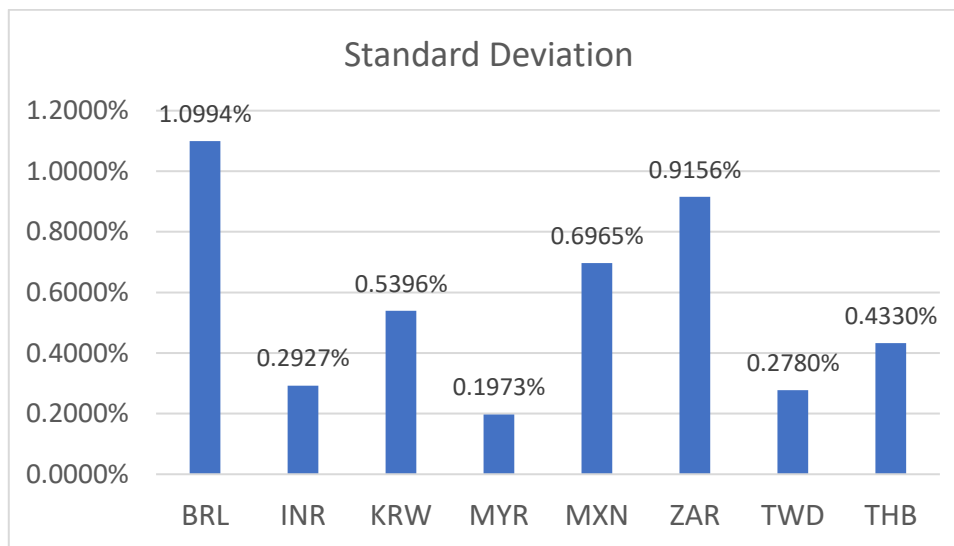


Figure 3 above shows that during the pre-war period, the South African Rand and Brazilian Real had the highest volatility, with standard deviation of 0.9026% and 0.8435% of daily percent change while the Taiwanese Dollar had the lowest (.1784%) standard deviation of daily percent changes among the eight emerging market currencies.

**FIGURE 4: STANDARD DEVIATION OF EMERGING MARKET CURRENCIES
(POST-WAR FEB 2022 – AUG 2022)**



During the post Ukraine war period, the Brazilian real has the highest standard deviation of daily percent changes at 1.0994% while the Malaysian Ringgit was the most stable with a low standard deviation of 0.1973%. The standard deviation of the daily percent changes has increased for four of the eight currencies in the post-Ukraine war period, while four of the currencies had similar or slightly lower standard deviations. Therefore the impact of the Ukraine war on the volatility of emerging market currencies is mixed.

METHODOLOGY

In this study, the results for the maximum 1-period holding period loss for an individual currency “i” or for a portfolio of currencies “p” is

$$E(e_i) - (Z) \times (\sigma_{i \text{ or } p}) \quad (1)$$

where $E(e_i)$ is the expected percentage change in the currency’s value for the relevant period

The results for the modified maximum 1-period holding loss for an individual currency “i” or for a portfolio of currencies “p” can be estimated using

$$E(e_i) - (ModZ) \times (\sigma_{i \text{ or } p}) \quad (2)$$

where

$$ModZ = \left(z + \frac{Skew(z^2-1)}{3!} + \frac{Kurt(z^3-3z)}{4!} + \frac{Skew^2(2z^3-5z)}{36} \right) \quad (2A)$$

where z is the normal z-score corresponding to the desired confidence level

Skew is the skewness of the population

Kurt is the excess kurtosis or absolute kurtosis - 3

Portfolio’s variance:

$$\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij}, \quad (3)$$

Portfolio’s variance is computed using the above equation

where

σ_p = standard deviation of daily % changes in currency portfolio

σ_p^2 = variance of daily % changes in currency portfolio

w_i = proportion of total portfolio value denominated in currency i

w_j = proportion of total portfolio value denominated in currency j

σ_i = standard deviation of weekly percentage changes in currency i

σ_j = standard deviation of weekly percentage changes in currency j

ρ_{ij} = correlation coefficient of weekly percentage changes between currencies i and j

RESULTS

Currency Correlation (Emerging Markets)

The correlation coefficients between pairs of currencies can vary and hence are not stable and/or constant over time. The correlation coefficients for the eight selected emerging market currencies, based on daily percentage changes, are presented in Tables 2 & 3 during pre- and post-Ukraine war periods.

As it can be observed, for almost all of the currency pairs, the correlation coefficients have changed substantially between the pre- and post-Ukraine war periods. During the pre-war period TWD-BRL had the least correlation coefficient of 0.1362 among the eight currency pairs and ZAR-MXN had the highest of 0.6282 correlation coefficient.

TABLE 2: CORRELATION COEFFICIENT BETWEEN EMERGING MARKETS CURRENCY PAIRS (PRE-WAR AUG 2021 – FEB 2022)

	BRL	INR	KRW	MYR	MXN	ZAR	TWD	THB
BRL	1.0000	0.3244	0.3027	0.1349	0.3419	0.4283	0.1362	0.2870
INR		1.0000	0.3465	0.2391	0.3683	0.3862	0.3336	0.2664
KRW			1.0000	0.1991	0.3505	0.2899	0.3075	0.3620
MYR				1.0000	0.3490	0.2346	0.3459	0.3117
MXN					1.0000	0.6282	0.2571	0.3766
ZAR						1.0000	0.1891	0.4059
TWD							1.0000	0.1977
THB								1.0000

TABLE 3: CORRELATION COEFFICIENT BETWEEN EMERGING MARKETS CURRENCY PAIRS (POST-WAR FEB 2022 – AUG 2022)

	BRL	INR	KRW	MYR	MXN	ZAR	TWD	THB
BRL	1.0000	0.2949	0.2836	0.3691	0.6100	0.5756	0.1882	0.4647
INR		1.0000	0.0548	0.0598	0.1753	0.3747	0.0275	0.2439
KRW			1.0000	0.5010	0.2310	0.2408	0.5750	0.3363
MYR				1.0000	0.2281	0.3060	0.3787	0.2873
MXN					1.0000	0.6871	0.1755	0.5089
ZAR						1.0000	0.1821	0.5646
TWD							1.0000	0.1585
THB								1.0000

During the post-war period TWD-INR had the lowest correlation coefficient of 0.0275 among the eight currency pairs and ZAR-MXP had the highest correlation coefficient of 0.6871. From tables 2 and 3, the correlation coefficients between currency pairs are all different which can be attributed to the volatility of each currency during those periods. Interestingly, INR correlation coefficients with all other currencies decreased from the pre to post-war period reflecting the war's impact on the Indian rupee whereas BRL correlation has increased with six other currencies (except INR and KRW) during the same period.

Modified Value-at-Risk, Max daily loss results and standard deviation for emerging markets

The MVaR predicts the maximum one-day loss for the particular currency. The maximum one-day loss is the actual maximum loss for the particular currency during the eighteen-month period. We compare the MVaR to the max daily loss for the selected emerging markets currencies. Table 4 summarizes the actual maximum daily loss and the average daily MVaR for the entire six-month pre-Ukraine war time period. The MVaR for the Brazilian real (-2.1782%) indicates the deepest predicted maximum 1-day loss, while the MVaR for the Taiwanese Dollar (-0.4653%) predicts the smallest maximum daily loss, among the eight selected currencies.

TABLE 4: EMERGING MARKETS CURRENCIES REALIZED RETURN AND MVaR (PRE-WAR AUG 2021 – FEB 2022)

Currency	Max daily loss	MVaR @ 99%
BRL	-2.1782%	-1.9976%
INR	-0.6438%	-0.6926%
KRW	-0.9598%	-0.9773%
MYR	-0.6255%	-0.7212%
MXN	-2.0867%	-1.3566%
ZAR	-2.0801%	-1.7742%
TWD	-0.4653%	-0.4583%
THB	-1.2805%	-1.1798%

Comparing the maximum one-day loss for each currency relative to the predicted one-day loss using MVaR gives us a better understanding on the potential currency exposure risk. The maximum one-day loss seems higher than predicted by MVaR for all currencies with the exception of MXN, ZAR, TWD and THB.

Figure 5 offers a visual comparison of the maximum daily loss predicted by the MVaR model and the actual maximum one-day loss for the eight selected currencies during the pre-war period.

FIGURE 5: MAX ONE DAY LOSS vs MVaR FOR EMERGING CURRENCIES ONE- PERIOD LOSS/GAIN (PRE-WAR AUG 2021 – FEB 2022)

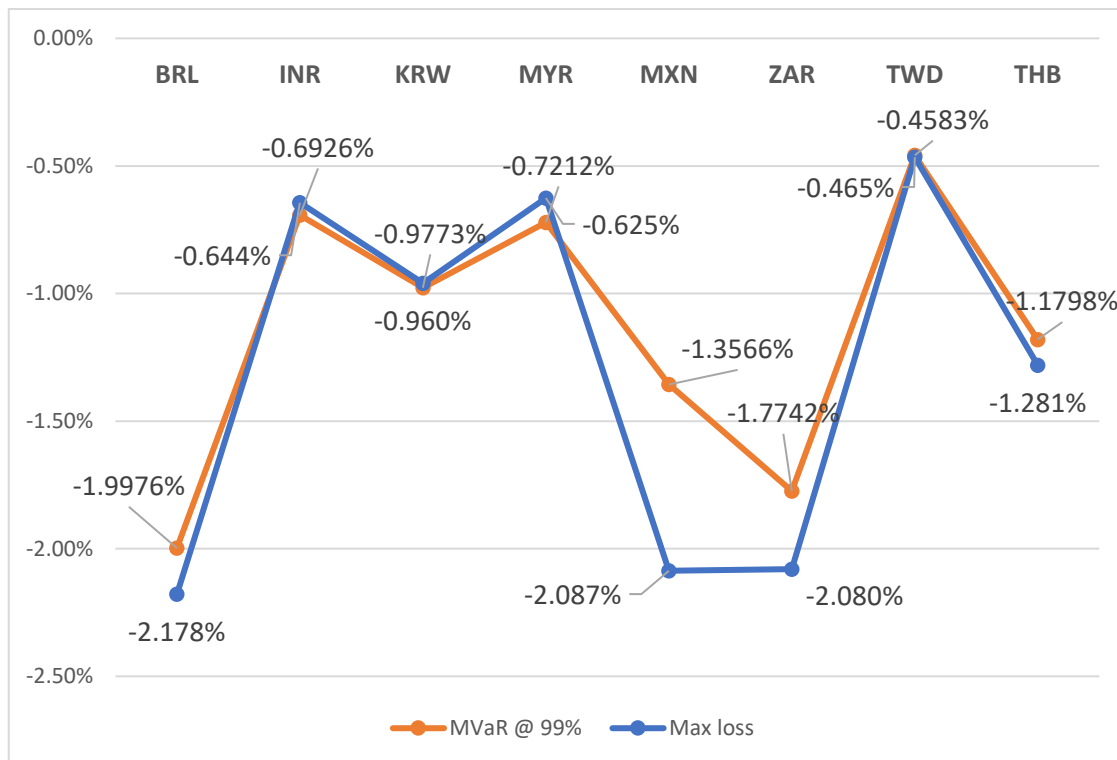


Table 5 summarizes the post-Ukraine war maximum one-day loss for each individual emerging market currency and the predicted MVaR one-day loss. The Brazilian real shows the largest predicted maximum

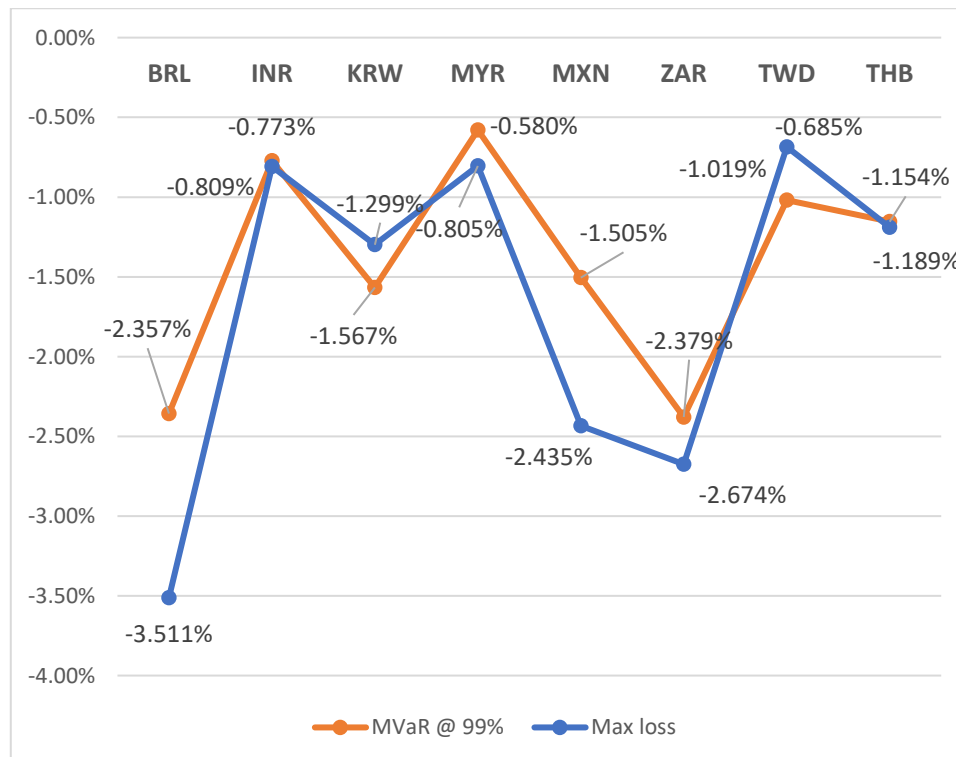
daily loss at -2.357 % while the smallest maximum daily loss is predicted for the Malaysian ringgit at -0.58%. During the post-Ukraine war period, all the emerging market currencies except KRW and TWD had a larger one-day loss compared to the predicted MVaR one-day loss.

TABLE 5: EMERGING MARKETS CURRENCIES REALIZED RETURN AND MVaR (POST-WAR FEB 2022 – AUG 2022)

Currency	Max loss	MVaR @ 99%
BRL	-3.5114%	-2.3571%
INR	-0.8088%	-0.7729%
KRW	-1.2989%	-1.5668%
MYR	-0.8048%	-0.5795%
MXN	-2.4350%	-1.5051%
ZAR	-2.6741%	-2.3791%
TWD	-0.6852%	-1.0194%
THB	-1.1892%	-1.1542%

Figure 6 offers a visual comparison of the maximum daily loss predicted by the MVaR model and the actual maximum one-day loss for the eight selected currencies during the pre-war period. It is striking to the difference between the pre-war and post-war comparison of the maximum one-day loss and predicted one day loss using MVaR. In the pre-war period, the maximum one-day loss is lower than predicted by MVaR for all currencies with the exception of BRL, MXN, ZAR and TWD. Whereas, in the post-war period for all emerging market currencies, the maximum one-day loss is consistently lower than the MVaR predicted one-day loss.

FIGURE 6: REALIZED VS. MVAR FOR EMERGING CURRENCIES ONE- PERIOD LOSS/GAIN (POST-WAR FEB 2022 – AUG 2022)



Optimal Hedging Portfolios:

We use nonlinear optimization methods to construct the optimal portfolio. The order of each currency's entry in the portfolio numerically makes the MVaR as small as possible at every instance. The MVaR is a complex function of the standard deviation as well as the skewness and kurtosis (equ 2). So, the entry order is influenced by the standard deviation, but also the covariances and kurtosis (i.e., we might have two currencies with equal standard deviations but unequal kurtosis, leading one of the two to be favored).

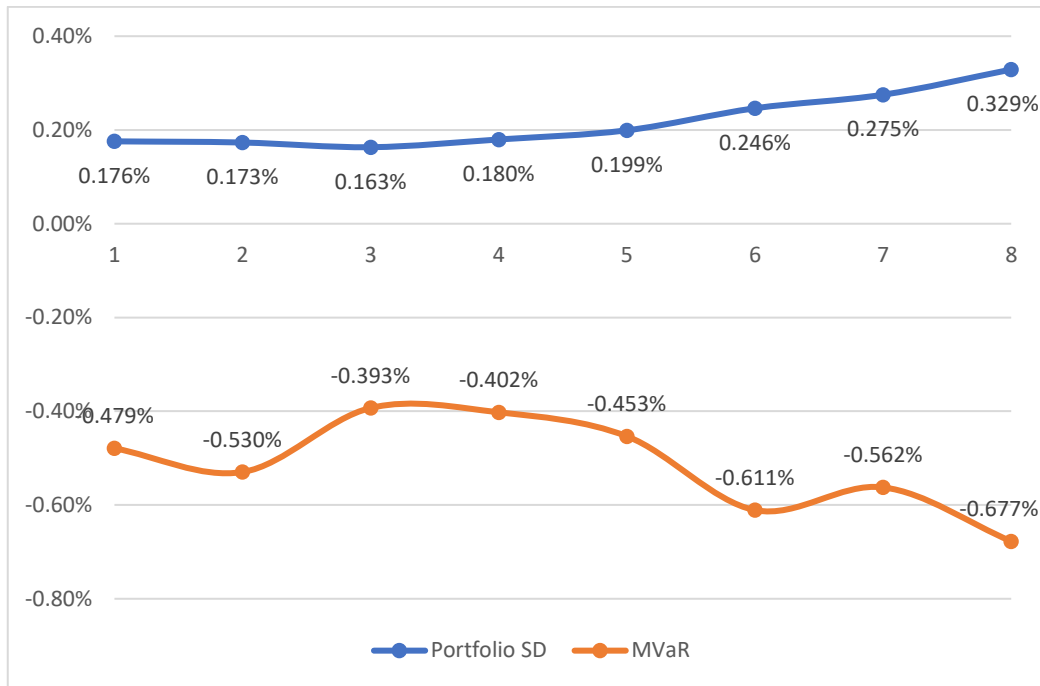
In Table 6 we present equally weighted hedge portfolios for the eight selected emerging market currencies, based on both the standard deviations and MVaR of the currency portfolios. The currencies are added to the portfolio starting with the currency with the lowest standard deviation, and each additional currency is added from lowest to highest volatility. The order of currency inclusion based on the least to highest standard deviation are as follows, Taiwanese Dollar, Malaysian Ringgit, Indian rupee, Korean won, Thai baht, Mexican peso, Brazilian real and South African rand. The resulting portfolio standard deviations reflect the pairwise covariances of the currencies in each portfolio. As we construct the currency portfolios using rolling three-month standard deviations and correlation coefficients, the computed MVaR values for the portfolios are different from individual currency MVar values in Table 4. For example, in Table 4 the TWD MVaR value is -0.4583 % (which is computed using six months of return data), whereas in Table 6 the TWD MVaR value is -0.4791% (based on three-months of SD data from the rolling three-month standard deviations over the six-month period). They reflect, in a sense, *optimal* currency portfolios based on modern portfolio theory and, hence, should provide superior information to MNEs about the risks of operating across multiple currencies

**TABLE 6: EMERGING MARKETS EQUALLY WEIGHTED CURRENCY PORTFOLIO
(PRE-WAR AUG 2021 – FEB 2022)**

Portfolio SD	MVaR	Portfolio Composition
0.17566%	-0.47912%	TWD
0.17316%	-0.52970%	TWD, MYR
0.16321%	-0.39301%	TWD, MYR, INR
0.17967%	-0.40229%	TWD, MYR, INR, KRW
0.19924%	-0.45345%	TWD, MYR, INR, KRW, THB
0.24624%	-0.61094%	TWD, MYR, INR, KRW, THB, MXN
0.27512%	-0.56234%	TWD, MYR, INR, KRW, THB, MXN, BRL
0.32886%	-0.67735%	TWD, MYR, INR, KRW, THB, MXN, BRL, ZAR

We find that the equally weighted three currency portfolio of Taiwanese dollar, Malaysian ringgit and Indian rupee has the lowest standard deviation (0.1632%). In addition, this three currency TWD, MYR, INR has the lowest MVaR value (-0.3930%) of all the currency portfolios during the pre-war period.

Figure 7 provides a graphical representation of the portfolio standard deviation and MVaR as the different currencies are added to the portfolio.

FIGURE 7: EQUALLY WEIGHTED EMERGING COUNTRIES CURRENCY PORTFOLIO (PRE-WAR AUG 2021 – FEB 2022)**TABLE 7: EMERGING MARKETS EQUALLY WEIGHTED CURRENCY PORTFOLIO (POST-WAR FEB 2022 – AUG 2022)**

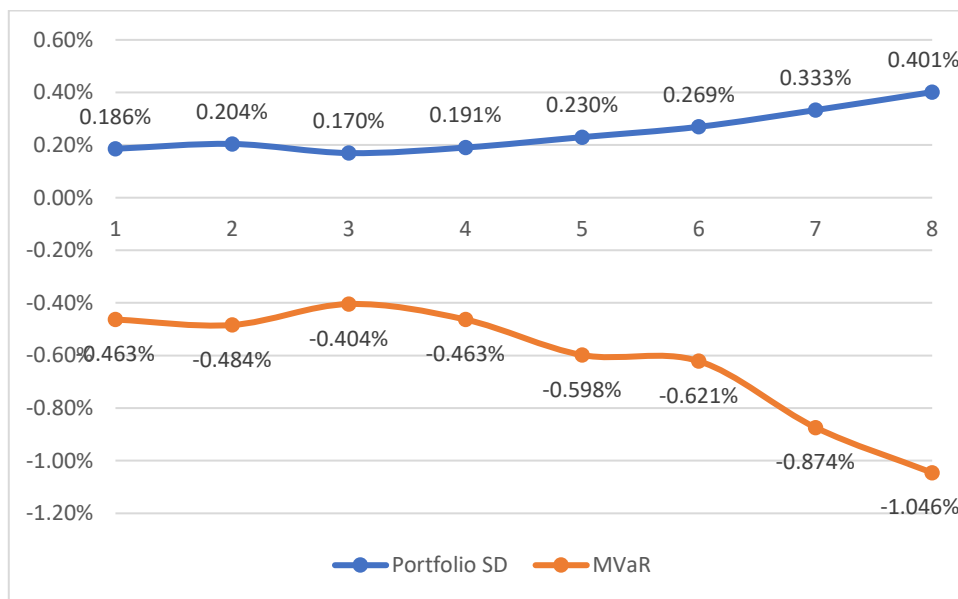
Portfolio SD	MVaR	Portfolio Composition
0.18606%	-0.46318%	MYR
0.20435%	-0.48394%	MYR, TWD
0.16963%	-0.40427%	MYR, TWD, INR
0.19071%	-0.46326%	MYR, TWD, INR, THB
0.23015%	-0.59808%	MYR, TWD, INR, THB, KRW
0.26940%	-0.62149%	MYR, TWD, INR, THB, KRW, MXN
0.33304%	-0.87357%	MYR, TWD, INR, THB, KRW, MXN, ZAR
0.40148%	-1.04551%	MYR, TWD, INR, THB, KRW, MXN, ZAR, BRL

In Table 7, we identify the optimal currency portfolios in the post-Ukraine war period. As in the pre-war portfolio construction, the currencies are added from least to highest standard deviation. The order of currency inclusion in post-war equally weighted portfolio is Malaysian ringgit, Taiwanese dollar, Indian rupee, Thai baht, Korean won, Mexican peso, South African rand and Brazilian real. As we construct the currency portfolios using rolling three-month standard deviations and correlation coefficients, the computed MVaR values for the portfolios are different from individual currency MVaR values in Table 5. For example, in Table 5 the MYR MVaR value is -0.5795 % (which is computed using six months of return data), whereas in Table 7 the MYR MVaR value is -0.4632% (based on three-months of SD data from the rolling three-month standard deviations over the six-month period). When standard deviation and MVaR are considered together, we find that the equally weighted three currency portfolio of Malaysian Ringgit, Taiwanese Dollar, and Indian Rupee has the lowest predicted MVaR one-day loss (0.40427%) in the post-war period as well, though we observe that the standard deviation of the optimal portfolio has increased

substantially during the post-Ukraine war period. We can conclude that in addition to the increase in the volatility of the individual currencies, the volatility of diversified currency portfolios has also increased during the post-war period.

Figure 8 presents a visualization of the portfolio standard deviation and MVaR as additional currencies enter the portfolio. The addition of the currencies to the portfolio from one (MYR) to two (MYR, TWD) decreases the resulting portfolio's standard deviation. Adding the third currency INR lowers the three-currency portfolio's standard deviation. This could be the optimal emerging market currency if MNEs wish to hedge their transaction exposure risk. Since adding more currencies results in the portfolio risk to continue to increase. Given the increased volatility in the post-war period, MNEs operating in emerging markets have substantial transaction exposure risk. In order to mitigate any currency loss, given the results hedging in these three currencies Malaysian ringgit, Indian rupee and Taiwanese dollar would offer the least expensive risk mitigation strategy. Though the eight-currency portfolio has the least standard deviation as hedging all currencies is quite expensive and not recommended. It will be interesting to further analyze what will be an optimal weighted hedging portfolio based on the emerging market currencies. This will further provide insight into what proportion of their currency needs to be hedged.

FIGURE 8: EQUALLY WEIGHTED EMERGING COUNTRIES CURRENCY PORTFOLIO (POST-WAR FEB 2022 – AUG 2022)



CONCLUSIONS

Our results indicate, with the exception of the Indian rupee and Thai baht, the currency volatility of the emerging countries has increased during the post-Ukraine war period compared to pre-war period. Additionally, comparing the maximum daily loss of the currencies during the pre- and post-war periods, all the emerging market currencies have a greater maximum loss in the post-war period except the Thai baht. Though the order of currency inclusion in the equally weighted portfolio is different in the pre- and post-war period, the three-currency portfolio of Taiwanese dollar, Malaysian ringgit and the Indian rupee have the lowest standard deviation as well as the MVaR. These results will convey to those MNEs, who have been operating in those eight emerging markets during pre- and post-Ukraine war periods. Accordingly, given the high cost of hedging they need to consider their emphasis on production in these three countries instead of all of the eight countries. Hedging is expensive and maintaining a hedge is costly. Finally, we

can conclude that MNEs need to carefully evaluate their foreign currency exposure and based on their currency inflows and outflows need to hedge based on the countries that they operate. Our model provides a roadmap to succinctly capture the expected maximum one-day loss as well the least riskiest hedging portfolio.

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Ethical Principles of Artificial Intelligence Applications in Healthcare: A Content Analysis

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Abstract

Rapid development of artificial intelligence (AI) has permeated various aspects of our lives. Its usage in the field of healthcare has shown significant improvement in the efficiency and efficacy of numerous aspects of healthcare services. However, wide applications of AI technologies in healthcare are also joined by ethical challenges threatening the privacy and security of public health. This study conducts a content analysis on primary organization and government documents related to ethical issues of AI in healthcare. While the transparency and explainability of AI technologies have been granted a great amount of focus, more domain-specific discussions are in need. Inclusiveness and equity of access to AI technology in healthcare should also be considered more by regulators and practitioners when proposing future standards and legislation frameworks.

Keywords: artificial intelligence, healthcare, ethics, principles, technology, content analysis

Evaluating Alternative Collaboration Strategies Between Volunteer and Government Agencies in Disaster Response Using Agent-Based Simulation

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Abstract

Ordinary citizens are the first responders in emergency situations since they are the ones close to the incident to inform the professionals and perform rescues. Many in the disaster response community have recognized the importance of citizens during disaster response, but many of these volunteers have not been adequately trained, which has the potential to do more harm than good. Consequently, emergency managers still question with regard to the collaboration between spontaneous volunteers and government officials in disaster planning efforts. This study assesses the tradeoff whether citizens as first responders improve the efficiency and effectiveness of disaster response operations under different collaboration strategies with government officials. The information available for disaster response planning includes verified requests obtained from traditional sources, such as on the ground assessment teams, and unverified requests obtained through social media, enabling a larger number of needs to be identified in less time. However, social media requests are not initially verified and some of them may be inaccurate. This study investigates the value of citizen collaboration with government agencies during disaster response using agent-based simulation under imperfect information.

1. Introduction

Disaster causes economic, cultural, and environmental damages that affect individuals, groups, communities, and whole societies. Recent disasters (e.g. Hurricane Harvey) confirmed that in addition to formal crisis management provided by government organizations, ordinary citizens organize to form emergent and temporary groups to deal with spontaneous relief and rescue activities [1]. During Hurricane Harvey, federal, state, and local research and rescue teams were operating at full capacity, but they did not have enough specialized equipment (e.g. high-water rescue trucks and boats), manpower, and situational awareness information during the disaster to rescue people in a timely manner [2]. People were trapped in knee-deep water in their homes. Floodwaters were rising, 911 lines were jammed, and people were posting desperate pleas for help on social media, hoping to reach someone on a rescue team. Despite these heartbreaking cases, citizens as first responders took their boats to reach those who were trapped [3]. However, citizens on the ground were initially untrained and may have been inexperienced and

uncoordinated. This is the exact crisis faced by humanitarian managers as they determine whether to accept assistance from ordinary citizens and collaborate with them in emergency situations when developing disaster response plans. Ordinary citizens are the first responders in emergency situations since they are the ones close to the incident to inform the professionals and perform rescues.

During the early phases of disaster response, these spontaneous volunteers, known as grassroots volunteers, self-organize to provide assistance in search and rescue activities. Advancing technologies and social media allow ordinary citizens to share information and coordinate grassroots participation to perform a quick and timely response to the affected population. Due to the scope of the disasters, authorities' abilities are not adequate for a thorough and timely response to all who are trapped. Therefore, officials turn to the public for help. In a press conference on August 28th, three days after Hurricane Harvey, the Federal Emergency Management Agency (FEMA) Administrator Brock Long said "*We need citizens to be involved. [...] We're going to need the whole community. Not only the federal government forces, but this is a whole community effort from all levels of government, and it's going to require the citizens getting involved*" [4]. However, even though the emergency response community has recognized the importance of citizens during disaster response, many of these volunteers have not been adequately trained, which has the potential to do more harm than good by disrupting organized responses and reducing the resources available to those affected people. Ordinary citizens who self-deploy to help others may become victims of the disaster and may need the support they provide. This will double government officials' efforts by rescuing the people who originally needed rescue as well as the volunteers who tried to help them.

This paper quantitatively assesses the value of collaborating formal government agencies with informal citizens during disaster response operations. This project investigates whether grassroots citizens' disaster response can improve the effectiveness of the response under different collaboration strategies. These alternative disaster response scenarios are developed and simulated in order to evaluate the impact of coordinating officials and citizens. Specifically, a retrospective case study will be built to develop search and rescue models under extreme disaster scenarios considering the two input streams: (i) verified request locations including 911 data obtained by emergency phone calls and on-the-ground assessment data obtained by search-and-rescue teams in-person, and (ii) unverified request locations social media data obtained by social media platforms. The main objective of our simulation was to explore the different collaboration strategies by analyzing how different numbers of volunteers and government agents affected the survivability rate of disaster victims across different region sizes.

In this study, we specifically explore how coordination between official emergency services and citizens can be managed in order to prevent any overlaps, how citizens as first responders' tasks can be coordinated, how novel collaborative disaster response models can be created, and how the performance of these alternative models can be assessed in emergency response settings. Answering these questions requires constructing a simulation model to test the different collaboration strategies under the different disaster scenarios. It is particularly useful for the emergency response community to identify the best practices of grassroots efforts. Consequently, this study aims to provide an insight into the current characteristics of emergency management activities and how these settings can be improved during disaster response.

This paper is organized as follows: in Section 2, a brief literature review is presented. Section 3 discusses the alternative collaboration strategies between government and volunteer agencies. Section 4 describes the proposed simulation model. Sections 5 and 6 present and discuss the results of the experiments and conclusions.

2. Literature Review

Modern disaster relief suffers from several logistics problems. While these problems can often be detrimental to relief efforts, modern researchers have investigated ways to overcome them. The following papers demonstrate the benefits of grassroots participation in humanitarian efforts.

Palen et al. (2007) examined the effect of grassroots citizens in previous disasters such as Hurricane Katrina and the 2003 California Wildfires [5]. Following disasters, these same citizens continue to offer relief in the form of necessities such as food, shelter, and employment. The use of online forums to distribute information to volunteers is growing in order to communicate quicker and in a more organized fashion.

Carafano et al. (2007) stated that the most important response period following a disaster is the first 72 hours, and federal and nationwide organizations often fail to respond appropriately during this time [6]. Federal plans to involve the citizens in disaster response need to account for several different factors. Citizens need reliable information to come to them from a trusted source and believe that the proposed actions are their best course of action to protect themselves and their loved ones. They also need the capacity to evaluate their own well-being as well as the physical and mental health of those they are trying to help in a limited capacity.

Gardner (2008) shares the stories of real-world volunteers that have participated in a similar collaborative program to those we are investigating [7]. Following Hurricane Ike, several relief centers opened up across

Houston that were staffed by volunteers. These volunteers typically had prior volunteer experience and were critical in distributing resources to survivors. The volunteers were primarily recruited by local community leaders whom they were in contact with. Many volunteers were notified of the opportunity to volunteer via electronic communication.

One modern technological development that has been particularly valuable in solving the problems that plague disaster relief is agent-based modeling. Many experiments have been run that used agent-based modeling to solve a specific problem facing humanitarian efforts. The following studies detail some of these experiments.

Das and Hanaoka (2014) noted that the largest challenges facing disaster relief efforts are the unequal supply and demand of resources and the different priorities of different people who are responsible for distributing them [8]. They used agent-based modeling to simulate the distribution of a specific item through a chain of command. Throughout each step, the priorities of the current person responsible for the item were considered by their model.

Lichtenegger and Vossner (2008) investigated the effectiveness of communicating information in traditional disaster relief. They used agent-based modeling to simulate the dissemination of information [9]. Their model emphasized the lack of control over how information is distributed between individuals of the same position along a chain of command in a given organization.

Espejo-Díaz (2020) attempted to optimize the delivery routes of relief aid following a disaster. He developed a model that used unique agents to seek out, store, transport, distribute, and consolidate relief aid [10]. He used optimization methods within his model in an attempt to ensure that the right supplies got to the right place at the right time.

3. Problem Statement

Our research focused on finding the optimal strategy for collaboration between government agents and grassroots volunteers. We analyzed three different collaboration strategies. These different strategies are summarized in Table 1 below. The Government column indicates which locations the government will visit. The Volunteer column indicates which locations volunteers will visit. The overlap column indicated whether or not both the government and the volunteers will each send an agent to the same individual location.

Table 1: Summary of Collaboration Strategies

Strategy	Government	Volunteer	Overlap
Strategy 1	Only Verified	Only Unverified	None
Strategy 2	Verified and Unverified	Verified and Unverified	None
Strategy 3	Verified and Unverified	Only Unverified	Only Unverified

In strategy one, the two groups divide and conquer; the government seeks out and aids only those citizens whose locations have been verified while the volunteers seek out only those citizens whose locations are unverified, such as those who have been broadcasted on social media. The two groups operate independently with different information; the volunteers only have information on unverified locations while the government only has information on verified locations.

In strategy two, the two groups fully collaborate; both government agents and volunteers service all citizens regardless of whether their location has been verified or not. A volunteer will never visit a location that has been visited by a government agent and vice versa, ensuring that they operate as efficiently and collaboratively as possible. The government is in communication with the volunteers and the two groups will not overlap their agents.

In strategy 3, the two groups do not collaborate at all. Volunteers will only help those citizens who have unverified locations like in scenario one, but the government will consider and act on all citizen locations regardless of verification status. Since the government is not in communication with the volunteers, they do not know which locations have already been visited by a volunteer and may send one of their agents to that same location. Similarly, a volunteer may visit a location that has already been visited by a government agent. This results in wasted time, since the two groups are overlapping their agents.

4. Methodology

In order to test the effect of grassroots participation in disaster relief, we developed an agent-based model that could compare the survivability rate of victims in need under different criteria. Agent-based modeling is a simulation method that emphasizes the relationships and interactions between actors, or agents. Each

individual agent acts on its own according to a set of parameters and the model’s results are based on how they interact with each other.



Figure 1: Simulation Model Agents

The proposed model in this paper considers several factors for input data as shown in Figure 1. The model can support any different number of government agents (illustrated by a yellow arrow), grassroots volunteers (illustrated by a magenta arrow), verified citizens (illustrated by a yellow house), and unverified citizens (illustrated by a magenta house). These four groups are our agents. Verified and unverified citizens are stationary and their primary role is to receive aid. Volunteers and government agents are mobile and seek out the nearest citizen that has not been aided yet. Their primary role is to deliver aid.



Figure 2: Special Model Agents

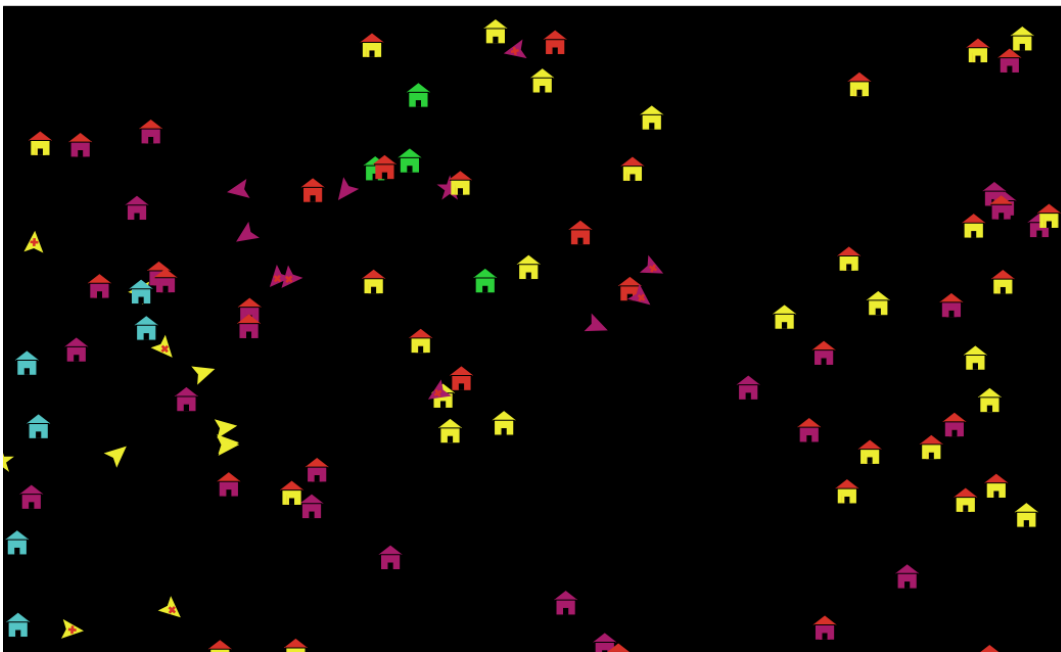
Our model also considers the fact that not everyone responding to relief requests will be trained to handle every need. As shown in Figure 2, trained volunteer and government agents are denoted with a red plus symbol. Similarly, the model considers the fact that different victims will need different types of relief, with some victims only being able to be helped by those responders who are professionally trained. Injured citizens can only be serviced by trained agents and are represented by a red roof.



Figure 3: Simulation Model Hindsight

The model outputs the number of victims helped by volunteers and the number helped by government agents as shown in Figure 3. The citizens that have been served by either a volunteer or government agent are illustrated by green and blue houses, respectively. It also provides the number of unverified citizens whose locations were visited but did not actually need help, resulting in time wasted. These are referred to as “false alarms,” and are illustrated by a red house. Lastly, the model provides the number of citizens who were not visited before the specified time ran out. These locations were not serviced before time expired and did not receive the support they needed. A screenshot of the model while it is running is shown in Figure 4 below.

Figure 4: Model Screenshot



5. Experiments and Results

The goal of our simulation was to explore the different collaboration strategies by analyzing how different numbers of volunteers and government agents affected the survivability rate of disaster victims across different region sizes. The survivability rate indicates the percentage of reported people in need of aid who were serviced within a given time frame. The number of victims in each region size is shown in Table 2 below.

Table 2: Region Sizes

Region Size	Number of Victims
Small	40
Medium	100
Large	200

We began by assigning the number of victims to three different region sizes: small, medium and large. A small region has 40 victims, a medium sized region has 100, and a large region has 200. The number of victims is split evenly into verified and unverified citizens. For example, a small region has 20 verified citizens and 20 unverified citizens.

Our next distinction between trials was the number of volunteers and government agents. We consider two different volumes as shown in Table 3: a low number of volunteers or government agents, 10, and a high number of volunteers or government agents, 30.

Table 3: Volunteer or Government Agent Volumes

Volume	Count
Low Number	10
High Number	30

We examined the survivability rate of each possible combination of region size and volume distribution. We tested these combinations of agent numbers and region size with all three collaboration strategies proposed in the problem statement section. For additional constraints, we assume that 50% of unverified locations will turn out to be false alarms. We also assume that 70% of government agents are trained to handle injured citizens while only 30% of volunteers are similarly trained. Additionally, 30% of both verified and unverified citizens are injured and can only be serviced by a trained agent. There is also a 5% chance that an untrained volunteer can die when servicing a location because they are putting themselves at risk without proper training. Lastly, we assume that each volunteer and government agent only has 8 hours to aid victims directly following the disaster. Ten random replicates of each of the experiments are generated. A total number of 360 different scenarios are modeled and run by NetLogo (an open-source agent-based simulation software).

We examined the average survivability rate of citizens in each combination of collaboration strategy and region size. The results are summarized in Table 4 below. The values were calculated by averaging the survivability rate of each iteration of the relevant combination of strategy and region size. For example, the average survivability rate of citizens was 74% in a small region when responders implemented strategy one.

Table 4: Experiment Results

	Small Region	Medium Region	Large Region	Average Survivability Rate
Strategy 1	0.74	0.60	0.56	0.63
Strategy 2	0.84	0.73	0.70	0.76
Strategy 3	0.79	0.67	0.61	0.69

Based on these results, we can make two recommendations. Our first recommendation is that government agents should consider visiting unverified locations regardless of whether or not they collaborate with grassroots volunteers. As seen in Table 4, citizens had the lowest survivability rate in each region when strategy one was implemented (average of 63%), the only strategy in which government agents will never visit an unverified location. The survivability rate of citizens when responders implemented strategy three increased by at least 5% in each region from their strategy one values and increased by at least an additional 5% when responders implemented strategy two. This correlates with our second recommendation: government agents should collaborate with grassroots volunteers during disaster relief processes. As shown by Table 4, all regions had their highest survivability rate when strategy two was implemented (average of 76%). When both the volunteers and the government work with the same information, they are able to visit a much larger number of locations collectively that allows a similarly larger number of citizens to receive aid within a given time frame.

6. Conclusions

This paper provides an insight into the current characteristics of emergency management activities during disaster response. Specifically, this paper focuses on whether government officials should collaborate with potentially untrained ordinary citizens as first responder during the disaster response operations. Three different alternative collaboration strategies are demonstrated across a variety of disaster scenarios: (i) the government organizations and volunteers operate independently and unverified citizens' locations are only served by the volunteers, (ii) the government organizations are in communication and fully collaborate with the volunteers, and (iii) the government organizations and volunteers operate independently like the first

scenario but the government agents consider and act on citizens' locations regardless of verification status. It is observed that the full collaboration between formal government agencies with informal citizens performs better than the other strategies. The results illustrate that citizen disaster response can aid the effectiveness of response. This study also shows that the government agents should consider acting on unverified relief requests communicated through social media when developing disaster relief plans. An additional area for future study is to consider data from real disaster scenarios when it becomes available for evaluating the alternative scenarios.

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IMPACT OF UKRAINE WAR ON THE CASH FLOW TRANSACTION RISKS OF MULTINATIONAL CORPORATIONS

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ABSTRACT

Because multinational corporations (MNCs) operate across different currencies, hence, exposing them to exchange rate risk. Thus, they may utilize a variety of tools to mitigate that risk. While there are different types of exchange rate risk, this study focuses specifically on the ongoing exposure of cash flow transactions denominated in the currencies of seven different developed countries. Since other types of risk (i.e., economic & translation) are evaluated based on yearly results, they are not considered in this study. The “modified” Value-at-Risk (MVaR) model is employed to estimate the maximum one-period losses during the six months prior to the onset of the Ukraine war and, in addition, the maximum one-period losses during the six months following the onset of the Ukraine war. The predicted losses using MVaR are then compared with the actual ex-post results. Our objective is to analyze the extent of cash flow transaction exposure and provide practical insights to MNCs as they decide whether or not they should hedge this risk. This study is noteworthy because it compares the pre-Ukraine war and post-Ukraine war time periods.

INTRODUCTION

Multinational corporations are entities that engage in international business ventures in a variety of ways. While their engagement in the international arena exposes them to exchange rate risk, including transaction exposure, whether or not they should hedge this risk depends on the specific circumstances. Depending on the expected costs of and benefits of hedging, MNCs may be better off hedging their foreign currency positions. There exist a number of tools which can be used to mitigate and/or eliminate the ongoing exposure of cash flow transactions risk. However, there may also be circumstances where maintaining an open position in a particular currency or portfolio of currencies (i.e., not hedging) is justified. Since most MNCs operate across multiple currencies, transaction exposure is generally associated with their total foreign currency portfolio. This portfolio risk is, in part, a function of the net positions in each currency (including both cash inflows and cash outflows) and the volatility of the individual exchange rates. It also depends critically on the co-movements of the currencies. As is well known, the volatility of exchange rates themselves and their co-movements are not stable over time. Accordingly, the ongoing exposure of cash flow transactions exposure can change over time.

In this study, the superior “modified” Value-at-Risk (MVaR) method is utilized as opposed to the “traditional” Value-at-Risk (VaR) to estimate a firm’s maximum one-period loss. Given MNCs’ intrinsic exposure to transaction risk, and due to the volatility in the foreign exchange markets, this study aims to provide a clear comparison of the transaction risk for the six-month period prior to the onset of Ukraine war and the transaction risk for the six-month period following the start of Ukraine war. The rationale for studying the pre-and post-Ukraine war time periods is to better understand the degree to which major international events, economic or otherwise, can impact currency movements and the associated risks. To the extent that these international dislocations alter exchange rates and their co-movements, MNCs’ ongoing exposure of cash flow transaction risks will change, and hedging decisions based on earlier or historic relationships will lead to suboptimal results. Similar studies are found in the recent literature. For example, Garcia and Castro (2018) analyzed the impact of the Great Recession on the Mexican peso/U.S.

dollar exchange rate. Sharma and Mathur (2016) evaluated changes in the risk associated with several currency rates resulting from Brexit. These findings, and the associated insights, will provide an important context as MNCs consider whether to hedge their exchange rate risks. Because the volume of foreign exchange transactions has increased so dramatically in the last two decades, the stakes involved in these decisions have become very high. As indicated in Table 1, below, the daily volume of trading around the world has increased from \$.14 trillion in 1985 to over \$6.6 trillion in 2019. This trend is likely to continue.

We believe there are no studies (as of now) to have explored possible changes in MNC's ongoing transaction risk in the pre- and post-Ukraine war periods. It is possible that the economic instability introduced by Ukraine war, including greater exchange rate volatility, and changed co-variances, has had a measurable impact on transaction risk. Focusing on seven developed countries' currencies during the six months before and the six months after Ukraine war, we use the MVaR approach to quantify predicted losses and then compare these losses with the actual/ex-post results. Wars and/or regional conflicts are "black swan" events that will likely impact an MNC's operations and ultimately its bottom line. By analyzing ongoing transaction risk pre- and post-Ukraine war to observe the immediate impact, we provide insight into how MNCs can prepare and plan for such unforeseen, but inevitable, future events. The rationale for selecting only six months (prior and post) is to capture the volatility of currency movements due to the war. This study also reveals how MNCs can minimize potential losses by determining which particular currency portfolios (i.e., combinations of currencies) have the least/most ongoing transaction risk and whether this has changed in the post-Ukraine war period. Further, the results of this study will offer valuable insights into effectively managing an MNC's short-term assets and liabilities and provide important information about potential entry and exit strategies for particular currency markets in the post-Ukraine war era.

PROBLEM STATEMENT

Nearly half a century ago, the era of fixed exchange rates system ended, and the reliability and relative predictability of fixed exchange rates gave way to today's era of floating exchange rates, with all its uncertainty and complexities. Multinational corporations have utilized statistical techniques to quantify the exchange rate risks they face and, in addition, developed approaches to mitigate these risks. One superior approach to quantifying the ongoing transaction risk associated with flexible exchange rates is that the "modified" value-at-risk (MVaR) approach, in which the skewness of the population as well as the excess kurtosis and/or absolute kurtosis are considered. In many cases, MVaR will give MNC's a more accurate estimate of their ongoing exchange rate risk (unlike the traditional simple "value-at-risk" (VaR) approach). This approach (MVaR) like (VaR), also places a specific dollar value on the downside risk (i.e., the maximum likely loss) an MNC will experience over a specific time period at a particular confidence level.

Research questions in this study

An increasingly important question for MNCs operating across multiple developed economies is the following: given the costs of hedging a currency's ongoing exposure, should MNEs attempt to mitigate (hedge) their currency exposure during black swan events like the Ukraine war, or alternatively, should their hedging strategy be altered during such events (assuming a firm decision has been made to hedge)? This question will be addressed by comparing the "modified" value-at-risk (MVaR) measures against the actual currency gains/losses (i.e., the ex-post results) for the six-month periods before the start of, and after the start of, the Russia-Ukraine war. Furthermore, we analyze the optimal currency portfolios for the seven currencies considered so that MNCs will have better information when considering their global business strategy and whether hedging their currency risks makes sense under these circumstances.

Justification of this study

The extraordinary growth in the daily volume and value of currency trading (see Table 1, below) has given rise to significant volatility in developed markets. In order to protect their bottom-lines, MNCs must hedge (or not hedge) their currency risks optimally. While there have been many studies utilizing “traditional” VaR measures, there have been no comprehensive studies of the “modified” value-at-risk (MVaR) measure comparing the maximum expected losses with the actual currency losses over the post-Ukraine war time period for developed markets’ currencies. A comparison of these findings with the pre-Ukraine war findings will have significant practical implications for MNCs and even mid-sized US firms that have significant revenues and/or expenditures across different developed markets’ currencies. The results of this research will help MNCs determine the best possible hedging strategy, given the expected benefits and costs of hedging and management’s preference regarding the familiar risk/return trade-off. Severe events like Ukraine war, have a global impact and may change the trajectory of exchange rates and impact their co-movements. Profit maximizing firms operating internationally need to be aware of how extensive these impacts might be and remain nimble in adjusting their hedging strategies as warranted. Our findings relating to the Ukraine war represent a case study of how a real-world black swan event can impact exchange rates, ongoing transaction risk, and profitability. Furthermore, they provide a template to MNCs for evaluating changes to the costs and benefits of hedging ongoing transaction risk in the face of such a significant international event.

TABLE 1: MILESTONES OF DAILY FOREIGN EXCHANGE TRANSACTION VOLUME GLOBALLY

Year	In \$ trillion
1985	\$ 0.14
1995	\$ 1.00
2006	\$ 2.00
2010	\$ 4.00
2014	\$ 5.00
2019	\$ 6.60

It is worth noting that on December 11, 2019, the Bank of International Settlements (BIS) reported that “on an average day in 2019, the sum of all transactions in the forex market amounted to almost 6.6 trillion U.S. dollars.”

The pre-Ukraine war period in this study starts August 23, 2021 and ends February 23, 2022. The post-Ukraine war period begins February 24, 2022 and ends August 23, 2022. Both are six months in duration. Our study is based on daily exchange rates for seven developed currencies using data obtained from the Federal Reserve System. Specifically, the following developed market currencies were considered in this study: the Australian dollar (AUS), the Canadian dollar (CAD), the Euro (EUR), the British pound (GBP), the Japanese yen (JPY), the Singapore dollar (SGD), and the Swiss franc (CHF).

Figures 1 & 2, below, indicate the minimum and maximum daily percentage changes for the seven developed market currencies during the pre- and post-Ukraine war periods. As indicated, the Japanese yen experienced the largest percentage changes with +1.66% and -1.35% pre-Ukraine war, and +2.16% and -2.58% post-Ukraine war (almost similar to Swiss franc which had the largest increase). By contrast, the Singapore dollar experienced the smallest percentage changes of the seven currencies with +0.60% and -0.60% pre-Ukraine war and +.61% and -.93% post-Ukraine war.

FIGURE 1: MINIMUM & MAXIMUM DAILY PERCENTAGE CHANGE FOR DEVELOPED MARKET CURRENCIES (PRE-WAR AUG 2021 – FEB 2022)

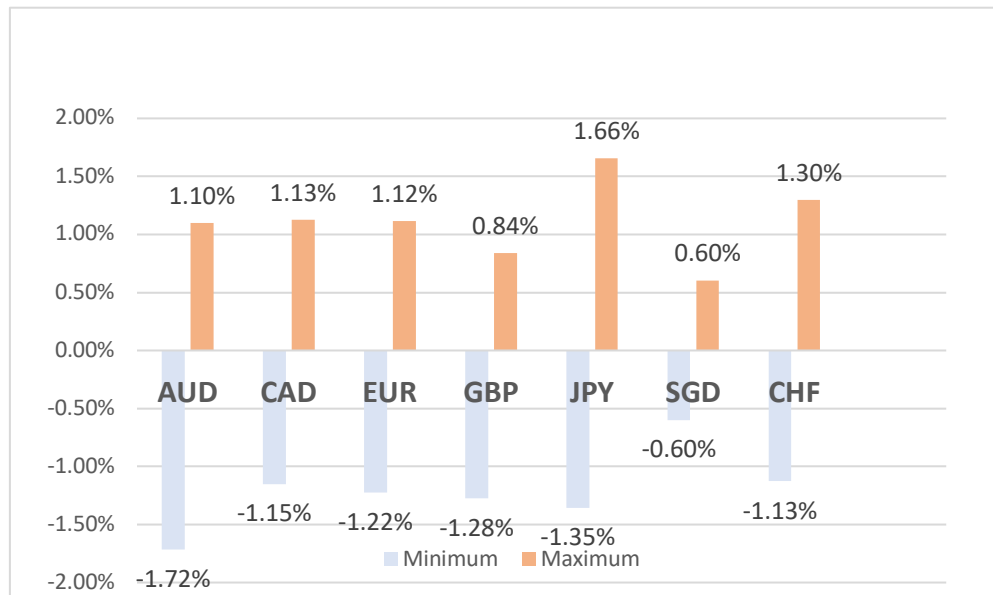
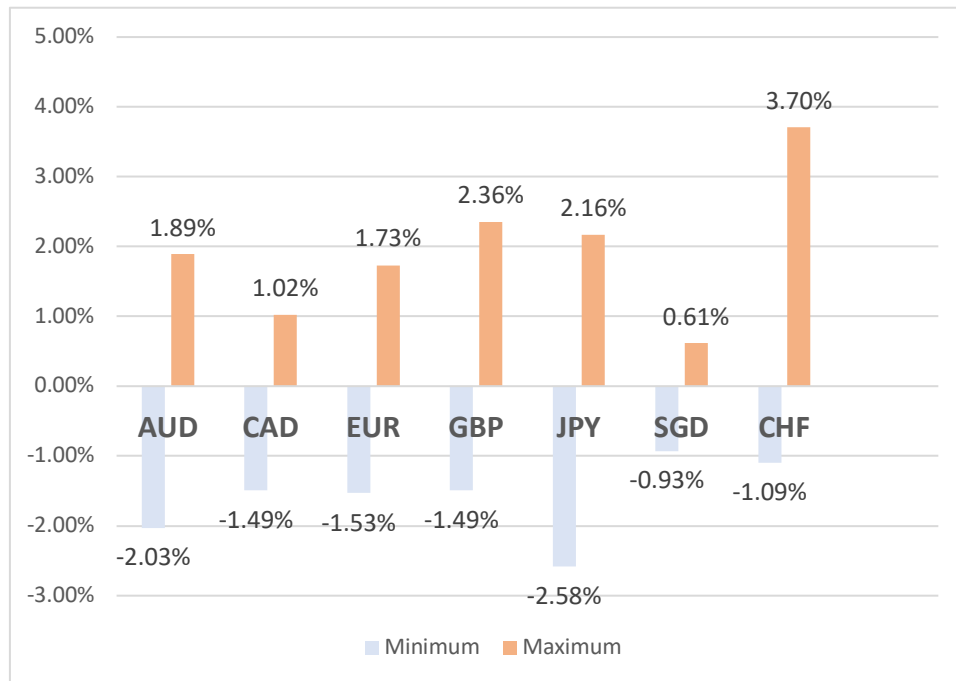


FIGURE 2: MINIMUM & MAXIMUM DAILY PERCENTAGE CHANGE FOR DEVELOPED MARKET CURRENCIES (POST-WAR FEB 2022 – JULY 2022)



Figures 3 and 4, below, indicate the standard deviations of the seven currencies based on their daily percent changes during the pre-Ukraine war and post-Ukraine war periods. As indicated in Figure 3, the Australian dollar and the Singapore dollar experienced the highest and the lowest volatility in the pre-Ukraine war

period, respectively, with standard deviations of .5903% and .2151%. During the post-Ukraine war months (Figure 4), the Australian dollar and the Singapore dollar experienced the highest and the lowest volatility in the post-Ukraine war with standard deviations of .7871% and .3078%, respectively.

FIGURE 3: STANDARD DEVIATION OF DEVELOPED MARKET CURRENCIES (PRE-WAR AUG 2021 – FEB 2022)

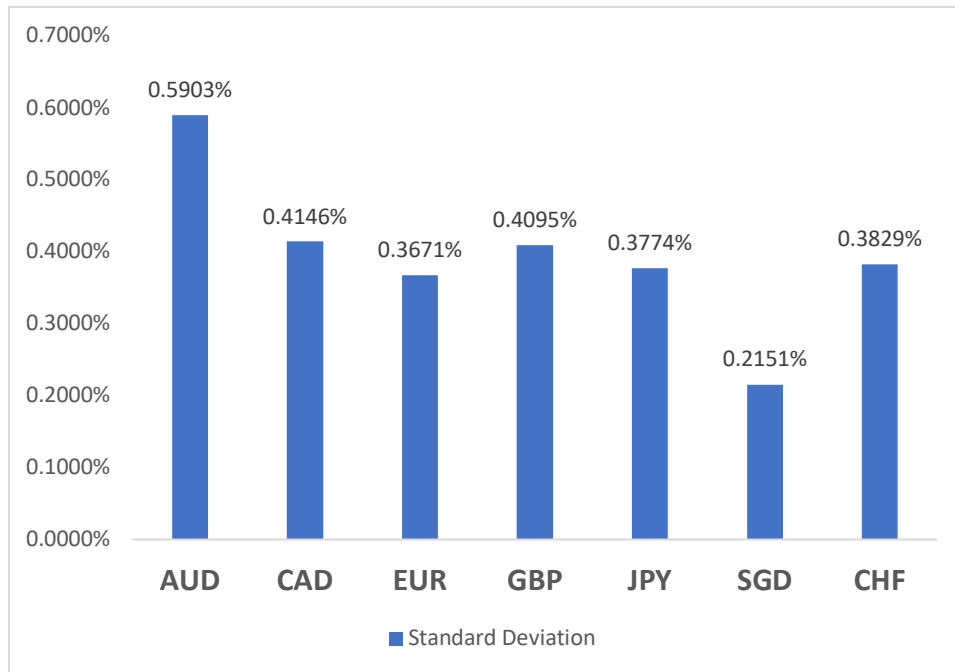
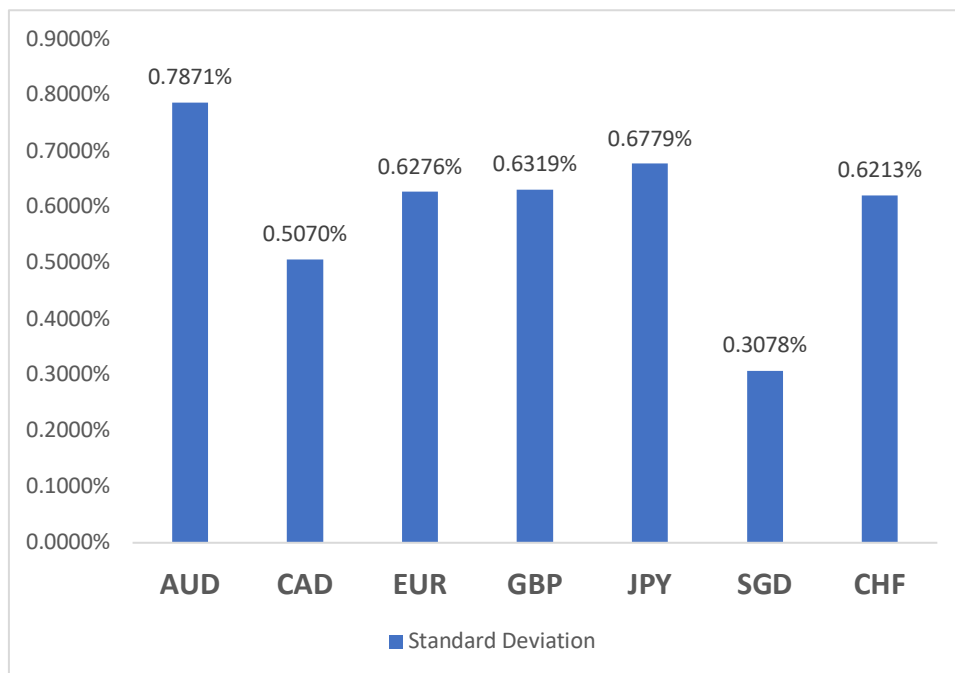


FIGURE 4: STANDARD DEVIATION OF DEVELOPED MARKET CURRENCIES (POST-WAR FEB 2022 – JULY 2022)



Figures 3 & 4, above, indicate the Australian dollar had the highest standard deviation among the seven currencies during both the pre/post-Ukraine war periods. A possible explanation for this instability could be the lingering effects of Australia's trade dispute with China from May through December 2020, which may have destabilized the Aussie dollar.

BACKGROUND / LITERATURE REVIEW

The article by Chambers, Kelly and Lu (2014) provides an excellent overview of the most common methods of estimating value-at-risk, including the analytical parametric, historical, and Monte Carlo simulation approaches. They discuss the advantages and the potential dangers of each approach in various applications.

Garcia and Castro (2018) apply VaR methodology to assess the risk associated with the Mexican Peso/U.S. Dollar exchange rate and how the risk differed/changed in the pre- and post-Great Recession (2008/2009) time periods. Sharma and Mathur (2016) estimate how the VaR associated with the exchange rates between the Indian rupee and the U.S. dollar, the Euro and the British pound have changed as a result of Brexit. In applying VaR to the Tunisian foreign exchange market, Saidane (2019) seeks to improve decision making in the face of financial crises noting that "when financial markets are subject to a major regime shift, many volatilities and correlations can be expected to shift." The article by Badaye and Narsoo (2020) uses high-frequency (one-minute) data to estimate the VaR for an equally-weighted portfolio of five currencies for developed economies. Similar to the Garcia and Castro and the Saidane articles, Badaye and Narsoo note that a variety of worldwide financial or other crises have elevated the need for robust models which can accurately forecast exchange rate risk.

Poornima, Reddy, and Reddy (2014) use VaR to forecast the risk of the Indian rupee in relation to the U.S. dollar, the Euro and the U.K. pound sterling. Kemda, Huang and Chinhamu (2015) use VaR to estimate the risk associated with the U.S. dollar/ZAR (South African) exchange rate. Fink, Fuest and Port (2018) examine the relationship between the yield curve and value-at-risk for the U.S. dollar/Euro exchange rate. Abbara and Zevallos (2018) test the accuracy of employing 15-minute VaR data for five major, equally-weighted currency portfolios to forecast exchange rate risk. Bedowska-Sojka (2018) uses VaR to test if the use of intraday data can improve forecasting the risk associated with the Euro/Polish Zloty foreign exchange rate. Uppal and Mudakkar (2021) find evidence that value-at-risk increases when exchange rates are "managed" (sometimes referred to as a "dirty float") rather than freely floating. They evaluate the risk associated with Pakistan's currency in relation to a number of major world currencies and determine that the risk of a managed float (e.g., the U.S. dollar and the Japanese yen) exceeds the risk of a free float. They note that the exchange rate volatility associated with managed floats can exceed that of freely floating exchange rates, in part, as a result of fat tails and skewness in the distribution of returns.

Su and Hung (2018) use a variety of value-at-risk models to forecast the risk of 21 stock and seven currency portfolios with different weighting combinations. They note that if a firm's value-at risk model overestimates the true risk, they may lose "the opportunity cost." Rodriguez and Ossa (2014) employ VaR to forecast the risk associated with a variety of Latin American stock and currency markets. Jammazi and Nguyen (2017) use value-at-risk and extreme value theory (EVT) to forecast the portfolio risk associated with crude oil prices and the U.S. dollar. They note the important role of both "heavy tailness" and skewness. The paper by Cera, Aliu and Cera (2019) uses the VaR model to forecast risk associated with the relatively new stock markets in Eastern European countries. Gaio, Junior, Lima, Passos and Stefanelli (2018) compare value-at-risk for a variety of emerging and developed countries' stock markets both pre- and post- two different international financial crises. Noting that VaR studies have been criticized for their inaccuracy resulting from the 2008-2009 financial crisis, Buberokoku (2019) examines and evaluates a variety of approaches to estimating value at risk for eight different types of financial variables, including

foreign exchange rates. Sinha and Agnihotri (2015) examine the effects of “nonnormality” in Indian financial markets due to financial instability and political uncertainty.

Using the standard deviations of the seven emerged currencies studied (shown in Figures 3 and 4, above) and, equally important, their correlation coefficients (subsequently described), the present study will be the first to compare the modified value-at-risk (MvaR) of various combinations (portfolios) of emerged currencies with their ex post results (i.e., the actual maximum losses) for both the pre-Ukraine war and post-Ukraine war time periods. The MVAR approach, as indicated below, allows for both skewness and excess kurtosis in the probability distributions of expected returns. An evaluation of these findings should provide MNEs key insights and objective data on the potential costs and benefits of hedging their exchange rate risks, and how these benefits and costs may have changed in the post-Ukraine war era.

METHODOLOGY

The exchange rate data was obtained from the Federal Reserve website. In this study, the results for the maximum 1-period holding period loss for an individual currency “i” or for a portfolio of currencies “p” is

$$E(e_t) - (Z) \times (\sigma_{i \text{ or } p}) \tag{1}$$

where $E(e_t)$ is the expected percentage change in the currency’s value for the relevant period.

The results for the “modified” maximum 1-period holding loss for an individual currency “i” or for a portfolio of currencies “p” can be estimated using

$$E(e_t) - (ModZ) \times (\sigma_{i \text{ or } p}) \tag{2}$$

where

$$ModZ = (z + \frac{Skew(z^2-1)}{3!} + \frac{Kurt(z^3-3z)}{4!} + \frac{Skew^2(2z^3-5z)}{36}) \tag{2A}$$

where

z is the normal z-score corresponding to the desired confidence level

$Skew$ is the skewness of the population

$Kurt$ is the excess kurtosis or absolute kurtosis – 3

Portfolio’s variance is computed using the equation below:

$$\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} w_i w_j \sigma_i \sigma_j \rho_{ij}, \tag{3}$$

where

σ_p = standard deviation of daily % changes in currency portfolio

σ_p^2 = variance of daily % changes in currency portfolio

w_i = proportion of total portfolio value denominated in currency i

w_j = proportion of total portfolio value denominated in currency j

σ_i = standard deviation of weekly percentage changes in currency i

σ_j = standard deviation of weekly percentage changes in currency j

ρ_{ij} = correlation coefficient of weekly percentage changes between currencies i and j

Currency Correlation

The correlation coefficients (included in the above equation) between any given pair of currencies can vary and, hence, are not stable and/or constant over time. Based on their daily percentage changes, the correlation coefficients for the seven developed market currencies for the pre-Ukraine war and post-Ukraine war periods are presented in Tables 2 & 3, below. As can be observed, for any given pair of currencies the correlation coefficients generally change from one time period to the next. As examples, the correlation coefficient for the JPY/CAD exchange rate changed from -.0329 (pre-Ukraine war) to .0509 (post-Ukraine war); for the JPY/AUD exchange rate the correlation coefficient changed from -.0035 (pre-Ukraine war) to .1161 (post-Ukraine war).

TABLE 2: CORRELATION COEFFICIENTS BETWEEN DEVELOPED MARKET CURRENCY PAIRS (PRE-WAR AUG 2021 – FEB 2022)

	AUD	CAD	EUR	GBP	JPY	SGD	CHF
AUD	1.0000						
CAD	0.7651	1.0000					
EUR	0.4876	0.3432	1.0000				
GBP	0.7159	0.6140	0.6047	1.0000			
JPY	-0.0035	-0.0329	0.4228	0.1673	1.0000		
SGD	0.7524	0.6347	0.6505	0.7030	0.2549	1.0000	
CHF	0.3898	0.3153	0.6915	0.4657	0.5848	0.4584	1.0000

TABLE 3: CORRELATION COEFFICIENTS BETWEEN DEVELOPED MARKET CURRENCY PAIRS (POST-WAR FEB 2022 – JULY 2022)

	AUD	CAD	EUR	GBP	JPY	SGD	CHF
AUD	1.0000						
CAD	0.7696	1.0000					
EUR	0.5571	0.5979	1.0000				
GBP	0.6775	0.6529	0.7382	1.0000			
JPY	0.1161	0.0509	0.1420	0.2718	1.0000		
SGD	0.7585	0.6733	0.7792	0.7891	0.2467	1.0000	
CHF	0.5238	0.4641	0.6290	0.6767	0.4571	0.6015	1.0000

Modified Value-at-Risk, Ex-Post Results and Standard Deviations

Tables 4 and 5, below, compare the predicted MvaR against the actual ex-post results for each individual currency for the pre-Ukraine war and post-Ukraine war periods, respectively. The MvaR predicts what will be the maximum one-day loss for the particular currency. What is shown in Tables 4 and 5 is the average daily MvaR for the entire 6-month time period. The ex-post result is the actual average daily gain/loss for the particular currency for the entire 6-month time period. It is worth noting that the MvaR for the pre-Ukraine war period indicates the British pound (GBP) had the largest likely average maximum one-day loss (-1.1842%). For the post-Ukraine war period, the Canadian dollar (CAD) had the largest likely maximum one-day loss (-6.0842%). Despite these predicted maximum losses, the actual ex-post results for the GBP were a loss of -.08091 and for CAD -0.1450% respectively (much less than predicted).

TABLE 4: DEVELOPED MARKETS CURRENCIES REALIZED RETURN AND MVaR (PRE-WAR AUG 2021 – FEB 2022)

Currency	$(S_1 - S_0)/S_0$	MVaR @ 99%
SGD	-0.2062%	-0.4686%
EUR	0.1057%	-0.9589%
CHF	0.0549%	-1.2322%
CAD	-0.3054%	-1.0440%
JPY	0.3888%	-0.8780%
AUD	0.5721%	-0.9577%
GBP	-0.8091%	-1.1842%
Average	-0.0285%	-0.9605%

TABLE 5: DEVELOPED MARKETS CURRENCIES REALIZED RETURN AND MVaR (POST-WAR FEB 2022 – JULY 2022)

Currency	$(S_1 - S_0)/S_0$	MVaR @ 99%
SGD	-0.2313%	-0.7452%
EUR	-0.1180%	-1.7721%
CHF	-0.0056%	-2.1261%
CAD	-0.1450%	-6.0842%
JPY	-0.1001%	-2.0704%
AUD	-0.3948%	-1.0954%
GBP	-0.2443%	-1.6902%
Average	-0.1770%	-2.2262%

Importantly, comparing MVaR with the ex-post results during the pre-Ukraine war period (Table 4) reveals that, with the exception of SGD, CAD, and GBP which experienced moderate losses, unhedged positions on all other currencies would have resulted in gains. Comparing the averages across all seven currencies, the actual ex-post loss of -0.0285% was far less than the average MVaR predicted loss of -0.9605%. With respect to the post-Ukraine war period (Table 5), the findings were quite unusual. All seven currencies experienced a modest actual loss ranging from -0.0056% for CHF to -0.3948 for the AUD. Consequently, an unhedged position in all the currencies would have resulted in significant losses. However, comparing the averages across all seven currencies, the ex-post loss of -0.1770% was less painful than average MVaR predicted loss of -2.2262%.

PRELIMINARY RESULTS

(At the submission time, the month of August data are not available. It will be included after August 23rd for the final presentation version)

Equally weighted Modified Value-at-Risk (MVaR) estimates and the realized/ex-post outcomes $((S_1 - S_0)/S_0)$ for the currency portfolios of the seven developed markets are presented in Tables 6 and 7, below. Table 6 represents the pre-Ukraine war period. Table 7 represents the post-Ukraine war period. For both periods, MVaR is based simply on the arithmetic averages of the MVaR for each currency included, but not including the impact of any possible interactions (correlations) between the currencies. These equally weighted portfolios are constructed starting with the currency with the lowest standard deviation. Then each additional currency is added from lowest to highest volatility. Accordingly, the last currency added to the portfolio has the highest standard deviation. Since these are equally weighted portfolios, every additional currency added to the portfolio increases the average predicted maximum one-day loss, as evident from the rising Avg MVaR values in both Tables 6 & 7.

**TABLE 6: DEVELOPED MARKETS AVERAGE CURRENCY PORTFOLIO
(PRE-WAR AUG 2021 – FEB 2022)**

Currency	Avg $(S_1 - S_0)/S_0$	Avg MVaR	Portfolio Composition
SGD	-0.2062%	-0.4686%	SGD
EUR	-0.0503%	-0.7137%	SGD, EUR
CHF	-0.0152%	-0.8866%	SGD, EUR, JPY
CAD	-0.0877%	-0.9259%	SGD, EUR, JPY, CHF
JPY	0.0076%	-0.9163%	SGD, EUR, JPY, CHF, GBP
AUD	0.1016%	-0.9232%	SGD, EUR, JPY, CHF, GBP, CAD
GBP	-0.0285%	-0.9605%	SGD, EUR, JPY, CHF, GBP, CAD, AUD

**TABLE 7: DEVELOPED MARKETS EQUALLY WEIGHTED CURRENCY PORTFOLIO
(POST-WAR FEB 2022 – JULY 2022)**

Currency	Avg $(S_1 - S_0)/S_0$	Avg MVaR	Portfolio Composition
SGD	-0.2313%	-0.7452%	SGD
EUR	-0.3131%	-0.9203%	SGD, CAD
JPY	-0.2570%	-2.6416%	SGD, CAD, CHF
CHF	-0.2223%	-2.4242%	SGD, CAD, CHF, EUR
GBP	-0.1978%	-2.3534%	SGD, CAD, CHF, EUR, GBP
CAD	-0.1658%	-2.3156%	SGD, CAD, CHF, EUR, GBP, JPY
AUD	-0.1770%	-2.2262%	SGD, CAD, CHF, EUR, GBP, JPY, AUD

In contrast to Tables 6 and 7 which were based solely on arithmetic averages, Tables 8 and 9 (below) show both the MVaR and the standard deviations of the currency portfolios including the effect of the covariances between the various currencies. As we construct the currency portfolios using rolling standard deviations and correlation coefficients, the computed MVaR value for portfolios are different from Table 6. For example, in Tables 4 and 6 the SGD MVaR value is -0.4686% (which is computed using six months of return), whereas the in Table 8 SGD MVaR value is -0.4655%. They reflect, in a sense, optimal currency portfolios based on modern portfolio theory and, hence, should provide superior information to MNCs about the risks of operating across multiple currencies. A point of clarification: We use nonlinear optimization methods to construct the optimal portfolios. The order of each currency's entry in the portfolio numerically makes the MVaR as small as possible at every instance. The MVaR of the portfolio is a complex function of the standard deviation as well as the kurtosis, etc., as shown by the MVaR equation (page 7). So, the entry order is influenced by the standard deviation, but also the covariances and kurtosis (i.e., we might have two currencies with equal standard deviations but unequal kurtosis, leading one of the two to be favored).

**TABLE 8: DEVELOPED MARKETS EQUALLY WEIGHTED CURRENCY PORTFOLIO
(PRE-WAR AUG 2021 – FEB 2022)**

Portfolio SD	MVaR	Portfolio Composition
0.2406%	-0.4655%	SGD
0.3184%	-0.7404%	SGD, EUR
0.2931%	-0.8200%	SGD, EUR, JPY
0.2865%	-0.8145%	SGD, EUR, JPY, CHF
0.2796%	-0.7947%	SGD, EUR, JPY, CHF, GBP
0.2753%	-0.6369%	SGD, EUR, JPY, CHF, GBP, CAD
0.2852%	-0.6602%	SGD, EUR, JPY, CHF, GBP, CAD, AUD

**TABLE 9: DEVELOPED MARKETS EQUALLY WEIGHTED CURRENCY PORTFOLIO
(POST-WAR FEB 2022 – JULY 2022)**

Portfolio SD	MVaR	Portfolio Composition
0.2037%	-0.4945%	SGD
0.2592%	-0.6116%	SGD, CAD
0.2350%	-0.5126%	SGD, CAD, CHF
0.2508%	-0.9895%	SGD, CAD, CHF, EUR
0.2649%	-1.0441%	SGD, CAD, CHF, EUR, GBP
0.2384%	-1.1762%	SGD, CAD, CHF, EUR, GBP, JPY
0.2627%	-0.9928%	SGD, CAD, CHF, EUR, GBP, JPY, AUD

In the pre-Ukraine war period (Table 8, above), other than the Singapore dollar, we find that the equally weighted six currency portfolio of the Singapore dollar, Euro, Japanese yen, Swiss franc, Great Britain, and Canadian dollar has the lowest standard deviation (0.2753%). At the same time, the same six currency portfolio has the lowest MVaR (-0.6369%) as well. For the post-Ukraine war period (Table 9, above), other than the Singapore dollar, we find that the equally weighted three currency portfolio of the Singapore dollar, Canadian dollar, and Swiss Franc has the lowest standard deviation (0.2350%). Interestingly, the same three currency portfolio has the lowest MVaR (-0.5126%) as well.

CONCLUSIONS AND FUTURE DIRECTION

Utilizing the MVaR approach, the maximum likely 1-period portfolio losses ranged from (-0.9605%) in the pre-Ukraine war period to (-2.2262%) in the post-Ukraine war period (Tables 6 and 7). Surprisingly, the realized/ex-post results for those same portfolios for the two time periods were (-0.0285%) and (-0.1770%), respectively.

These results strongly suggest that MNCs operating in the seven identified developed currency markets who hedge their positions on a routine basis should pause to reevaluate their hedging strategy. Hedging is expensive, and maintaining a hedge is costly. Our findings indicate that MNCs with net overall cash inflows would not have benefited by not hedging their currency positions during both time periods, regardless of how many of the seven developed market currencies they were dealing with. Of course, any MNCs experiencing net cash outflows would indeed have not benefited from hedging their positions.

In addition to the above findings, a comparison of the volatility in the developed countries' currency markets in the pre- and post-Ukraine war periods is revealing as ongoing transaction risk seems to have increased in the post-Ukraine war era. Specifically, the maximum one-period loss surged by nearly 132% post-Ukraine war, while, at the same time, the realized gain plummeted by nearly 521%. For the future, an analysis of an expanded time frame may provide MNCs with an even clearer and more confident understanding of the decision-making process.

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Implementation of an EXCEL/Analytics "Spine" in the BBA Curriculum

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Abstract

The author of this paper is a faculty at a business school in a metropolitan area and he was asked by the dean of the college of business to form a committee to create a set of deliverable tasks/activities within the current business curriculum, where students are exposed to the Excel based exploration, problem solving, and analytics so that by the time they are graduating they are proficient in Excel. The committee proposed that when possible and in all courses that are applicable, throughout the BBA curriculum, we develop Excel based learning, problem solving, data analysis, and data visualization to achieve proficiency in Excel by the time our students graduate. This article reviews those proposed activities suggested for the specific courses within the BBA program.

Description of the Analytics Spine

The main goal of this program is to create an "EXCEL Spine" where students are exposed to the Excel based exploration, problem solving, and analytics so that by the time they are graduating they are proficient in Excel. We proposed that when possible and in all courses that are applicable, throughout the BBA curriculum, try to develop excel based learning, problem solving, data analysis, and data visualization to achieve proficiency in Excel by the time our students graduate. The proposed start time was Fall 2021. The plan is to integrate Excel and Analytics into the BBA Program as much as possible with the hope that repeated use of Excel could lead to Excel/Analytics proficiency.

Below are examples of the tasks/exercises that were suggested by the faculty to be included in the Analytics spine:

For the first and second year students and their courses here were a few suggestions:

- 1) CPTG 2201 Computer Applications for Business to be re-structured to cover MS Excel, mostly if not exclusively.

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2) Potential other courses to cover Excel: Principles of Micro and Macroeconomics and Principles of Accounting I and II.

2-a) Examples of an assignment in Principles of Macroeconomics: Go to BLS website, and download the national/state/regional unemployment rate for the last 20 years and graph it.

Also, download the time series for the CPI, GDP deflator and calculate the inflation based on both CPI and GDP deflator and compare them with each other.

2-b) Example of an assignment in Principles of Accounting I: Prepare financial statement and financial ratio analysis using Excel.

2-c) Examples of an assignment in Principles of Microeconomics: 1) Using formulas for TFC, TVC, TC, AFC, AVC, ATC, MC create a Cost Table in an excel sheet for the hypothetical "Firm A"

Also, Extract data for market shares in an industry (say with oligopoly structure) and draw a pie chart for the market shares for the top N firms in that industry.

2-d) Example of an assignment in Principles of Accounting II: Prepare product cost report and prepare an income statement under variable and absorption costing.

For the third and fourth year students and their courses, here are some proposed examples:

3) Examples of activities using Excel in Business Statistics:

The homework assignments, in-class quizzes, and the data analytics project include problems, to be completed in Microsoft Excel. Moreover, students perform the data analysis tasks using Excel to compute measures of location, measures of dispersion, and/or measures of position. Also, perform one-sample hypothesis testing, two-sample hypothesis testing, regression analysis, and/or correlation analysis in Excel.

4) Example of Activities using Excel in Operations and Supply Chain Management:

Perform different forecasting methods such as: Simple Moving Average, Weighted Moving Average, Single Exponential Smoothing, Double Exponential Smoothing, Time Series Forecasting using Regression and Measures of Forecasting Error.

5) Examples of activities in Excel in Marketing Research:

Sampling plan, word association analysis, descriptive statistics, and regression analysis.

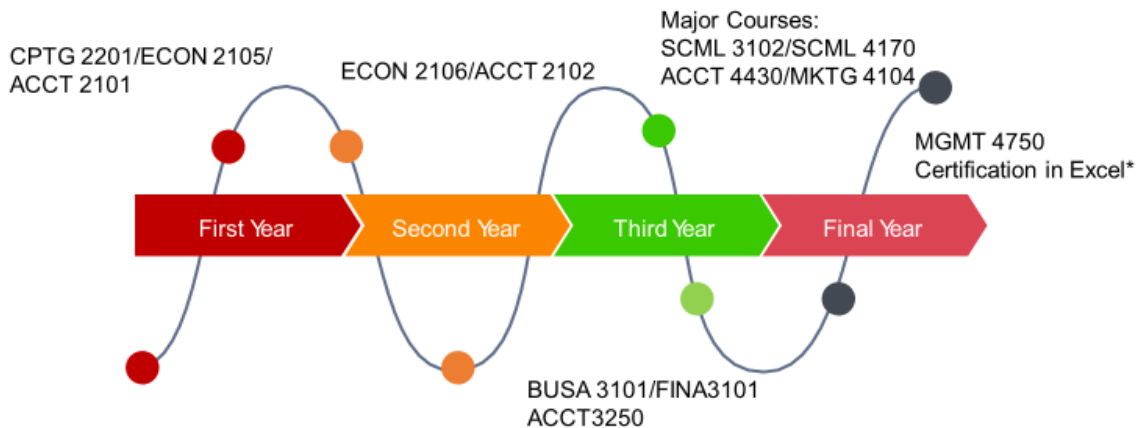
6) Examples of activities in Excel in Financial Issues in Supply Chain Management:

Perform calculations on Firm's Financial Ratios, Bankruptcy Predictors (Z-Score), Rough Cut Supplier Capacity Analysis, Net Present Value (NPV), Internal Rate of Return (IRR), Configured Sourcing Network, Supplier Performance Index, Cash Conversion Cycle, DuPont Model

We are currently working on the pilot plan for the implementation of Excel/Analytics Spine in Fall 2021. We will collect feedback/comments during pilot implementation phase. We are also looking into MS EXCEL certification requirements and options.

Here is the summary of the Excel Spine Proposal:

Proposal 1: “Excel and Analytics” Spine



* At the early stage of planning and the implementation may take a few more years after the pilot year.

After a pilot implementation in Fall 2021, the author found out that more has to be done for the students to be proficient in Excel. If anything, the preliminary results showed that there is a huge gap between students’ understanding of basic Excel functions and where the employers want them to be. While the result was somewhat disappointing, it presents opportunities for huge improvements, much needed by the employers, and shows that this initiative is indeed an appropriate one.

Table 1: Preliminary results for pilot implementation in Fall 2021

Measure	ECON 2105		ECON 2106	
	Count	%	Count	%
N = number of students	25		16	
n = number participated	11	44.00%	2	12.50%
Average of those participated (out of 2)	1.1818	59.09%	2	100.00%
Average of the whole class (out of 2)	0.52	26.00%	0.25	12.50%

Below the readers could see the two Excel assignments that was assigned to the students. Notice that since these two courses were introductory Economics courses a very minimal knowledge of Excel was assumed and most of the functions and the needed tricks are explained in details to help students with a limited knowledge of Excel move forward, and at the same time many important applied excel functions were used to make the assignment interesting to the students who are a bit more advanced.

Example 1: Excel and Analytics Spine Assignment - Inflation – Principles of Macroeconomics

Excel and Analytics Spine Assignment
Inflation
ECON 2105 – Reza Kheirandish

Item	Details
Learning Objective	Upon completion of this assignment students will be able to download time series data from an available dataset, save it, calculate a formula and generate a new column based on that formula, and graph the resulting time series (CLO: Excel and Analytics Spine).
Activity:	Students will download data, calculate formula, and graph the data, and save their Excel sheet
Deliverable:	Excel and Analytics D2L assignment - Takes 15-30 minutes.
Instructions	On-D2L
Additional Help	If needed, you could use the Skillsoft tutorials to learn Excel. Here is the link to Skillsoft: https://claytonstate.percipio.com/ The login name and password are similar to your SWAN, DUCK, or Email credentials.
	<p>Note: the instruction below is created for a PC user. For Mac users the steps are similar but might be slightly different.</p> <ol style="list-style-type: none"> 1. Go to www.bls.gov 2. Under the menu on top find “Data Tools” and then choose “BLS Popular Series” 3. Under “Price indexes” Choose “CPI for All Urban Consumers (CPI-U) 1982-84=100 (Unadjusted) - CUUR0000SA0” and click on “Retrieve data” 4. Under “Change Output Options:” select “2000” to latest date present (for example 2022) and click on the blue circle beside it “Go”. Notice that the table below the page is going to be adjusted for the selected years. 5. Click on “more formatting options:” 6. Under Select view of the data Select “column format” and check the “original data value” box. 7. Under “Select the time frame for your data” select specify year range” from “2000” to current year (for example 2022) 8. For “Output Type” select “HTML Table”

9. Make sure that the “select one time period:” radio button and “Annual Data” are selected.
10. Click on “Retrieve Data” and you will see a table with Download XLSX link on top of the table. You should have one observation per year (period shall be M13). If we are currently in the middle of a year, the annual data will be only available till last year.
11. Click on the XLSX link and depending on your browser, your excel file will be downloaded.
12. You can either save the file or open it in Excel. Open the excel sheet. It shall look like this:

Series ID	Year	Period	Value
CUUR0000SA0	2000	M13	172.2
CUUR0000SA0	2001	M13	177.1
CUUR0000SA0	2002	M13	179.9
CUUR0000SA0	2003	M13	184.0
CUUR0000SA0	2004	M13	188.9
CUUR0000SA0	2005	M13	195.3
CUUR0000SA0	2006	M13	201.6
CUUR0000SA0	2007	M13	207.342
CUUR0000SA0	2008	M13	215.303
CUUR0000SA0	2009	M13	214.537
CUUR0000SA0	2010	M13	218.056
CUUR0000SA0	2011	M13	224.939
CUUR0000SA0	2012	M13	229.594
CUUR0000SA0	2013	M13	232.957
CUUR0000SA0	2014	M13	236.736
CUUR0000SA0	2015	M13	237.017
CUUR0000SA0	2016	M13	240.007
CUUR0000SA0	2017	M13	245.120
CUUR0000SA0	2018	M13	251.107
CUUR0000SA0	2019	M13	255.657
CUUR0000SA0	2020	M13	258.811

13. Make sure to click on “enable editing” on top.
14. Now calculate the inflation by using this formula:
Annual inflation rate between the last year and the current year
= (CPI(current year year) – CPI(last year)) / CPI(last year) *100
15. Note that in excel you should start from the second row (year) on the top since there is no previous year for the very first row (year)
16. For example if my CPI data values are stored on column D and starts from row 13, then in cell E14, I shall type “=(D14-D13)/D13*100” (without “ ” sign).
17. Next use the fill function of Excel. Click on the last cell where you entered your formula (cell E14), and click and hold and drag down the little green square at the bottom-right of that cell using your mouse or touchpad. Continue dragging down till you reach the last row of your data. All of the cells below E14 will be populated with the similar and appropriate formula and all of the inflations will be calculated. Enter the

	<p>label for the new column “Inflation” (in my example in cell E12)</p> <p>18. Select all of the cells in columns “Year” and “Inflation” Here is how: Start from Year and hold and drag down the mouse or touchpad till all cells are selected and then hold “ctrl” key and repeat the same procedure with column “Inflation” while holding the “ctrl” key. Both columns should be highlighted. Then select “Insert” from the menu, and under “charts” select “scatter”. I prefer the one with lines connecting the dots, but you can choose different options.</p> <p>19. Great! You have graphed the inflation for US economy using CPI as the price index from 2001 till now!</p> <p>20. From the menu, select “File”, then “save as”, browse to desired location/folder and then enter the file name “inflation-your full name” (in my case Inflation-RezaKheirandish) and choose the “save as type” to be “Excel Workbook” (it is the default option) and click save.</p> <p>21. Upload the file on D2L assignment page for Excel and Analytics Spine.</p> <p>22. Congratulations! You are done with the extra credit assignment!</p>
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Example 2: Excel and Analytics Spine Assignment - Cost Functions – Principles of Microeconomics

Excel and Analytics Spine Assignment

Cost Functions

ECON 2106 – Reza Kheirandish

Item	Details
Learning Objective	Upon completion of this assignment students will be able to download an excel dataset, save it, calculate a formula and generate a new column based on that formula, and graph the resulting variable (Excel and Analytics Spine).
Activity:	Students will download data, calculate formula, and graph the data, and save their Excel Sheet.
Deliverable:	Excel and Analytics D2L assignment - Takes 15-30 minutes.
Instructions	On-D2L
Additional Help	If needed, you could use the Skillsoft tutorials to learn Excel. Here is the link to Skillsoft: https://claytonstate.percipio.com/ The login name and password are similar to your SWAN, DUCK, or Email credentials.
	Note: the instruction below is created for a PC user. For Mac users the steps are similar but might be slightly different.

23. Go to “Week 15” or “Excel and Analytics Spine” Module and download the Excel sheet “Raw Data-Excel and Analytics Spine Assignment – Micro”
And open the file. Make sure to click on “enable editing” if appears on the top.
24. In the first row if quantity is zero and the Total Cost is 62, where that cost is coming from? Fixed Cost or Variable Cost? Knowing the Variable Cost is zero at quantity zero ($E2=0$), and the Fixed Cost has to be 62, then the whole column D will be “62”, since Fixed Cost is fixed and does not change. For the moment just enter “62” in D2 and “0” in E2.
25. Now calculate the variable cost for Quantity=10 by using this formula: Variable Cost = Total Cost – Fixed Cost (since $TC=TFC+TVC$)
26. Note that in excel you should start from E3 (we already established that $E2=0$) and enter “=C3-D3”
27. Next use the fill function of Excel. Click on the last cell where you entered your formula (cell E3), and click and hold and drag down the little green square at the bottom-right of that cell using your mouse or touchpad. Continue dragging down till you reach the last row of your data (E12). All of the cells below E3 will be populated with the similar and appropriate formula and all of the Variable Costs will be calculated.
28. Use the fill function to fill 62 in all of the cells D3 to D12, by starting from the cell D2 and then click and drag down the little green square at the bottom-right of that cell using your mouse or touchpad. From now on, I refer to this action “fill function” and do not repeat describing what to do again, but when I say use “fill function” do just as described above. Note that all of the cells in column E will be updated as you use the fill function in column D. That is the beauty of using fill function with a formula: it recalculates the cell values based on the new values as they are entered/filled!
29. Now calculate Total Revenue = Price * Quantity
30. In Cell F2, type “=B2*A2”, and then use the fill function and fill all of the cells for Total Revenue (F2-F12)
31. Profit = Total Revenue – Total Cost
32. In cell G2, type “=F2-C2” and then use the fill function to fill G3-G12
33. Marginal Cost = change in Total Cost / change in Quantity
34. In cell H3 type “=(C3-C2)/(A3-A2)” and then use the fill function. Notice that I did not start from H2, Why? The reason is that there is no previous total cost **before** quantity

	<p>zero, so we cannot calculate any change at the row where quantity is zero. Marginal cost for quantity zero is not defined. Doing this step we filled cells H4-H12.</p> <p>35. Observation: At which quantity profit is maximized? What is the Marginal Cost at that quantity and is it equal to MR?</p> <p>36. Remember that for a perfectly competitive firm, $MR=Price=6$. In our case profit is maximized at Quantity = 90 and the maximum profit is \$216.</p> <p>37. At that Quantity, $MR=MC$, or $P=MC$! Now let's graph the cost function:</p> <p>38. Select all of the cells in columns "Quantity" and "Total Cost" Here is how: Start from Quantity and hold and drag down the mouse or touchpad till all cells are selected and then hold "ctrl" key and repeat the same with column "Total Cost" while holding the "ctrl". Both columns should be highlighted. Then select "Insert" from the menu, and under "charts" select "scatter". I prefer the one with lines connecting the dots, but you can choose different options.</p> <p>39. Great! You have graphed the Total Cost function for this given firm!</p> <p>40. From the menu, select "File", "save as", browse to desired location/folder and then enter the file name "CostFunction-your full name" (in my case CostFunction-RezaKheirandish) and choose "save as type" to be "Excel Workbook" (it is the default option) and click save.</p> <p>41. Upload the file on D2L assignment page for Excel and Analytics Spine.</p> <p>42. Congratulations! You are done with the extra credit assignment!</p>
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In spring 2022, we implemented this pilot in more core courses, and the results will be discussed in this paper (work under progress). We hope to be able to have a full scale implementation in Fall 2022. I hope to be able to report the results of that implementation at SEINFORMS 2023!

IMPLEMENTATION OF PASSWORD MANAGERS (PMS) IN SMES AND NPOS: AN ADAPTED IT ACCEPTANCE MODEL FRAMEWORK

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ABSTRACT

Password Managers (PMs) have recently gained popularity due to their convenience, dependability, and multi-device compatibility. Consequently, corporations and big organizations utilize PMs in their password policies and best practice documentation while developing security postures and maintaining good password hygiene; however, there is limited research about PMs implementation in Small and Medium Enterprises (SMEs) and Nonprofit organizations (NPOs). The current paper recommends an implementation model framework of PMs into the daily operations of SMEs and NPOs by adapting a well-known Technology Acceptance Model (TAM).

Keywords: Password Manager, SME, NPO, Technology Acceptance Model, Security

Introduction

Password Managers (PM) have gradually gained popularity in recent years due to their high efficiency in providing users with a convenient, dependable, and multi-device compatible method of creating, storing, and using passwords. [1] According to the NIST guidelines, strong passwords should be unique, long, and composed of numbers and special characters. [2] Considering the large number of accounts requiring passwords, pins, and passcodes, adherence to various password policies or best practices has become vastly intimidating. Therefore, PMs—requiring a user to remember a single long password known as the master password—alleviate this stress and ensure that passwords remain unique and private. [3]

Big organizations and corporations immediately recognized the benefits of such tools. Consequently, PMs are now included in various enterprise-level password policies and password best practice documentation when developing security postures and maintaining good password hygiene. [2] However, despite the numerous advantages these tools offer, there is a limited body of knowledge about using PMs by SMEs (Small and Medium Enterprises) and NPOs (Nonprofit Organizations).

The current paper uses the Technology Acceptance Model Framework to propose an implementation model of the PMs into the daily operations of SMEs and NPOs. The authors believe that using PMs could benefit SMEs and NPOs to optimize their operations, considering that SMEs and NPOs often lack awareness and resources [4], making the implementation process of new technologies slower and more challenging compared to their counterparts.

Background

Various studies indicate that users face challenges managing the growing number of accumulated passwords, passcodes, and pins required in the current digital era. Consequently, users often find themselves

adopting strategies to simplify their password management. [5] This scenario frequently leads to poor password practices, such as using short and easy-to-guess passwords, writing passwords down, or using the same password for multiple accounts.

Multiple studies in the IT and cybersecurity field aimed to understand the utilization of traditional passwords and their significance concerning account security. [1] Several studies have focused on evaluating end-user behavior to approach a higher level of personal account security. [6] However, the topic became significantly relevant since more and more workplaces increasingly use individual accounts for employees with multiple passwords that they must remember to access work-related applications.

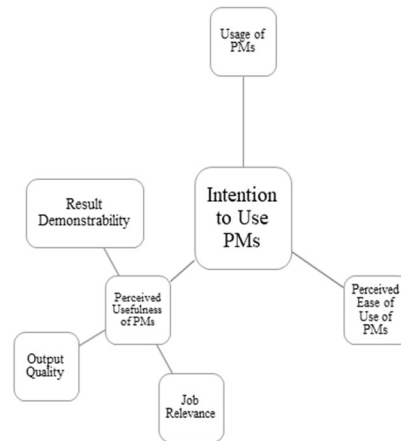
LastPass Analytics (2021) reports that the average business employee maintains an average of 191 passwords, pins, and passcodes, which can be the source of password fatigue within the enterprise environment. [7] In addition to the growing number of passwords, introducing password-related security policies, such as increasing password complexity or expiration, adds to the burden of fatigue. Consequently, these practices result in poor password hygiene because employees cannot remember all of their passwords. Furthermore, another layer of potential vulnerability is added when these passwords are frequently written down in personal notebooks, notes, or unencrypted files [8][9]

Therefore, recently the emphasis has shifted to addressing the limitations of the human mind by introducing technologies that facilitate password management. Consequently, these technologies—called Password Managers (PMs)—offload the burden on the human mind created by the current digitalized era and minimize the required memorization of numerous passwords, pins, and passcodes. [1][10]

The Technology Acceptance Model and Password Managers

According to Hoong et al. (2017), the first version of the Technology Acceptance Model (TAM) was developed by Fred D. Davis in 1989 and considered two main factors that are the base of the Intention to Use New Technologies in a work context: "Perceived Usefulness (PU)" and "Perceived Ease of Use (PEOU)." TAM2 is the extended theory version and was proposed by Venkatesh and Davis in 2000. TAM2 proposes five factors influencing "Perceived Usefulness": *Job Relevance*, *Output Quality*, *Result Demonstrability*, *Subjective Norm*, and *Image*. Additionally, Experience and Voluntariness have been added in TAM2 as influencing factors for *Subjective Norm* that influence *Intention to Use* and, ultimately, the *Usage Behavior*. TAM3 added additional factors such as demographic factors, experience, and more determining factors for *Behavioral Intention*. Considering that the topic of Password Managers in SMEs and NPOs is still underdeveloped, the authors will adapt the TAM2 framework to demonstrate how a technology tool such as a Password Manager (PM) can be introduced into the daily operations of the SMEs and NPOs. [11] Figure 1 is the proposed adapted version of the TAM2 framework applicable to Password Managers (PMs) adoption SMEs and NPOs.

Figure 1. *The Technology Acceptance Model of Password Managers, adapted from Davis (2000)*



Intention to Use the PMs: A study found that 69% of the employees in the workforce would use an enterprise PM if offered. [9] Another study conducted by Ciampa (2011) concluded that an 89% increase in PM usage could be observed after a PM awareness and training session. Another study (2020) proved the increased use of PMs following awareness training, implying that PM adoption rates are directly proportional to user training and awareness. [3] Therefore, training and awareness are the two main factors affecting the intention to use PMs. Consequently, SMEs and NPOs should stimulate awareness and training activities for their employees to increase interest and intention to use the tools.

Perceived Usefulness of PMs: Improving the security posture of SMEs and NPOs is one of the primary reasons organizations would choose to implement PMs. However, end users regard security as a secondary task, and as a result, they tend to avoid significant engagement with security if it interferes with their day-to-day tasks. Nonetheless, blaming the users for failing to follow best security practices is an ineffective strategy to improve security. Therefore, security engineers must research the underlying reasons behind user behaviors and create security systems according to the user's needs and capabilities. [10]

Qvintus (2018) suggests that the lack of utilization of PMs is due to an underestimation of the risks that the "insecure behavior" may have. The implementation and use of PMs continue to prove safer than the current antiquated password policies within the working environment [9], so the SMEs and NPOs' leadership should start promoting the usefulness of the PMs to their employees for a smoother adoption. One way to do so is to promote the (Perceived) **Ease of Use of PMs**: Password Managers (PMs) are intended to lessen password fatigue and other related stressors by reducing login times, facilitating password creation and storage, and limiting password reuse. PMs frequently provide data backup capabilities that allow users to export their saved passwords to offline storage facilities to alleviate data loss concerns when returning or resetting a password.

Moreover, this feature is also used for easy transfer if the need to change the PM providers arises. [9][12] PMs are adequate as they require the users to remember a single long password, known as the master password. This feature is **Job Relevant** because employees generally use different platforms and applications in their daily operations. As a result, this process alleviates the burden on the user's mind and ensures that passwords are preserved as unique and private. [13] Therefore, the employees would be more disposed to accept the technology if these advantages are presented.

The second factor that would ease the PMs adoption is presenting the **(Perceived) Usefulness of PMs**: As mentioned before, password reuse has been identified as a common denominator in several reported security

breaches. [1] According to a Global Password Security Report published in 2018, 50% of users utilize the same password for their work and personal accounts. These results are also supported by Google research, which found that 65% of users used the same password for both work and personal accounts in 2019, contributing to the 81% of hacking-related breaches reported in the DBIR 2019. [5] Implementing PMs promises to improve password hygiene, consequently decreasing password-related incidents. Therefore, the **Result Demonstrability** and **Output Quality** of PMs are recognizable when discussing security concerns.

Enterprise Password Manager Applications

Enterprise-level PMs offer extra administrative features that providers of personal PMs often fail to provide. When accessing the advantages of an enterprise-level PM, scalability, security capabilities, administrative ease, and price are the areas of consideration. [9][14][15] The following PMs have been among the top choices of enterprise-level PMs:

LastPass is a cloud-based authentication solution that provides multiple SSO policies and Active Directory connectivity for easy integration. Cloud-based password managers work as extensions on browsers. [9] Various essential features, such as employee authentication, admin roles and permission, and general access management, are simplified by the import or group-creating capabilities of LastPass Business. [3] Furthermore, these capabilities are complemented by LastPass's intuitive interface, multi-factor authentication capabilities, and 24-hour customer support.

As the most popular personal PMs, LastPass can link personal accounts to enterprise accounts while keeping the information isolated, allowing users to access their password vaults in any environment. [7][15]

Another important PM is 1Password, a cloud-based authentication solution that allows for complete control over the password management aspect of the enterprise. Like LastPass, 1Password provides custom groups and roles for ease of management and customizable access policies. In addition, 1Password has "guest accounts" functionalities and a shared vault that further simplifies daily tasks by preventing the creation of temporary accounts. [15] One significant feature of 1Password is the custom reporting that informs on various metrics, such as overall password habit health and the provision of family accounts of all enterprise users. [3] [7]

The fundamental functionalities of enterprise PMs are consistent across the board; the distinction among various PMs can be observed through their interfaces, the signature auxiliary capabilities, and prices. Besides LastPass and 1Password, other significant enterprise PMs are Dashlane, Keeper, and Roboform. [15]

Limitations of PMs

PMs are applications that allow users to create secure, robust passwords, save them together in a single secure encrypted file, and utilize them with only one master password to memorize. Thus, the master password unlocks the encrypted vault, granting the user access to all the saved passwords. [16]

Despite their growing popularity and numerous benefits, PMs are still underutilized for multiple reasons: if implemented without the proper policies and regulations, they may become vulnerable. In addition, PMs frequently lack extra safeguards, making them prime targets for cyberattacks; furthermore, the level of account protection depends on the complexity of the master password and the additional countermeasures, such as implementing multi-factor authentication. [12][17]

In various studies, dual-factor or multifactor authentication has been shown to significantly reduce the likelihood of password-related compromises, even when coupled with other poor password habits, such as weak passwords or password reuse. [17][18] Furthermore, it has been discovered that the absence of dual-factor authentication significantly impacts potential password-related data breaches.

Discussion and Conclusions

Due to their remarkable effectiveness in giving consumers a practical, stable, and multi-device compatible way to create, store, and utilize passwords, password managers (PMs) have become increasingly popular. As a result, when creating security postures and upholding good password hygiene, we can see the increased use of PMs in enterprise-level password policies and password best practice guidelines. For PMs to work, users must memorize a single, lengthy password known as the master password. Consequently, this procedure relieves user stress and guarantees that passwords are kept distinctive and confidential. While big enterprises and corporations have already implemented PMs, there is little research about the usage of PMs in SMEs and NPOs.

By integrating a well-known Technology Acceptance Model (TAM), the current research suggests an implementation model framework of PMs into the daily operations of SMEs and NPOs. According to the authors, PMs could help SMEs and NPOs optimize their operations because these organizations frequently lack resources and awareness.

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INVESTOR DEMANDS FOR CLIMATE REPORTING: EVIDENCE FROM SHAREHOLDER PROXY PROPOSALS

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ABSTRACT

This research describes the 21st-century trend for increased reporting over climate-related issues in U.S. publicly held corporations and offers optimism for enhanced information flow to all users of financial and non-financial data. Analysis of individual shareholder proposals placed before the overall ownership annually of the thirty companies comprising the Dow Jones Industrial Average reveals a positive trend in stockholder activism. The paper suggests a holistic reporting approach so that measurement and reporting of physical climatic changes in the environment affecting a company are packaged with the reporting of the financial results of corporate operations.

Keywords: Climate change reporting, Integrated reporting, International Sustainability Standards Board (ISSB), Sustainability assurance, Sustainability disclosure

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JEL Classifications: G30, H00, M14, M41

INTRODUCTION

Sustainability reporting is becoming increasingly popular in the 21st century as investors who typically viewed it as a constraint to economic progress are changing to a vision that concerns for environmental, social, and governance (ESG) issues may actually benefit rather than harm corporate performance. This paper focuses on environmental, and specifically climate change. The paper reviews the relevant literature including climate-related standards and frameworks established by authoritative accounting bodies. The current conditions in the U.S. affecting reporting to stockholders are analyzed, and the future prospects for improved climate reporting are evaluated. The trend in stockholder activism demonstrated by the increase in proxy proposals in large publicly held corporations demonstrates the interest that investors hold in assuring the qualitative attributes of company and social sustainability.

CLIMATE ACCOUNTING'S ROLE IN SUSTAINABILITY

Background & Linkage to Financial Reporting

Initial reporting efforts originated with the World Economic Forum (WEF) in 1971 and through various organizations and evolutions expanded into the requirements of the International Sustainability Standards Board (ISSB) in 2021. Carbon footprints, global warming, pollution, and biodiversity loss have become commonplace for companies to publish in some manner their sustainability efforts. Unfortunately, that information has been until recently fragmented, far from standardization, and generally divorced from the corporate financial performance.

Sustainability accounting owes much of its original emphasis to the field of social accounting. Kaya and Yayla (2007) credit Berle and Means (1932) as the first social responsibility source. The terminology of “social accounting” appeared in the work of J. R. Hicks (1942), with the movement emerging in the 1960s. Hopwood (1978), Hopwood & Burchell (1980), and Burchell et. al. (1980) and other pundits have written extensively on the importance of social accounting. Gray (2002) argues that environmental and sustainability accounting germinated from social accounting in the 1990s. Elkington (1993) used the expression “triple-bottom-line,” to illustrate the importance of people, profits, and planet.

The Glasgow Conference at the 2021 United Nations Climate Change Meeting (COP26) appears to be a pivotal point in sustainability accounting. The ISSB was formed at this conference under the auspices of the International Financial Reporting Standards (IFRS) Foundation. The ISSB attempts to capture the best efforts of predecessor organizations such as the Climate Disclosures Standards Board (CDSB), International Integrated Reporting Council (IIRC), and Sustainability Accounting Standards Board (SASB), the International Organization of Securities Commissions (IOSCO), Task Force on Climate-Related Financial Disclosures (TCFD), and WEF.

The guidance of the ISSB promotes public companies to disclose ESG matters accompanying reports on their financial performance. The perspective of making informed decisions was seen as more solid when both qualitative and quantitative measures, including effects of and on climate, the environment, and overall sustainability were disclosed.

Rationale for Reporting Climate Change & Biodiversity Issues

Climate change accounting refers to the measuring and recording of actions companies may engage to deal with the effects of climate changes, diving into the specifics of individual companies rather than the broader macro economy. Fossil fuel burning, deforestation, and overconsumption are examples of human interference leading to climate change. Atmospheric carbon greenhouse gas (GHG) emissions appear to be a leading cause of climate change. Some companies have established targets for reducing such footprints, including Amazon (2022) where that company plans to be carbon neutral by 2040. Several large firms have established similar targets.

Jones & Solomon (2013) maintain that reporting on such issues causes companies to be even more aware of biodiversity, hence creating a sense of more recognition of the need for controls. Without formal standards for reporting, company publications can exaggerate their commitment toward biodiversity (Boiral, 2016). Ideally, biodiversity efforts should be disclosed by any company that contributes to climate change, as transparency in reporting assists in decision usefulness. Boiral & Heras-saizarbitoria (2017) further argue that the ethical climate continues to draw increased global attention through concerns of both internal managements as well as external parties. Value systems have to be addressed. Fair reporting of biodiversity loss may require societal ethics overriding economics of individual companies (Clemencon, 2021).

RESPONSES TO CLIMATE ISSUES

Political concerns in the U.S. are responsible in part for the slow reaction. Money spent in one direction is frequently viewed as money that is not available to spend on other matters or corporate pet projects. Reluctance to disclose the effects of carbon emissions, deforestation, and fossil fuel use may also be attributable to outright denial of existence of a problem. Research may be helpful to examine the efficacy in separating traditional financial accounting from those issues which are future-oriented and viewed as outside the purview of generally accepted accounting principles.

Without integration into the financial reporting framework, climate-related issues are reported in a hit-or-miss fashion, according to management's discretion, if at all, in selected media, and absent professional assurances. Companies may choose to report sustainability data in a totally unregulated manner, varying from supplementary information in annual meeting materials, to stand-alone sustainability reports, to corporate website promotions, and other materials. Additionally, with no assurance provided by an independent body, stakeholders overall have little comfort that they are receiving credible information.

The traditional financial audit is performed by independent Certified Public Accountants (CPAs) subject to standards established by the Public Company Accounting Oversight Board (PCAOB) for public companies. Private companies have assurance provided by the American Institute of Certified Public Accountants' (AICPA) Auditing Standards Board (ASB). Unless a climate-related issue directly ties to transactions affecting a company's financial statements, sustainability data are lacking in governance, regulation, and independent professional assurance.

Denial, Politics, and Greenwashing

The U.S. climate change denial is especially high compared to other developed economies (Wong-Parodi and Feygina, 2019). The 2012 Paris Climate Agreement which was eventually ratified in 2015 by almost 200 nations addressed the importance of interrelationships between climate change and economic factors. Strong nationalistic leanings expressed by then President Trump arguing on the basis of a cost-benefit analysis relative to other countries led to the U.S. withdrawal from the agreement. Analysis by Esparcia, et al. (2021) concluded that media with a Republican tendency voiced denial of climate changes, and those with a Democratic leaning reported broadly on environmental concerns and climate change issues.

Greenwashing is the corporate practice of providing narrative statements suggesting to stakeholders that the company's industrial output and mission are more environmentally beneficial as result of management actions. As companies operate with excessive profit motivation, greenwashing can become common. Statements of what the entity is doing good for the environment, but without backup of reliable measures and audits, can taint the overall usefulness of reports. Furthermore, anomalies can occur. While many Australian professionals advocate the need for ESG reporting, the country itself is among the world's largest exporters of coal and liquefied natural gas, including being one of the highest emitters of greenhouse gas per capita (Gelineau, 2022).

Weakness in Clarity, Transparency, & Global Reporting Comparability

The Global Sustainable Competitiveness Index (GSCI) is a measure internationally used to rank countries. Over 100 metrics categorize five subtopics: Intellectual Capital, Natural Capital, Social Capital, Resource Efficiency, and Governance Efficiency (Solability.com, GSCI, 2021). Japan and New Zealand along with eighteen European countries hold the top twenty positions on the index. The U.S. ranks poorly, placing 30th in the index. The GSCI report indicates the low U.S. ranking is attributable to deficiencies in social capital and resource efficiency.

According to a KPMG survey (The KPMG Survey of Sustainability Reporting, 2020) North American companies rank near the bottom on issues relating to biodiversity loss and climate risk. Furthermore, the survey shows the U.S. lags at 54% behind the world leaders in Sustainable Development Goals (SDG), along with efforts toward integrated reporting. Dumay, et al., (2017) point to numerous disagreements about the implementation of a suitable framework being responsible for the drag in the U.S. Dumay, et al. include the U.S. as one of ten countries where the majority of companies acknowledge some form of climate risk. Hopefully, this optimistic note carries through with detailed reporting and disclosure.

De Villiers, Rinaldi, & Unerman (2014) offer the historical reluctance by U.S. companies to disclose future-oriented issues as a possible impediment to integrated sustainability reporting. Even though countries globally have engaged in various levels of sustainability reporting, such clarity is frequently missing, leading to insufficient comparability, confusion, and different interpretations. Guidelines exist on what should be included, yet companies can omit information stating that management or its board view as confidential, unavailable, or not applicable. Credibility is eroded when cherry-picking is allowed. Internal and external accountants are often hesitant to offer actions to improve change, and even regulators can play an overly conservative role.

ACTIONS BY THE ACCOUNTING PROFESSION AND SHAREHOLDERS

In scanning the websites of large accounting firms and professional societies, climate issues seem to be emerging as more prevalent. If company management and their boards are slow to respond, will other key stakeholders in the sustainability reporting process take up the reins? On the investor side, shareholders through the power of the corporate proxy, may provide the greatest gains in achieving enhanced climate-related reporting.

Climate-related risks arise from various changes in a company's accounts. Assets and liabilities are subject to impairment, useful life, and valuation. The dialectic in the accounting reporting conundrum is the responsibility to report the immediate past (short run) while now also being concerned with the current and future (long run).

Developments Toward Integrated Reporting

Eccles & Saltzman (2011) demonstrate the importance of disclosing both financial and non-financial information on ESG matters. Researchers Cheng, et al. (2014), Humphrey, et al. (2017), and O'Dwyer & Unerman (2020) echo the need to have all the company's stakeholders view reporting in an integrative fashion.

The leading U.S. accounting firms, professional organizations, and authoritative standard-setting organizations are now becoming advocates for integrative reporting (Barth, Cahan, Chen, & Venter, 2017). The question remains as to whether their statements will prove as strong as direct shareholder action in proxy contests.

Assurance reporting by independent accountants can play a key role in “policing” at a professional level the reliability, truthfulness, or fairness of overall financial and climate information. Without the external player of the independent audit the arguments of Cho, Roberts, and Patten (2010) seem valid that companies with lower environmental performances tend to manage through biased verbiage and tones in their disclosures. Under these conditions, greenwashing can continue until somehow arrested. Some studies reveal superior corporate performance when positive environmental and corporate earnings are aligned. Al-Tuwaijri, Christensen, and Hughes (2004) emphasized this correlation between environmental and economic performance, with the confirming observation that companies with expanded environmental practices disclose more useful information overall.

External critics and pundits in other countries are quick to point that suggested U.S. improvements toward sustainability integration into financial reporting has been very slow. Except for a regulatory push from the United States Securities and Exchange Commission (SEC, 2022), and a few endorsements from “Big Four” public accounting firms, the greatest recent gains appear to evolve from the stockholder ownership base itself, as provided by the current research described in this paper’s tables and exhibits. The impact of the SEC exposure draft requiring climate-related disclosure in the notes to the financial statements accompanied by an independent audit by external accounts remains to be seen. Analysis of public company shareholder proposals requiring climate change reporting and disclosure may have a more immediate impact on society.

METHODOLOGY TO MEASURE SHAREHOLDER INTEREST

Shareholder Proposal Activity—a Quasi-Experiment Investigation

U.S. Shareholder activism is a driving force as public entities must respond to the votes of the ownership. Individuals and group owners can prepare a formal proposal, and ownership volume is not a necessary condition for the proxy to be included for a vote. Religious orders of sisters and not-for-profit organizations may present proposals, as long as they own a share.

Shareholder proposals may prove beneficial in multiple ways. For example, a shareholder proposal scheduled for the Annual 3M (2022) meeting specifically indicates disclosure is needed beyond concerns for profitability, and suggests that costs to the global environment should be reported, including any additional long run enterprise risks. The experience at Valero offers another example. Even with increased public scrutiny surrounding the damaging effects of climate change, Valero (2022) shareholders presented a proposal at the Company’s annual meeting requiring a report on greenhouse gas emissions targets.

As typical with board of directors’ response, the Valero board’s opposing statement to the proposal included the company’s commitment to expanding its existing disclosures in ESG best-practice

frameworks and update regularly such ESG reporting. While not included with the financial statement data, the directors claim all critical climate change information will be included in their separate reports—such as an annual Stewardship and Responsibility Report, ESG Overview, Carbon Disclosure Project (CDP) Climate Questionnaire, SASB Report, and TCFD reports—a series of documents separate from the financial statements and related assurance.

In addition to stating a defensive response, company management and directors also are likely to take proactive measures to counter criticisms of their strategies. In the discussion of risk factors in Valero’s 2021 form 10-K, the company states that climate-related litigation could evolve. Law suit contingencies arise from various operational causes, and possibly even as a result of disclosures. Governments and private parties file lawsuits or other actions based on ESG-related practices, and these actions pose additional risks. “Greenwashing” over carbon neutrality can be part of this risk. Valero states that the company is not a party to any such litigation. The increased risk remains for liability attributable to information on climate change and other ESG disclosures (Valero, 2022).

Proxymonitor.org is a website providing proxy information on the largest Fortune 250 publicly held companies from 2006 to 2022. Exhibit 1 (in the Appendix) displays the number of climate-related environmental proposals and the total number of proposals for these years. The trend demonstrates a relatively stable percentage of climate to total proxies ranging from 3.77% to 11.76%. Following reductions in the pandemic years of 2020 and 2021 of 3.77% and 4.53%, 2022 witnessed a rebound to 9.29% as 51 of the 549 proposals are climate-related. Not only has the volume of proposals of a specific type increased, but also the actual success vote. Table 1 (below) shows the success rate of climate related proxies measured by votes of 50% or greater for six most recent years. A column is also presented for votes on proxy proposals that failed, but at least did achieve 25% of the shareholders voting.

**Table 1. TREND IN SUCCESS RATE OF CLIMATE-RELATED PROXIES
(Shareholder Votes “For” in Fortune 250 Companies)**

	Success Counts			
Year	0 - 24.99%	25.00-49.99%	50.00-100.00%	Total
2016	35	23	0	58
2017	24	23	3	50
2018	12	12	2	26
2019	13	11	0	24
2020	8	9	3	20
2021	4	9	10	23
Totals	96	87	18	201

SOURCE: Drawn from Proxymonitor.org

Votes “for” have dramatically flipped from 2016 where 35 of 58 proposals garnered less than 25%, while 0 of the 58 captured a win with 50% or greater. Contrasted with the most recent year, 2021,

only 4 of the proposals received a vote less than 25% but 10 of total 23 votes received a winning vote with greater than 50%. Appendix Exhibit 2 provides a more detailed analysis of these successful “for” votes, demonstrating the total percentage of the winning votes, the individual Company name, its industry, and a brief description of the proxy item. Virtually all (14) of these winners call for a “report” strongly suggesting the need for an enhanced integrated reporting model. The remaining four proposals did not specifically indicate the need for a formal “report,” but did state the need for quantitative assessment, targets, reductions—information that a user would expect to be disclosed in some form to the entity’s stakeholders.

Dow Jones Industrial Average (DJIA) as Barometer

Rather than examine the entire 250 Companies covered in Proxymonitor, the authors of this research focused on shareholder proposals of the thirty companies comprising the DJIA. The 2022 proxies by number of proposals are displayed as Exhibit 3 in the Appendix. The Dow was selected on the basis of large company sizes in terms of capitalization and the vetting that these companies endure to be listed in the widely recognized DJIA index. The exhibit shows each Company’s name, symbol, the most recent year end for meeting and annual report availability, the total number of proxies, as well as the total number that are climate-related. The total number of proxies is decomposed into two designations. Those proposed by management, or the board of directors are indicated by C for “Company.” The “Shareholder” proposal counts are indicated by the letter S. Table 2 below shows the climate-related proposals and results before the Dow companies in 2022.

Table 2. SUCCESS RATE FOR 11 OF 30 DOW COMPANIES CLIMATE-RELATED PROXIES IN 2022 (Shareholder Votes “For”)

Dow 30 Evidence – 2022 Results		
Symbol/Name	Report Requested by Shareholders	% “For”
BA/Boeing	Report on net zero indicators	89.09
CAT/Caterpillar	Report on climate policy	95.50
CVX/Chevron	1 Adopt medium and long-term GHG reduction targets	32.60
	2 Report on net zero impacts	38.70
	3 Report on reliability of methane emissions	98.10
GS/Goldman Sachs	Policy adoption to ensure finance not contribute to fossil fuels	11.19
HD/Home Depot	Report on deforestation	64.66
HON/Honeywell	1 Report issuance on lobbying activities to mitigate climate risks	39.15
	2 Report on environmental and social due diligence	21.09
JPM/JP Morgan	1 Policy adoption to ensure finance not contribute to fossil fuels	9.97
	2 Report on setting targets for GHG emissions	15.30
MCD/McDonalds	Report issuance on plastic use reduction	41.52
MMM/3M	Report on environmental costs & impact on market returns	13.16
TRV/Travelers	1 Report issuance on measuring GHG emissions for underwriting	55.24
	2 Policy adoption to ensure finance not contribute to fossil fuels	13.07
WMT/Walmart	Report on refrigerants released & effect on climate change	5.51

SOURCE: Drawn from Proxymonitor.org

The 11 companies carrying a climate-related proposal, the specific report requested, and the voting results are shown in Table 2. While 19 of the 30 Dow companies had no climate-related proposals for 2022, this does not mean that these companies fail to have stockholder interest in climate. Nonparticipation in the 2022 proxies by the 19 Dow companies may be attributable to several reasons. Some of these entities already have a fairly significant reporting regimen for sustainability, and some may have had a successful climate proxy vote in prior years. Annual proxy proposals for Apple, Caterpillar, and Chevron (SEC EDGAR, 2022) reveal the continued interest in climate issues. Apple (AAPL) prides itself as a leader in sustainability metrics.

The momentum in proposals can increase each year. Caterpillar's (CAT) 2022 shareholder proxy provided a straight repetition of its 2021 climate proposal where it previously failed with a strong vote of 47.44% (ProxyMonitor.org). Similarly, Chevron's (CVX) 2022 proposal carried a provision for audited Directors' report on Net Zero effect underlying the financial statements. This barely missed passing in the prior year at 47.80%. Exhibit 4 in the appendix shows the specific climate-related proxy calls for the 2022 annual company meetings. Table 2 below displays the summary of the voting results.

The results of Walmart and Chevron (SEC EDGAR, 2022) show the voting persistence. Walmart's (WMT) 2022 shareholder proposal for a company report to limit impact on climate change through increased scale of refrigerant reduction that is released during company operations is a duplicate of the 2021 proposal where it received a vote of only 5.51%. Chevron (CVX) is the only Dow company for 2022 proposals where the Directors actually state that they recommend a vote "for" at least one of the shareholder proposals. Typically, the Directors recommend votes against all shareholder proposals. Overall, the volume of climate-related proposals and the increasing favorable acceptance of these proposals is a promising development toward an improved model of integrated financial and sustainability reporting.

The 11 Dow companies shown in the Appendix Exhibit 4 along with detail of their specific shareholder requests for report summarized in Table 2 and the actual voting results of the 16 shareholder proposals for 2022 provide growing confidence for increased shareholder enthusiasm. Encouragement is further shown with the success demonstrated in the percentage of votes "for" the proposals, but also with overall shareholder agreement in fully approving 5 of the 16 proposals (results over 50%), and also with 4 of the 16 obtaining results of between 25% and 50%.

Integration of Accounting Disclosure and Assurance

McKinsey & Company (Bernow, et al., 2019) conducted surveys on the extent of audited sustainability reports, where 97 % of investors believed that there should be some kind of audit, and 67% believed that the audit should be full, similar to a financial audit. Even as a company moves toward implementation of shareholder climate-related information, further attestation is needed to satisfy the user.

Assurance can vary in scope and depth, including where the information to be assured is displayed, what is assured, level of assurance, the assurance provider, the standards used and the follow through controls. The location of the information may be crucial since free-standing sustainability

reports suggests much less weight than annual report information, including 10-Ks, and other regulatory filings. Climate change measurement may cover greenhouse gas emissions, but could also include energy and water data, soil erosions, and fire damages. Also important is agreement among the stakeholders on what constitutes materiality, what items constitute disclosure inclusion, and specifically the number of years in short-term, intermediate, and long-term measures.

The SEC's (2022) proposal for climate mandates is intended to provide more consistent, comparable, and reliable information for financial statement users, and that agency is invoking its broad powers to regulate for a broader class of stakeholders rather than just investors and creditors. Under the SEC mandate, GHG emissions disclosures would include Scope 1 level, company-generated emissions in its production cycle, and Scope 2 level, indirect emissions generated from purchased or leased energy. The mandate would also specify that limited assurance by outside independent accountants in a review engagement is required for the large, accelerated filers, with a move to reasonable assurance (audit) after two years. Furthermore, if Scope 3, indirect emissions generated by a business in any of its transportation, distribution, waste or spoilage, is considered material, that detail must be included in the disclosures. Under the SEC proposal, financial statements would now be expanded to include impact of line-item metrics, disaggregated expenditure metrics, and financial estimates and assumptions (SEC, 2022).

CONCLUSIONS

It is comforting to see a diplomatic solution evolving in the aligned interests of climate issues and economic returns to stakeholders. The proxy proposal process driven by individual shareholder interests, both large and small, appears to be successful, with professional authorities and regulators operating in an environment to assist the flow of relevant information, not constrain it.

Investor and Other Direct Stakeholder Gains

Proponent literature on moves toward ESG-friendly strategies focuses greatly on the general society. However, investors may benefit in specific ways. The management of climate risk and monitoring the emission of greenhouse gases clearly could have a direct effect on some companies' financial performance. The 2022 SEC guidance for publicly traded companies helps close the gap between the issuing corporation and the investing public on progress toward mitigating the risks that shareholders are concerned in their proxy proposals. Investors will now have greater access to information for evaluating how the physical climate impacts their portfolios. Wildfires, soil erosion, and rising sea levels may be better studied as input variables on the future of a company's overall sustainability.

As supply chains become increasingly green, and the expanded disclosure of Scope 3 emissions, contract competition among suppliers should benefit multiple players. Investors are becoming more aware of long-term impacts and the need for carbon offsets or projects that ensure natural resource resilience. The exaggerations attempted in greenwashing narratives should diminish. With appropriate regulation, investors would be better able to compare Scope 1, 2, and 3 emissions of competing commercial entities. Harmonization and convergence from standard-setting bodies will accelerate advances in disclosure.

Other Stakeholder and Societal Gains

Sustainability gains do not stop with investors and creditors. Reporting and disclosure transparency improves public trust. Corporate reputations and leadership will improve, opening the door for increased consumer involvement. Customer loyalty and retention will also improve in the process. Evaluation of climate related information and its dissemination leads to cost-saving. Companies may also gain a competitive advantage. If an enterprise is implementing sustainable efforts while its counterparts are not, then competitive advantages will be realized.

Sustainable efforts will also benefit organizations in the labor market. Employee pride and loyalty would likely radiate when a company makes concerted efforts toward sustainability, and the actions seem to improve the lines of communication within an organization. Positive decisions by management and boards increase employee motivation and commitment. Talented employees who share the similar values will be attracted to a synergy of winning.

The future is of the utmost importance. Climate issues, to the extent they can be controlled, along with other corporate sustainability efforts, form the future environment. Humans, other life forms, and physical structures need sustainability, and investors through the proxy process can be the driving force. Reporting on the relevant topics under the guidance of reasonable standards would be helpful. This should include climate-related issues in annual financial reporting. Shareholder persistence is rewarded. The evidence presented shows that directors and management do listen and respond, but over a longer time-horizon. Recurring proxy proposals deliver the message that the described environmental issues are important, and the company can make a positive difference even though it may take several years to obtain the successful votes. Shareholders need to continue proposal submissions and gains will be realized.

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APPENDIX

Exhibit 1 – Trend in Shareholder Proposals – Fortune 250 Companies

Year	Number of Proposals	Climate-Related / Environmental (CRE)	% of CRE in Relation to Total
2006	385	28	7.27
2007	393	41	10.43
2008	357	42	11.76
2009	382	25	6.54
2010	380	44	11.58
2011	840	43	5.12
2012	580	30	5.17
2013	576	36	6.25
2014	589	52	8.83
2015	593	60	10.12
2016	581	58	9.99
2017	805	50	6.21
2018	515	26	5.05
2019	504	24	4.44
2020	531	20	3.77
2021	508	24	4.53
2022	549	51	9.29
TOTALS	9,068	654	7.21
Source:	Drawn from Proxymonitor.org		

Exhibit 2 – Growth in Success of Climate-Related Proposals — Fortune 250 Companies

Year	"For" Votes	Company	Industry	Item
2017	62.10%	Exxon Mobil (XOM)	Petroleum Refining	Report on policies to limit global warming.
2017	65.70%	Occidental Petroleum (OXY)	Crude Petro & Nat Gas	Report on policies to limit global warming.
2017	56.80%	PPL Corp (PPL)	Electric Services	Report on policies to limit global warming.
2018	52.47%	Anadarko Petroleum (APC)	Crude Petro & Nat Gas	Report on climate change risk analysis.
2018	59.66%	Kinder Morgan (KMI)	Nat Gas Distribution	Assess long-term impacts of scenarios of climate change policies.
2020	53.50%	Chevron Corp (CVX)	Petroleum Refining	Report on climate lobbying.
2020	53.90%	Phillips 66 (PSX)	Petroleum Refining	Report health risks petrochemical operations.
2020	67.68%	Procter & Gamble (PG)	Soap & Cleaning Preps	Report efforts to eliminate deforestation.
2021	60.70%	Chevron Corp (CVX)	Petroleum Refining	Substantially reduce GHG emissions.
2021	58.63%	ConocoPhillips (COP)	Petroleum Refining	Set emission reduction targets for GHG.
2021	62.66%	Delta Air Lines (DAL)	Air Transportation	Report on climate lobbying.
2021	63.80%	Exxon Mobil (XOM)	Petroleum Refining	Report on climate lobbying.
2021	76.44%	Norfolk Southern (NSC)	Railroads, Line-Haul	Report on climate lobbying.
2021	79.37%	Phillips 66 (PSX)	Petroleum Refining	GHG emissions reduction targets.
2021	62.01%	Phillips 66 (PSX)	Petroleum Refining	Report on climate lobbying.
2021	65.04%	United Airlines (UAL)	Air Transportation	Report on climate lobbying.
2021	81.21%	DuPontdeNemours (DD)	Plastics, Resin, Rubber	Annual report on plastic pollution.
2021	97.97%	General Electric (GE)	Electronics & Equip.	Report on Net Zero Indicator.
Source:	Drawn from Proxymonitor.org			

Exhibit 3 – 2022 Proxy Proposals for Shareholder Vote –Dow 30 Companies

Dow 30 Evidence				
Symbol	Name	Year End	Number Proxies	Climate-Related
AAPL	Apple	9/25/21	3C, 6S	0
AMGN	Amgen	12/31/21	3C, 0S	0
AXP	American Express	12/31/21	3C, 1S	0
BA	Boeing	12/31/21	4C, 4S	1
CAT	Caterpillar	12/31/21	3C, 4S	1
CRM	Sales Force	1/31/21	4C, 1S	0
CSCO	Cisco	7/31/21	4C, 1S	0
CVX	Chevron	12/31/21	4C, 6S	3
DIS	Disney	10/2/21	3C, 5S	0
DOW	Dow	12/31/21	3C, 1S	0
GS	Goldman Sachs	12/31/21	4C, 4S	1
HD	Home Depot	1/30/22	5C, 6S	1
HON	Honeywell	12/31/21	3C, 3S	2
IBM	IBM	12/31/21	3C, 3S	0
INTC	Intel	12/25/21	4C, 2S	0
JNJ	Johnson & Johnson	1/2/22	4C, 10S	0
JPM	JP Morgan	12/31/21	4C, 6S	2
KO	Coca-Cola	12/31/21	3C, 3S	0
MCD	McDonalds	12/31/21	3C, 7S	1
MMM	3M	12/31/21	3C, 2S	1
MRK	Merck	12/31/21	3C, 3S	0
MSFT	Microsoft	12/31/21	4C, 5S	0
NKE	Nike	5/31/21	3C, 3S	0
PG	Procter & Gamble	6/30/21	3C, 1S	0
TRV	Travelers	12/31/21	3C, 5S	2
UNH	UnitedHealth Group	12/31/21	3C, 2S	0
V	Visa	9/30/21	3C, 0S	0
VZ	Verizon	12/31/21	4C, 4S	0
WBA	Walgreens	8/31/21	3C, 3S	0
WMT	Walmart	1/31/22	3C, 5S	1
Source:	Developed by the authors from the individual companies			

Exhibit 4 – 2022 Climate-Related Issues for Stockholder Vote – Dow 30 Companies

Dow 30 Evidence	
Implications for Policies, Reports, and Disclosures	
Symbol/Name	
BA Boeing	Report issuance on Company's criteria of meeting Net Zero Indicator, including Scope 3 emissions & any policy revisions to be responsive to the Indicator.
CAT Caterpillar	Report issuance disclosing the Company's climate policies, preferences, and improvement targets, responsive to Net Zero Benchmark Indicators.
CVX Chevron	1. Set and publish medium and long-term targets to reduce Green House Gas Scope 1, 2, & 3 emissions. 2. Audited Directors' report on IEA Net Zero underlying financial statements. 3. Disclosure of Scope 1 changes.
GS Goldman Sachs	Policy adoption to ensure that Company's lending & underwriting do not contribute to new fossil fuel development.
HD Home Depot	Report issuance assessing how Company could increase scale, pace, and rigor of efforts to eliminate deforestation.
HON Honeywell	1. Report issuance on lobbying activities to mitigate risks on any misalignment with Paris Agreement goals. 2. Directors' environmental & social report on emissions & spills impact on human health.
JPM JP Morgan	1. Policy adoption to ensure financing not contribute to new fossil fuel supplies. 2. Report by Directors setting GHG emissions to G-20.
MCD McDonalds	Report issuance on plastic use with respect to Pew Report & effects on ocean pollution.
MMM 3M	Report publication on links between environmental costs and political activities and their impact on market returns.
TRV Travelers	1. Report issuance on GHG emissions--measurement, disclosure, plans to reduce relative to underwriting, insuring, & investment activities in line with metrics of Paris Agreement. 2. Policy adoption and disclosure to help ensure underwriting practices not support new fossil fuel supplies in line with IEA's Net Zero Emissions by 2050 Scenario.
WMT Walmart	Report issuance on how Company plans to limit impact on climate change by increased scale to reduce refrigerants released from operations.

Source: Climate issues on 11 of the 30 individual companies identified by the authors

KNOWLEDGE CREATION AND MANAGEMENT: THE ROOTS OF JAPAN'S CULTURE OF INNOVATION

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ABSTRACT

Since the end of WWII, Japan has developed into a powerhouse of industrial and technological innovation. This continues today with the island nation having the third biggest economy in the world after the US and China. This has been achieved by a nation with almost no natural resources to speak of, a nation where global export is the lifeline of its economy and its exported products are considered some of the most technologically advanced in the world with innovation being a cornerstone. This paper will introduce concepts of knowledge management and how the Japanese utilize these in unique ways based on culture factors in order to innovate and establish strategic advantages.

INTRODUCTION

In recent years there emerged a theory within Japanese knowledge management circles that a big factor in Japan's economic success through the early 1990s was from the organizational knowledge creation skills and expertise found in many Japanese companies. "Organizational knowledge creation" specifically refers to the ability of a company not only to create new knowledge but to disseminate it throughout the organization, as well as incorporate this knowledge into its products, services, and overall corporate systems. The result is that this brings about the incremental and continuous innovation for which many Japanese companies are known for in the world.

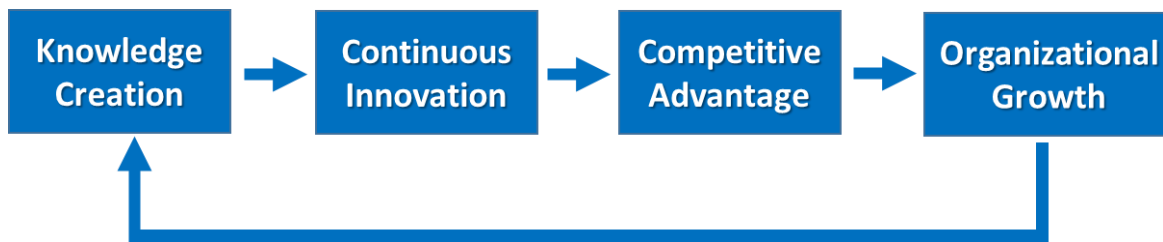


Figure 1: The Knowledge Creation Cycle

This paper will present certain essential components of this theory which is based on the understanding that companies not only possess and process knowledge but in fact *create* knowledge as they do business. The premise is that this creation and utilization has been an important factor in Japanese companies' international competitiveness. For example, in Japanese companies the management structure, HR management processes, consensus-building, etc., are all well-known and much researched in terms of Japan's power in international competitiveness. But, the theory presented here argues that *knowledge* and specifically *tacit knowledge* is a major factor behind these other, well-known and researched areas which much of the West already knows about regarding the Japanese business culture.

THE SOCIAL-CULTURAL ORIGINS OF JAPANESE KNOWLEDGE AND LEARNING

Western tradition on knowledge, learning, and reasoning has a long history going back to classical Greece and even further, while there is almost none to speak of in Japan. In Western tradition the two dominant approaches are *rationalism* (mathematics is a good example) and *empiricism* (experimental data-based science). Even though these two fundamental traditions are virtual opposites of each other, they are the foundation of Western thought.

The “*Japanese*” approach to knowledge and corporate management practice, as well as everyday life in general, is a highly integral approach, combining Shinto, Confucianism, Buddhism, Taoism, and Western Scientific Materialism. The Japanese value system itself stems from these 5 areas, greatly influencing corporate culture and thought. These make up the so-called *Japanese ethic*.

Shinto is the indigenous religion of Japan. It emphasizes harmony of all living and natural elements. Shinto holds that the Japanese race is descended from *kami* or gods. Thus the overwhelming concept of harmony in all surroundings and situations and the traditional belief of superiority of the Japanese race, which many Japanese still believe in, originates from the Shinto tradition.

Confucianism was imported to Japan from China approximately 2,500 years ago and is more of a social code of behavior rather than a religion. Confucianism identifies types of relationships with distinctly clear patterns of behavior that govern each. This distinct social code is easily transferable to the Japanese corporation in relation to the seniority system and overall corporate structure of the majority of Japanese companies even today.

Like Confucianism, Buddhism and Taoism also originated in China and were brought to Japan approximately 1,000 years ago. Japanese society developed its own mixture of these two concepts calling the result *Zen Buddhism*. Zen stresses meditation and concentration and actually reinforces Shinto. Together these were practiced by the samurai. In modern Japan, traditionalists still practice these concepts; and, in relation to the business culture, it can be said that modern-day samurai, in the form of company managers, practice these philosophies as well.

Scientific Materialism refers to the Western concepts of the natural universe and the cause-and-effect relationships that are at the core of scientific thinking^[1] (mentioned at the beginning of this section). These concepts were first introduced to Japan beginning in 1854 when the country began opening up to active Western trade and modernization. Japan adopted portions of this philosophy when it embarked on this course of modernizing its industries.

An additional basis for modern day Japanese values and behavior is the notion of “*wet-rice farming*.” Many historians claim that the introduction of wet-rice farming to Japan from China sometime between 1,000 to 300 BC created a lifestyle that instilled the Japanese with a high level of patience, perseverance, diligence, cooperation, and group dependence. Wet-rice farming is a fairly complicated process requiring elaborate irrigation systems. Maintaining such systems is virtually impossible for one individual or even one family, and requires those qualities mentioned above.^[2] The fact that Japan is an isolated country of which the majority of the terrain is very rugged and natural resources are relatively scarce, only adds to the difficulty. In Japan the saying goes “*eating rice from the same pot*” (同じ鍋からご飯を食べる) meaning: we, the Japanese, are all in it together. This group think plays an important role in knowledge creation and use. It is the idea that the group is more important than the individual which enables many Japanese companies to create and disseminate much information to all in the company instead of keeping information compartmentalized, as is done in many Western organizations. Thus actions are taken for the benefit of everyone in the group as opposed to the individual which in the West may keep knowledge to him or herself for self-promotion and/or self-preservation.

It is interesting to note that in certain areas the concepts mentioned above actually conflict and compete with each other on an ideological basis. But, the Japanese have learned to accept such competing ideologies where many Westerners would find them mutually exclusive and unworkable. In effect, the Japanese have come to use whatever belief system or ideology they see as appropriate at any given time based on the particular situation at hand. This is quite a profound ability on their part, and, in fact, showing significant flexibility within the Japanese system of beliefs; a system which directly transfers to the Japanese corporate world.

From the above descriptions we can say that for the Japanese, knowledge means: (1) wisdom that is acquired from the perspective of the whole personality; (2) knowledge that develops from relationships; and (3) knowledge through flexibility. In Zen Buddhism training for example, students are required to devote themselves to the world of ‘non-logic’ throughout their learning process. This is virtually opposite of rationalism in the West. The importance of this is that it emphasizes personal and physical experience over indirect, intellectual abstraction.

Furthermore, while most Western views of human relationships are atomistic and mechanistic, the Japanese view is collective and organic.^[3] It is within this context that the Japanese emphasize subjective knowledge and intuitive intelligence. Thus *the main distinction between Western and Japanese thought on knowledge is one of the scientific vs. the humanistic approach.*

In the early part of the 19th Century Frederick W. Taylor attempted to “manage by science.” He prescribed certain scientific methods and procedures to organize and operate work. This “Scientific Management” was an attempt to formalize workers’ tacit knowledge and skills into objective and scientific knowledge. The shortcoming of this theory was that it failed to take into account the direct experiences and judgments of workers as a source of *new* knowledge, a knowledge that can be leveraged for innovation and strategic advantage.

In the 1920s and 1930s a group of management academics at Harvard headed by George Mayo conducted experiments concluding: “.....social factors such as morale, a sense of belonging, and interpersonal skills needed to understand human behavior significantly improved productivity.”^[4] Mayo went on to develop a new management theory of “human relations” which argued that human beings are social animals who should be understood and treated within the context of the social group. This went against the previous theories of Taylor. Mayo’s theory touches upon the Japanese way of management and group culture.

Consider recruitment of new employees in Japan. This usually takes place at the start of April which is also the start of most Japanese companies’ fiscal year. The typical manager will seek out an individual which he can mold into what the company needs. Very rarely do companies seek out specialists, although this is changing slowly. The main point is that **managers look at an individual’s capacity to learn and be trained.** Managers in Japan look upon college graduates with liberal arts degrees as ignorant, unreliable, and virtually worthless until they are whipped into shape at the company “boot camp.”^[5] This “boot camp” closely emulates the traditional notion of military recruitment. New Japanese company recruits wake up in the morning, perform calisthenics at their desk, work, eat, sleep, even bathe, **together.** The next day they do it over again. In fact a good portion of the large traditional companies in Japan like Mitsubishi, Mitsui, Sumitomo, and Sanwa, may actually require their new recruits to initially stay in company dormitories if they are single, or company apartments if they are married, thus bringing them closer to the corporate family from the start.

What is the implication of this system for managers? It is this sense of belonging to the Company-group, or more importantly, being part of the company family. Once the new recruit is accepted into the company, the company becomes an extension of his family. These ideas of groupism, belonging, and family are fundamentally the strongest elements, not only in Japanese corporate life, but in the psyche of Japan as a country and as a people. Managers realize this strong sense of belonging in their everyday

dealings with their employees. A Japanese manager will not worry that his employees are looking to leave, therefore his actions reflect this knowledge. *This creates a sense of stability within the company.* Employees feel a great sense of belonging to a group and will work together effectively in many areas of the company including the creation and sharing of knowledge for the good of the entire group.

THE KEY: KNOWLEDGE CONVERSION

Western management traditions are rooted in *explicit* knowledge, that is, something clear-cut, formal, systematic. Japanese companies however have a different understanding of knowledge based on the values and beliefs outlined above. They do recognize the importance of explicit knowledge but to them a far more important type of knowledge is *tacit* knowledge. Tacit knowledge is highly personal and difficult to formalize thus making it difficult to communicate and share with others. It includes subjective insights, intuitions, hunches and is rooted in the individual's experience, ideals, and values. See also the table below.

Tacit knowledge is composed of two elements: cognitive and technical. The cognitive element focuses on what is referred to as "mental models" such as paradigms, perspectives, beliefs, and viewpoints. These help individuals to perceive and define the world around them, their image of reality. The technical element is focused on specific skills and know-how.

TACIT (Subjective)	EXPLICIT (Objective)
Knowledge of experience (body)	Knowledge of rationality (mind)
Simultaneous knowledge (here and now)	Sequential knowledge (there and then)
Feel for yourself, do, learn	Review others' work and duplicate

Figure 2: The Two Types of Knowledge

While in the West there has been an almost continuous controversy over which approach towards knowledge and learning is more truthful: rationalism or empiricism, both strong forms of explicit knowledge, Japan emphasizes tacit knowledge but without separating the explicit portion. The theory presented here holds that tacit knowledge and explicit knowledge are not mutually exclusive and the Japanese approach to knowledge creation is based on the specific interaction of these two entities. This interaction is given the term "*knowledge conversion*."

There are 4 Modes of knowledge conversion:

1. **Socialization:** Tacit ➔ Tacit
Socializing is the process of sharing experiences thus creating tacit knowledge. Also Tacit knowledge can be acquired without using language such as when an apprentice observing and imitating a master craftsman. A specific Japanese example is Honda Motors and the "brainstorming camps" it has developed enabling its employees to meet in an informal setting in order to solve difficult problems. Another example is Matsushita Electric (Panasonic) in the past it has required its engineers and designers to actually work with master bakers in Osaka's best hotel so that they can acquire knowledge on how to bake good bread thus incorporating this into an automatic bread-making machine they eventually developed.
2. **Externalization:** Tacit ➔ Explicit
Externalization is the process of articulating tacit knowledge into explicit knowledge. This is typically seen in the process of concept creation and very much integrated into product innovation. Ideas, concepts, images, hypotheses are "hammered-out" into articulated knowledge in various forms such as writing, instructions, diagrams, etc. When this is too

difficult to do directly, i.e., we can not find an adequate expression for an image through analytical methods, externalization can take place thru metaphor and/or analogy. Canon copiers is a good example of this. It analogized a disposable copier cartridge with a beer can thus creating the first disposable aluminum copier cartridge.

3. **Combination:** Explicit ➔ Explicit
Combination is the process of systemizing concepts into a knowledge system. Formal education and training falls under this type of knowledge conversion.
4. **Internalization:** Explicit ➔ Tacit
Internalization is a process of incorporating explicit knowledge into tacit knowledge. It is closely related to “learning by doing.”^[6] For explicit knowledge to become tacit there are two steps involved. The knowledge should first be verbalized or recorded into documents, manuals, etc. (Externalization). We can say that this “standardizes” the knowledge. The next step is for this material to be used by individuals in order to create and expand their personal tacit knowledge (Internalization). If this is done on a wide-basis within an organization, and from the same “standardized” foundation of explicit knowledge, the individual tacit knowledge that is created by the employees becomes part of the organizational culture. Honda and Sony are prime examples of this.

Among the four types of knowledge conversion, *Externalization* holds the key to knowledge creation because it creates new explicit concepts from tacit knowledge. And, it is this type of process which a significant number of Japanese companies utilize based on the socio-cultural origins of their views on knowledge and learning.

Below is a graphical model demonstrating that the optimum drive for organizations, and one which many Japanese organizations follow, is what is referred to as *The Knowledge Spiral Model*. This was originally proposed by Ikujiro Nonaka and Hirotaka Takeuchi in 1995. It essentially identifies that there is a constant change of knowledge from one type to the other and that this is an ongoing process that builds up organizational advantage; this model incorporates all four modes of knowledge conversion.

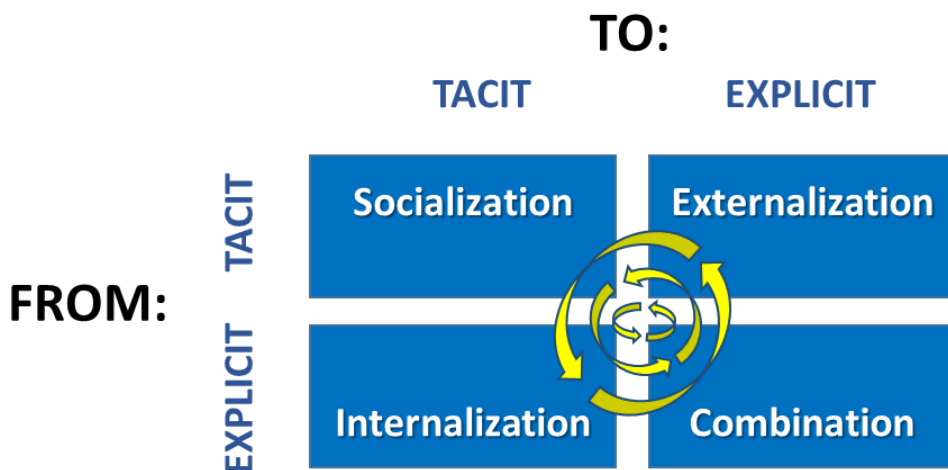


Figure 3: The Knowledge Spiral Model

There are four conditions required at the organizational level to promote this knowledge spiral.

1. **Intention:** The corporate intention and strategic direction, not only must be realized but must be conveyed to all within the organization from executive to entry-level staff. What are the

organizational goals? Are these goals clearly defined and made clear to all employees? What kind of knowledge is required in order to meet these goals? Is the organization capable of creating, accumulating, and exploiting its knowledge?

2. **Autonomy:** Are employees allowed to act autonomously to some extent? Are new ideas encouraged by the organization? Are employees motivated to create new knowledge within the organization?

A powerful tool for creating conditions in which individuals can act autonomously is providing for self-organizing teams. Such teams should be cross-functional, involving members from a broad cross-section of different organization activities. Cross-functional teams are often used in Japanese companies in every phase of innovation. See also the table below.^[7]

Functional Background of Product Development Team Members (2009)								
Company	R&D	Prod.	Sales/ Mark.	Plan.	Service	QC	Other	Total
Fuji Xerox	5	4	1	4	1	1	1	17
Honda	18	6	4	0	1	1	0	30
NEC	5	0	2	2	2	0	0	11
Epson	10	10	8	0	0	0	0	28
Canon	8	3	2	1	0	0	1	15
Mazda	13	6	7	1	1	1	0	29
Matsushita	8	8	1	1	1	1	0	20

Figure 4: Functional Background of Product Development Teams

3. **Fluctuation & Creative Chaos:** Japanese companies utilize this idea of *creative chaos*. This essentially means that, at times, management purposely employs ambiguous visions and intentionally creates flux within the organization as a means of bringing about individual initiative. However, in the opinion of the author this is not practical in certain situations. Creative chaos will work on a company which is doing fairly well and has at least a clear overall vision, one that is communicated to all employees and is fairly homogeneous in its culture. But, if the organization is, for example, a subsidiary (non-homogeneous) where it may not be getting the “*whole corp. picture*” from the parent company, as has been the case with many Japanese subsidiaries in the U.S. throughout the 80s and 90s, then the idea of Fluctuation and Creative Chaos has a very high probability of backfiring and failure in the opinion of this author.
4. **Redundancy:** This refers to information which goes beyond the immediate operational requirements of the members of the organization. Sharing such information in effect expands tacit knowledge because individuals can sense and absorb what others are trying to articulate. A very good way in which Japanese organizations promote redundancy is through strategic job rotation of many personnel within the organization. A young mechanical engineer may be assigned to the Design Group for 3 years, to R&D for the following 5 years, to Planning for the following 3 years and back to Design or Engineering as a manager. This is very typical in many Japanese companies who, as previously mentioned, seek generalists and not so much specialists. The author personally went through this type of strategic job rotation that lasted 5 years and involved job postings both in Japan and the United States. The negative aspect of redundancy in general, (not job rotation) is that employees spend too much time managing information and not enough on actual doing work. But, then again, the goal is to create a mid-level tactical and/or operational manager anyway.

Incorporating the four modes of knowledge conversion along with the four conditions required for promoting the so-called knowledge spiral, we can provide a basic construct or model which serves as the ideal example of the process outlined by the theory. This process model consists of the five phases shown

here. Note that many of the ideas shown above are represented here in this model. These ideas have roots in the socio-cultural aspects of the Japanese, as discussed at the beginning of this paper.

1. Phase 1: Sharing Tacit Knowledge

The first step is to start tapping into individuals' tacit knowledge which is the key source of *new* knowledge for the organization. But since tacit knowledge is mainly acquired thru experience and not easily transferable, *the company has to create opportunities for the sharing of this tacit knowledge on as many level sin the organization as possible*. This sharing needs to be done thru interaction opportunities. A self-organized team is a good way to accomplish this.

2. Phase 2: Creating Concepts

This is the most intensive interaction portion of the process where a shared mental model in the particular field of interest, the self-organizing team then articulates this further into more concrete substantive form in words, phrases, diagrams; eventually it is crystallized into explicit concepts. Thus Tacit ➔ Explicit conversion has occurred. At this phase autonomy of individuals is important. It allows for free-thinking thus enabling faster and more diverse, innovative, and optimal business management solutions.

3. Phase 3: Justifying Concepts

This newly-created explicit knowledge must be justified at some point. This involves evaluation and a determination of the newly-created concepts and ideas are truly worthwhile for the particular organization. Typically cost, profit margin, and degree in which the product can contribute to the company's growth are factors that are considered at this stage. It is very important to note that in a true knowledge creating company, it is the role of the top management to formulate the justification criteria in the form of organizational intentions which are expressed in terms of strategy and vision. If they fail to do this, the project most likely will fail from lack of support.

4. Phase 4: Building an Archetype

Here the justified concept can now be transformed into something tangible like an archetype. This can take the form of a prototype in product development or a new process, system, or operating mechanism. Because this phase is relatively complex, dynamic cooperation among different departments is critical. The self-organized team again is a good way to approach this phase. The key here is trust !

5. Phase 5: Cross-Leveling of Knowledge

Organizational knowledge creation is continuous. New knowledge should be spread and trigger knowledge creation and utilization in affiliated companies, customers, suppliers, and others associated with the organization, thus spread along the value system associated with the initiator company. Innovation in one area can bring about innovation in another. The important point in this function is that each entity such as affiliated company, supplier, customer, etc., needs to possess the autonomy to take the knowledge developed elsewhere and apply it freely across different levels and boundaries in their own organization.

ORGANIZATIONAL STRUCTURE AND KNOWLEDGE CREATION

As with Japanese society in general, Japanese companies are rigidly organized and extremely hierarchical. Although companies promote a sense of equality through equal compensation and wage parity this is true only *within* each specific level of the organization, that is, these concepts are valid horizontally and not vertically. At the top of the organizational structure is the kaicho (chairman), who is followed by the *shacho* (社長, president). In most companies however the vast majority of the actual

work is accomplished by the *kacho* (課長, mid-level department manager). This is important as we will see later.

Leaders in Japan are generalists and their main responsibility is to maintain the morale of their workers, who do the actual work.^[8] Japanese often choose their leaders with personal qualities in mind rather than particular skills, experience or some specific knowledge. Younger employees are closely observed as they come up the ranks. Those selected for promotion are not necessarily the brightest and quickest. They are likely to be the best listeners and above all *the best harmonizers*, the ones who work loyally, steadily and quietly and promote these qualities in others.^[9]

Above all else *wa* (和) or *harmony* is of prime importance to both Japanese society as well as to the Japanese organization. It can be said that *wa* constitutes the essence of Japanese life as a whole. The Japanese try to promote *wa* in all situations of their daily lives. Harmony is the single key for maintaining face. Japanese managers concentrate their efforts on motivating all workers, whatever their background and ways of thinking, to work harmoniously together. Japanese managers see themselves as humanists with utmost concern for human beings. However, Japanese humanism is different from Western humanism. In the West individual personalities are the focus of humanistic philosophy and personal liberties are of prime concern. On the other hand, *Japanese humanism is not concerned with the individual but rather with relationships between individuals and groups*. Japanese strive to develop a self that is in harmony with the surroundings while in the West the exact opposite occurs - Westerners strive to express a unique personal character that sets them apart individually.

We have seen that harmony and relationships are very important. One method promoting these is *Ringi seido* (稟議制度) a commonly-used formal procedure of management by group consensus. A *ringisho* is a proposal that originates in one section, and is forwarded to all relevant sections on the same level, the section heads, the managers, the directors and the president of the company.^[10] Upon receiving the *ringisho*, each individual reviews the proposal, makes comments and affixes his personal seal to it. He/she then passes it on to the next individual. If there is significant opposition to the proposal as it stands, it will be revised and the process will be repeated once again. The ultimate purpose of this system is to eliminate dissension and get general agreement on a proposal.

This system provides for greater participation in the decision-making process within the Japanese company. Essentially any decision adopted through this method has already been agreed upon by the time it is set to be formalized. An added benefit of this system is the fact that many individuals throughout the company gain a wide-range of information and valuable knowledge on certain particular important aspects and decisions of the corporation; thus better, more informed decisions can be made leading to greater innovation; and a spreading of knowledge within the company takes place.

In Japanese corporations, middle managers are at the very center of knowledge management. Although Japanese companies are very structured and hierarchical, much weight and decision-making takes place at the mid-management level. This is unlike the West which has adopted primarily a Top-Down approach or more recently a Bottom-Up approach with empowerment and other similar programs that companies are introducing.

The Top-Down approach is the quintessential hierarchical model. In terms of knowledge creation, this occurs within an information-processing approach. Basic information is filtered upward to the top management who then use this to create plans and orders which are then passed down the pyramid to those assigned to carry them out. Top management concepts become the operational conditions for middle managers who must decide how to make them happen. The middle managers then make the operational plans for the “*front-line*” employees who must implement them. The Top-Down approach is well-suited for dealing with explicit knowledge; but, in controlling knowledge creation from the top it neglects the development of tacit knowledge that occurs on these corporate front-lines across so many

functional departments. In this model, middle managers process much information but, they do not have a key role in *creating* information. This approach is more information processing (flow) instead of knowledge creation and management.

The Bottom-Up approach is centered on autonomy which, as we discussed, is something that enhances tacit knowledge. Top management serves as sponsor of entrepreneurially-minded front-line employees. But, a negative aspect of this model is that more autonomy and less interaction takes place within the organization; a kind of “*every person for themselves*” mentality forms. Thus knowledge is created individually and not necessarily optimized by interaction, and in many cases not shared or disseminated within the company as it should be.

In both Top-Down and Bottom-Up knowledge conversion is not optimized but limited. The theory we are presenting here suggests a third approach which many Japanese companies have adopted. It is an approach with focus at the *middle* (the *Middle Core Model*). It is the middle managers which create knowledge and generate a “*double knowledge spiral*” involving both top management and front-line employees. These middle managers are usually the leaders of development teams, self-organized task forces, and other such groups. Thus they are at the very center of knowledge management, positioned at the intersection of both vertical and horizontal flows of information. These managers are the knot that binds top management with front-line or the bridge between visionary ideals formed at the top and the often chaotic reality which exists at the bottom front-lines. These middle managers are the true “*knowledge engineers*” in Japanese corporations.

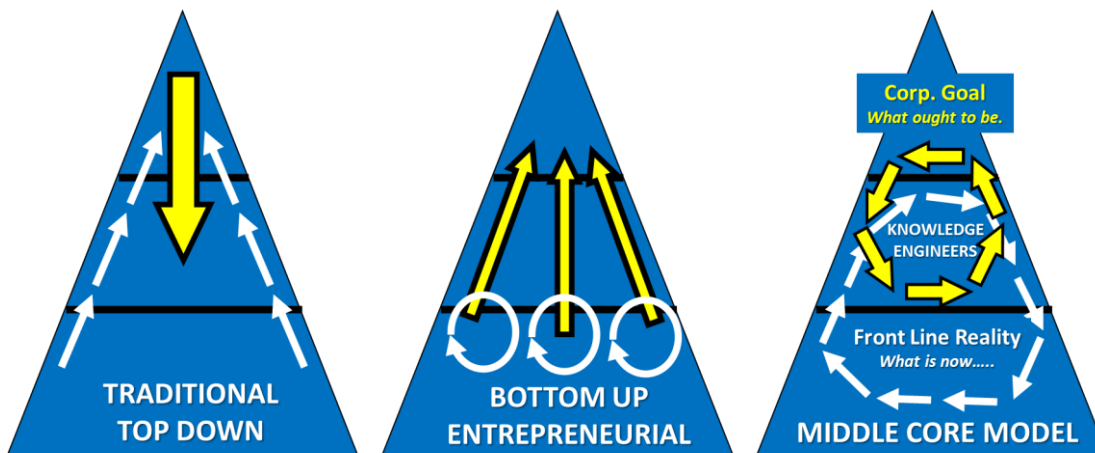


Figure 5: Three Hierarchical Models of Knowledge Creation

This concept is completely opposite of the West which sees middle managers as unnecessary and there have been massive layoffs of these individuals in the 1980s, again in the aftermath of the .com bubble, and finally after the 2007-2008 Economic Crisis and more recently with the COVID19 pandemic. The theory we present in this paper, and which was first conceptualized by Nonaka and Takeuchi contends that in Japanese companies these individuals play a more dynamic and important role in the organization. Of course this idea must be analyzed further and considered within the context of the economic problems that Japan has gone thru in the almost two “lost decades” but its resilience, we feel based on this approach to knowledge and innovation, has maintained the country in its relatively strong position as the third largest economy in the world.

CONCLUSION

This paper presented certain differences between Western and Japanese knowledge creation and management within organizational learning. Interaction between tacit and explicit knowledge in the West

tends to take place mainly at the individual level and concepts tend to be created through externalization efforts of top leaders. In Japan, on the other hand, the interaction of tacit and explicit knowledge tends to take place at the group level. The danger with this, if taken too far, is the tendency to develop so-called “*group-think*.”^[11]

The Japanese approach, because of deep-rooted socio-cultural factors, emphasizes the tacit side of knowledge and the conversions associated with creating explicit knowledge from tacit knowledge. The overall theory depends on what is referred to as the knowledge spiral in which there is a constant conversion from one type of knowledge to the other. We mentioned the four conditions required at the organizational level in order to promote the knowledge spiral mentioned.

In conclusion, the theory presents five guidelines in utilizing this approach in an organization:

1. Create a knowledge vision, not only a vision based on products, services and financials.
2. Develop a knowledge crew with diversity which can nurture insight and intuition in a wide area, thus enabling better chances for innovation.
3. Build a high-density field of interaction at the front-lines. This should be a place where a rich source of original experience can be gained through dialog.
4. Adopt a Middle-Up-Down management approach.

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Rapid Inventory Replenishment in Healthcare Related Disasters

ABSTRACT:

Healthcare-related disasters, such as pandemic emergence of a new virus into a population with no pre-existing immunity, could lead to massive loss of life due to lack of inventory replenishment. Given the importance of such a topic, there should be an abundance of literature and practical tools to help governments, organizations and individuals to improve their abilities to respond. This research identifies a gap in literature in regards to optimal ordering quantities of perishable biopharmaceuticals. Furthermore, it collects data from various medical, government and non-government organizations to identify tools to better manage critical inventory during limited, emergency periods. Next, the research results provide a more useful model that can be applied by practitioners faced with limited time, resources and inventories to better handle emergency situations. Existing models were adapted to provide an alternative to optimization solutions due to the likely time sensitive nature of the problem. The newsvendor and traveling salesman models have been applied extensively and extended to model a variety of inventory and capacity decision making problems. These models have been further adopted to include perishable products supply chains. Finally, the article identifies a way forward for researchers and practitioners to prepare to apply this tool before a catastrophic event occurs.

Stock Price Prediction of Major Pharmaceutical Companies using Transfer Learning

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Abstract

Transfer Learning (TL) is well known to have good potential in computer vision and other domains. TL has been used in previous studies to perform stock price prediction using related stocks. However, relatedness is not well defined and hence there was a research gap. This work explored the research question – would TL work well using training on larger aggregated stock price indices and applying such pre-trained models to a particular sector like, stock prices of pharmaceutical companies? We based our training on our earlier model built using 64 years of S&P 500 stock index price data. Our base learners were primary methods like Support Vector Regression and Decision Tree Regression, and ensemble methods like Gradient Boosted Regression (GBR), AdaBoost Regression, LightGBM, Random Forest and Stacked Generalization (SG). In this study, top 20 pharmaceutical companies were selected based on 2021 revenues. Data for about 30 years for these pharma companies was used for prediction. We evaluated the prediction for one day, five days and ten days to ensure the accuracy of the results. Ensemble models performed the best, particularly, GBR. The high level of accuracy indicates that transfer learning may hold good potential in this domain, especially due to its versatility in the size of the training data set.

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Keywords: Ensemble; machine learning; deep learning; prediction; stock; neural network; artificial intelligence; pharmaceutical; transfer learning

1. Introduction

Investment and trading in stocks is a vital part of financial investment. Hence, prediction of the stock market is an interesting topic to investors, speculators, financial institutions such as banks and investment companies across the world. Financial time series forecast has been attempted by several studies and Deep Neural Networks (DNN) have recently been used for such tasks. DNN generally requires a large amount of data whereas limited data points are available in case of some cases, such as new stocks. One of the approaches is to use stock prices of related stocks and use transfer learning (Nguyen. et al. 2019). But defining “relatedness” is prone to be arbitrary. This study tries to generalize the transfer learning approach using well-known aggregate indices, instead of arbitrary related stocks for transfer learning.

Our Transfer Learning works on the premise that the neural network may “learn” the price movement from the aggregate S&P indices and this knowledge in the form of existing model (trained on a large quantum of data from the earlier study) is applied to a related problem. Feature extraction is the key in transfer learning to get the features from the base model built on original data. However, with external sources such as social media platforms, news, etc., influencing the stock prices, stock prediction models must become more efficient to be capable of feature extraction (Li, 2018). While the base model contains multiple layers, one or two of the top layers are chopped or frozen and retrained with additional layers to successfully achieve the feature extraction process. However, TL has constraints, like if the target is in a different domain space compared to the source domain space, then transfer learning will not be effective (Yosinski et al., 2014). Also, TL is the only way to

analyze and predict especially in some specialized domains/fields such as bioinformatics, robotics etc., where data acquisition is expensive and difficult to construct and compile.

The objective of this paper is to perform TL through application of pre-trained models for aggregated stock index like S&P 500 and to fine-tune the learning to pharmaceutical companies in order to predict the future prices. Our hypothesis is that transfer learning works well and should be able to provide reasonably good results. We used the pre-trained models created from our earlier study “Ensembles for stock index price prediction” (Chakrabarty et al., 2022.)

2. Background

The field of Data Mining and Machine Learning has been widely and successfully used in many applications where patterns from past information (training data) can be extracted to predict future outcomes (Witten and Frank, 2011). Neural Networks, part of Machine Learning, have been used for prediction problems in time series arena. Several studies have attempted financial time series predictions. Specifically, most early studies tended to employ statistical methods, such as the weighted moving average (WMA) (Ziegel, 2002), the generalized autoregressive conditional heteroskedasticity (GARCH) model (Gabriel, 2012), and the autoregressive integrated moving average (ARIMA) (Ariyo, et al., 2014). However, these approaches made many statistical assumptions, such as linearity and normality of the model, whereas the financial time series is non-linear. Hence, these methods are ineffective for stock price forecasting. Apart from the statistical models, machine learning techniques have been extensively applied to financial time series prediction tasks due to their capability in nonlinear mapping and generalization (Guresan et al., 2011; Persio and Honchar, 2016; Adebiyi, et al., 2014; Kara et al., 2011).

TL was conceptualized originally by Bozinovski Stevo, and Ante Fulgosi in 1976 (Stevo et al., 1976) in which they had presented the idea that when data is not readily available, the idea of TL could be used in lieu of Neural Networks. As an example, speech recognition network trained only on American-English speakers, was applied to speakers of British accent. TL becomes a natural choice that we look at ways to reuse results from networks already trained for similar problems rather than “reinventing the wheel” every time. The knowledge encoded as weights is transferred from one Neural Network solving speech recognition task, for example, to another for speeding it up on another task such as medical diagnosis (Pratt et al.1, 1991).

Transfer learning becomes relevant and necessary with situations of scarce training data. Some relevant examples are situations where the data is rare, data is expensive to collect and/or label or data is not accessible. With big data repositories becoming more prevalent, transfer learning solutions are becoming an attractive approach for similar problems (Weiss et al., 2016; Day & Khoshgoftaar, 2017).

Previous studies have applied Transfer Learning to related stocks. Relatedness is arbitrary and hence our study focusses on generalizing the Transfer Learning approach using the S&P index-based study as base model and not the arbitrarily related stocks. In addition to this, no study in the past has attempted the application of transfer learning to evaluate the performance of stocks of pharmaceutical companies and hence our study is aimed to take care of these two aspects.

Transfer learning is an optimization technique that can help gain better performance or result in time savings. It can be used in situations where the model developed for one situation can be easily adapted to another related one. Some examples are as shown below:

- A model trained to enable automated car driving can be applied to automated truck driving
- Image recognition is one application area where a model trained to identify dogs can be improved for identifying human beings as an example
- In areas related to Natural Language processing, transfer learning could be especially useful. As an example, a model that knows structures in a language could be especially useful in auto-prediction algorithms:
 - A model developed for speech recognition in one language could be applied to another language
 - A model trained to read MRI scans can be applied as the foundation to read CT scans
 - A model trained for email categorization can be applied as the base for filtering spam from the rest.

Some of the possible applications of transfer learning could signify one of the three benefits as described by Lisa Torrey and Jude Shavlik (Torrey and Shavlik, 2010)

- The starting point of the skill on the source model is higher than what it would have been otherwise.
- The skill improvement rate while training the source model is steeper than what it would have been otherwise.
- The converged skill of the trained model is better than what it would have been otherwise.

3. Methods Used

In this study we used the pre-trained models from the study, “Ensembles for stock index price prediction” (Chakrabarty et. al, 2022), to analyze stock prices of 20 pharmaceutical companies. The models, both base learners and Ensembles are explained below.

3.1. Methods for Base Learners

3.1.1. Decision Tree Regression (DTR)

Generally used for data mining, the decision tree model has nodes and branches with splitting, pruning, and stopping as the primary building blocks (Song et al., 2015). The decision tree comprises of the root node, internal nodes, and the leaf nodes with a hierarchy of branches representative of the probabilities/outcomes at each node. In a decision tree, the model will decide based on the conditions. This is a better fitting model to use rather than linear sums of regression sums (LSRL) because it can handle the curves of the data if needed. To avoid overfitting in this model, the stopping rules are important decide when to stop splitting the branches of the tree. The time-series tree also has a time sequence comprised in the data, an attribute in its internal road. (Yamada et al., 2003)

3.1.2. Long Short-Term Memory (LSTM)

Long Short-Term Memory (LSTM) signifies artificial recurrent neural networks wherein apart from feed-forward, feed-backward neural networks are used (Adil et al., 2020). LSTM, with its longer memory capability is suitable for learning from datasets with longer time gaps.

3.1.3. Support Vector Regressor (SVR)

Support Vector machine algorithm (also called as Maximum margin classifier) helps generate high accuracy. It is simple as it does not use a lot of computation power. The goal of SVM is to draw a hyperplane to classify

samples into distinct sets. The optimal hyperplane would have maximum margin between itself and the datapoints on either side, so the chance of outliers is less. Support vectors are the samples lying closest to the hyperplane with samples plotted on a two-dimensional graph. For Support Vector Machine, it is only the support vectors that define the final decision boundary, and the movement of the other vectors/samples has zero impact (Ye et al., 2018). Future trend has been predicted using the Support Vector Regression by applying the SVM method to time series data.

3.1.4. *Transformer Model*

Leveraging the powerful GPUs and TPUs for optimal performance, the transformer model by parallelization of the activities can both remember and process longer sequential data. This concept was developed with the paper on the concept “Attention is all you need” (Vaswani, Shazeer, & Parmar)

3.2 *Ensembles*

3.2.1 *Boosting:*

3.2.1.1 *AdaBoost*

AdaBoost is based upon the “weak learners” in the classification, regression forest was used along with the AdaBoost model so these are the stumps, or one node with two leaves. But unlike the random forest regression model, AdaBoost considers the weights of each of the two stumps, and the mistakes of the previous stumps when making more stumps. (Freund et al. 1996)

3.2.1.2 *LightGBM*

Light Gradient Boosting Machine is Microsoft’s version of a faster gradient modelling system, and it is more efficient than other boosting methods because it “splits” and “merges” the parameters to create a decision tree. Therefore, it can be more efficient than the Gradient Boosting, or AdaBoost because it is able to create and check the decision trees faster (Ke et Al., 2017).

3.2.2 *Stacked Generalization*

Stacking or Stacked Generalization is an ensemble method that takes the data and splits it into many folds and then feeds it into the basic classifiers. Then using the results of those classifiers, it combines it with the other folds of the same classifier. Then, it runs a logistical regression to give us the output. (Rokach, 2010).

3.2.3 *Gradient Boosting Regression (GBR)*

Gradient Boosting Regression (GBR) is very similar to AdaBoost. However, instead of creating a stump, it creates a single leaf and using that leaf it creates multiple trees. All these trees are bigger than the stumps and are made by factoring in the error and made multiple times until it makes enough trees to have no more significant difference in the outputs. (Hastie et al., 2009)

3.2.4 *Random Forests (RF)*

Random forests (RF) are just a more flexible version of the decision trees, because Decision Trees are not flexible for other groups of similar data. This was discovered by Ho in his article, where he states that many decision trees must be made to accurately get the outcome. (Ho, 1995).

3.3 Transfer Learning

Transfer Learning could be categorized into two categories based on feature spaces which are homogenous and heterogenous TL. Homogenous Transfer Learning signifies all of the following are common or similar or equal for both target and source spaces: attributes ($X_T = X_S$), labels ($Y_T = Y_S$), and same dimensions of space ($d_T = d_S$) whereas Heterogenous Transfer Learning signifies exactly the opposite situation wherein both the target and source spaces doesn't have anything in common and nothing overlaps which means $X_T \neq X_S$, $Y_T \neq Y_S$, and $d_T \neq d_S$. Various strategies could be implemented for both Homogenous TL and Heterogenous TL. The focus of the heterogenous transfer learning majorly is to align both the source and target domain assuming they are same (Weiss et al, 2016). In this study, we have used the Homogenous Transfer Learning as our source and target spaces are alike.

What is the need to use transfer learning even though we have expansive datasets due to the internet and widespread data storage? Well, even with the large datasets, some of the pharma companies mentioned in this study have only recently gone public. With TL, we already have a model from our original study and hence evaluation is possible for all the companies including the ones which have very minimal data. If we did not run the TL, then we would have used the Statistical tools such as ARMA, ARIMA which have multiple assumptions and cannot get such impressive results.

3.4. Metrics

Our performance metric is the mean squared error. The formula for this error is provided below. In the formula the Y_i is the test value, while \hat{y}_i is the estimated value. This is done with the sum of all the data in each of the company's model. The 'n' describes the number of data points in the training and validation phases and the 'q' is the number of data points in the testing phase.

$$\mathbf{MSE} = \frac{1}{q} \sum_{i=n+1}^{n+q} (Y_i - \hat{y}_i)^2$$

Formula 1: Mean Squared Error (MSE) formula

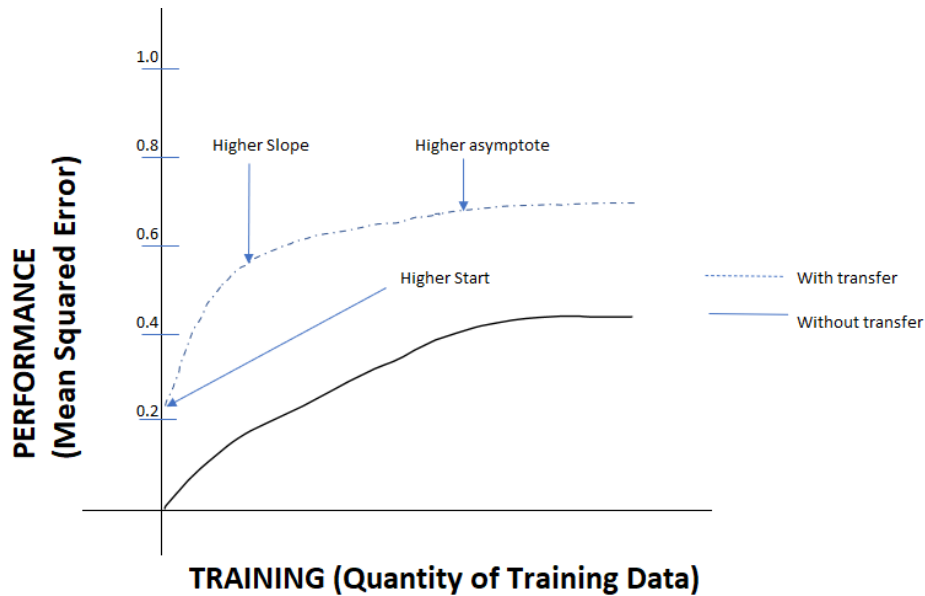


Figure 1: Transfer Learning Training Differences

Figure 1 represents the performance of a program with or without transfer learning. As shown in the picture above, the continuous line at the bottom represents the performance of a model built on original data without Transfer Learning which begins with no knowledge and reaches its full potential through training whereas the dotted line above represents learning with Transfer Learning where we start off with some knowledge and reach a better potential (of knowledge) shown by higher slope. This shows that the performance is better with transfer learning. The performance is measured by the MSE, and there is a visible MSE increase with transfer learning than without TL.

3.5 Data

Top twenty pharmaceutical companies in the world based on 2021 revenue numbers were considered for this study (<https://www.fiercepharma.com/special-reports/top-20-pharma-companies-2021-revenue>). Closing Stock prices for these companies from 05/06/1992 to 05/05/2022 were downloaded (<https://finance.yahoo.com/quote/YHOO/history?ltr=1>).

For some companies, data was available for less than 30 years. The following companies had a complete 30 years of data: Johnson & Johnson (JNJ), Pfizer Inc (PFE), Merck & Co (MRK), Bristol-Myers Squibb Co (BMY), GlaxoSmithKline (GSK), Eli Lilly and Co (LLY), Gilead Sciences (GILD), Amgen (AMGN), Abbott Laboratories (ABT), Novo Nordisk (NVO), Virtus Investment Partners Inc (VTRS).

The following companies did not have a complete 30 years of data with varying years: Roche Holdings AG Basel ADR Common Stock (RHHBY), 11.30 years; AbbVie Inc (ABBV), 20.67 years; Novartis AG (NVS), 4.51 years; Sanofi (SNY), 10.16 years; AstraZeneca (AZN), 1.02 years; Takeda Pharmaceutical Co Ltd (TAK), 17.68 years; Bayer AG (BAYRY), 4.54 years; BioNTech SE (BNTX), 27.45 years; Moderna Inc (MRNA), 26.61 years.

4. Results and Discussion

4.1 One day prediction

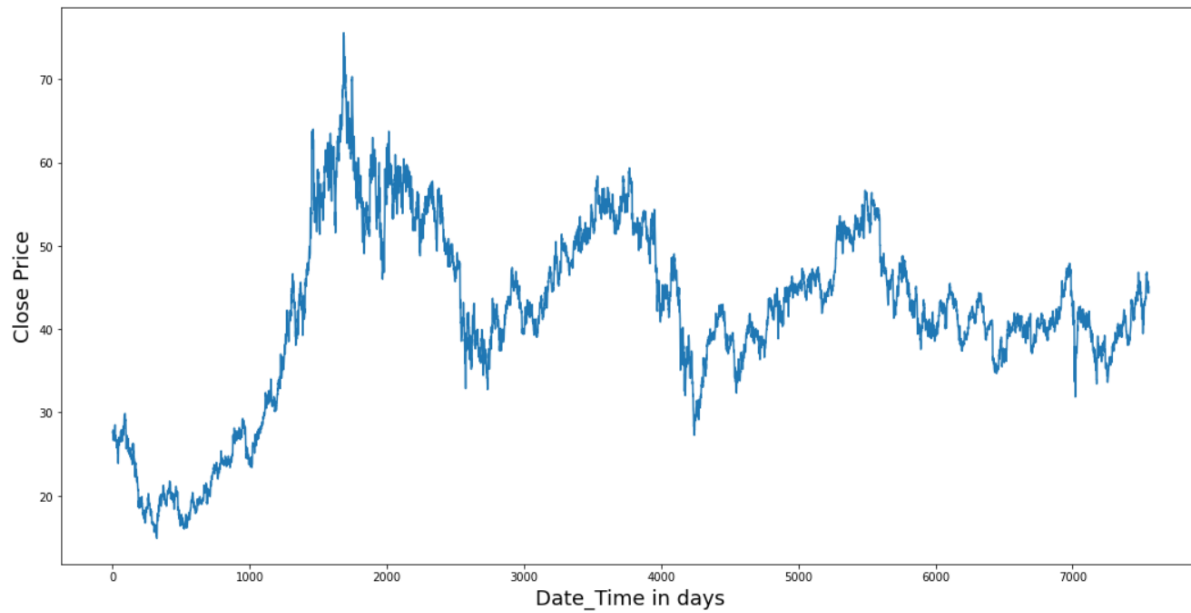


Figure 2: Daily stock price data of Glaxo Smithkline (GSK) for 30 years

Figure 2 represents the daily close stock prices of one of the companies, Glaxo Smithkline (GSK), for the last 30 years. There seems to be some peaks and troughs due to market scenarios. With Time Series data, we made sure we are not shuffling the data as it could cause issues with sequences. We split the data into training, validation, and testing data same as shown in Figure 3.

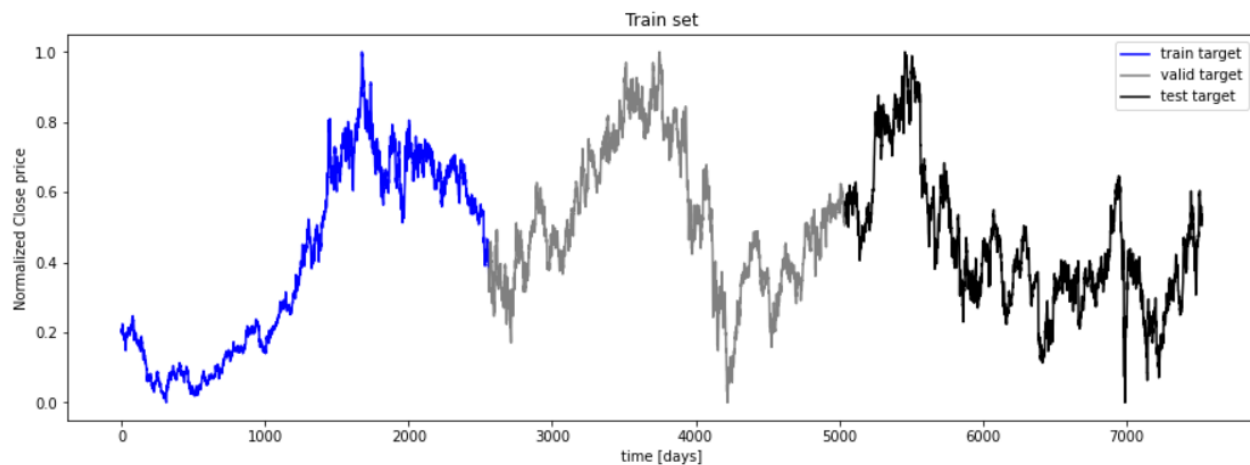


Figure 3: Data split of Glaxo Smithkline (GSK)

Figure 3 presents the normalized version of Figure 2, which has been split into training, testing, and validation. Normalization presents a more realistic data set by maximizing the local extrema.

In Figure 4, showing the mean square error for all the 20 companies using the eight models loaded using transfer learning, we observe that the Gradient Boosted Regression performed well along with Stacked Generalization relative to the other models.

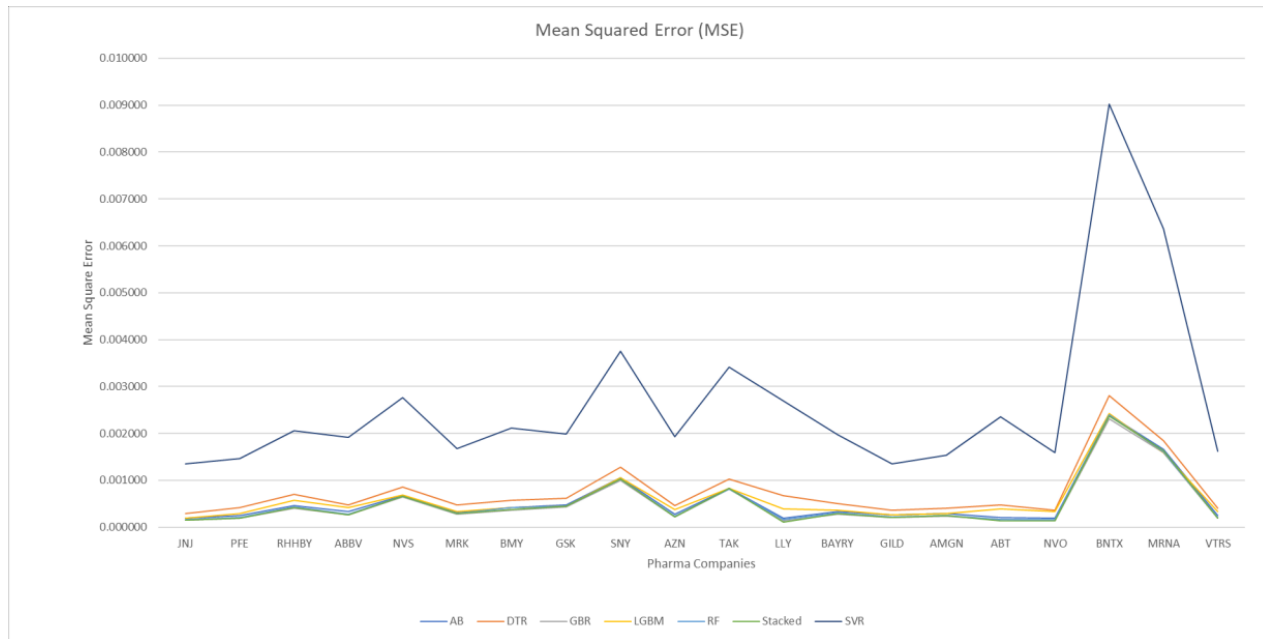


Figure 4: Mean Square Error (MSE)

Table 1: Mean Square Error (MSE)

Company Tickers / Models	AB	DTR	GBR	LGBM	RF	Stacked	SVR
JNJ	0.000193	0.000298	0.000152	0.000195	0.000170	0.000156	0.001347
PFE	0.000251	0.000412	0.000189	0.000294	0.000205	0.000191	0.001465
RHHBY	0.000466	0.000699	0.000411	0.000570	0.000435	0.000425	0.002064
ABBV	0.000335	0.000472	0.000262	0.000420	0.000273	0.000260	0.001911
NVS	0.000674	0.000852	0.000638	0.000685	0.000659	0.000660	0.002770
MRK	0.000326	0.000475	0.000279	0.000328	0.000291	0.000293	0.001675
BMJ	0.000414	0.000578	0.000366	0.000415	0.000415	0.000378	0.002113
GSK	0.000475	0.000614	0.000432	0.000452	0.000449	0.000446	0.001982
SNY	0.001057	0.001286	0.001002	0.001054	0.001024	0.001031	0.003750
AZN	0.000282	0.000463	0.000220	0.000380	0.000235	0.000214	0.001936
TAK	0.000830	0.001028	0.000816	0.000828	0.000814	0.000830	0.003416
LLY	0.000194	0.000673	0.000132	0.000395	0.000161	0.000111	0.002688
BAYRY	0.000335	0.000505	0.000274	0.000357	0.000300	0.000289	0.001967
GILD	0.000260	0.000368	0.000209	0.000262	0.000218	0.000211	0.001350
AMGN	0.000287	0.000409	0.000231	0.000286	0.000245	0.000242	0.001533
ABT	0.000211	0.000478	0.000159	0.000390	0.000166	0.000134	0.002353
NVO	0.000193	0.000369	0.000137	0.000332	0.000164	0.000140	0.001585
BNTX	0.002399	0.002813	0.002314	0.002421	0.002397	0.002365	0.009030
MRNA	0.001657	0.001852	0.001590	0.001598	0.001600	0.001629	0.006361
VTRS	0.000246	0.000401	0.000190	0.000335	0.000210	0.000189	0.001620

Table 1 shows the MSE table for each of the transfer learning models for each of the 20 companies. Based on the metrics and the graph, we can learn that the Gradient Boosted Regression (GBR) performed the best. Stacked Regression performs comparably well and shows almost equivalent MSE and stands as the next best performer. Hence, we can state that Gradient boosted Regression, and Stacked Generalization are predicting the future stock prices for all the 20 the major pharma companies (in this study) using the transfer learning process. Detrending has been applied initially to exclude the extrema (peaks and troughs).

4.2 Five-day prediction

Apart from testing the model for one-day future prediction, we wanted to test the model for multiday predictions, in pursuit of this goal, we started the five-day prediction.

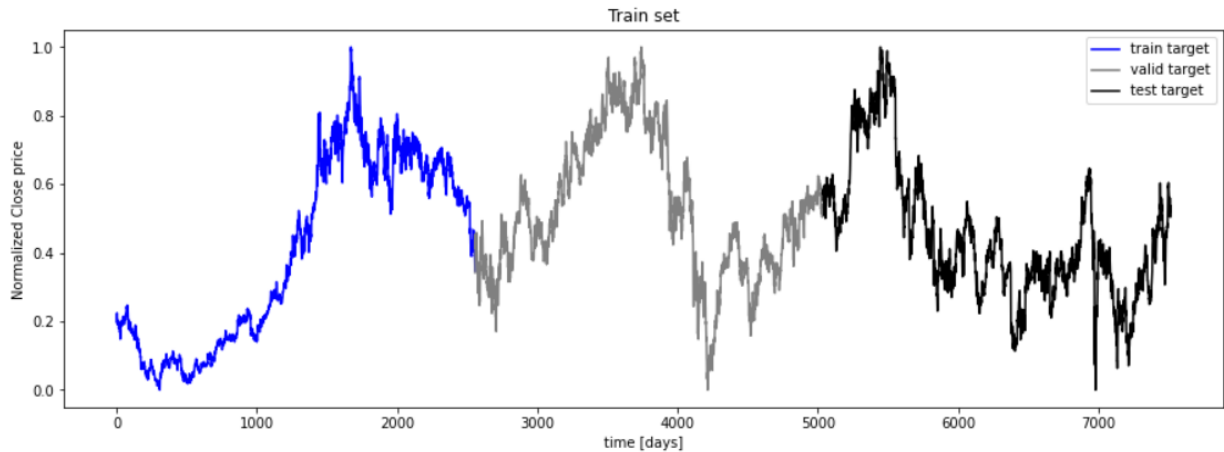


Figure 5: Data split for 5 day prediction

Figure 5 shows the data split for GSK, it has been split into training, validation, and test. In Figure 6, we show the mean squared error for all the 20 companies with the models used in transfer learning. We observe that Gradient Boosted Regression did really well with the lowest MSE scores. But, we notice that the fearsome peaks that were present only for one of the base models in the one day predictions are no longer prevalent, and in the 5-day prediction the troughs and crests flow with each other with the peaks being reached by all models. Similarities between the models depict less change between the models as the multiday predictions occur.

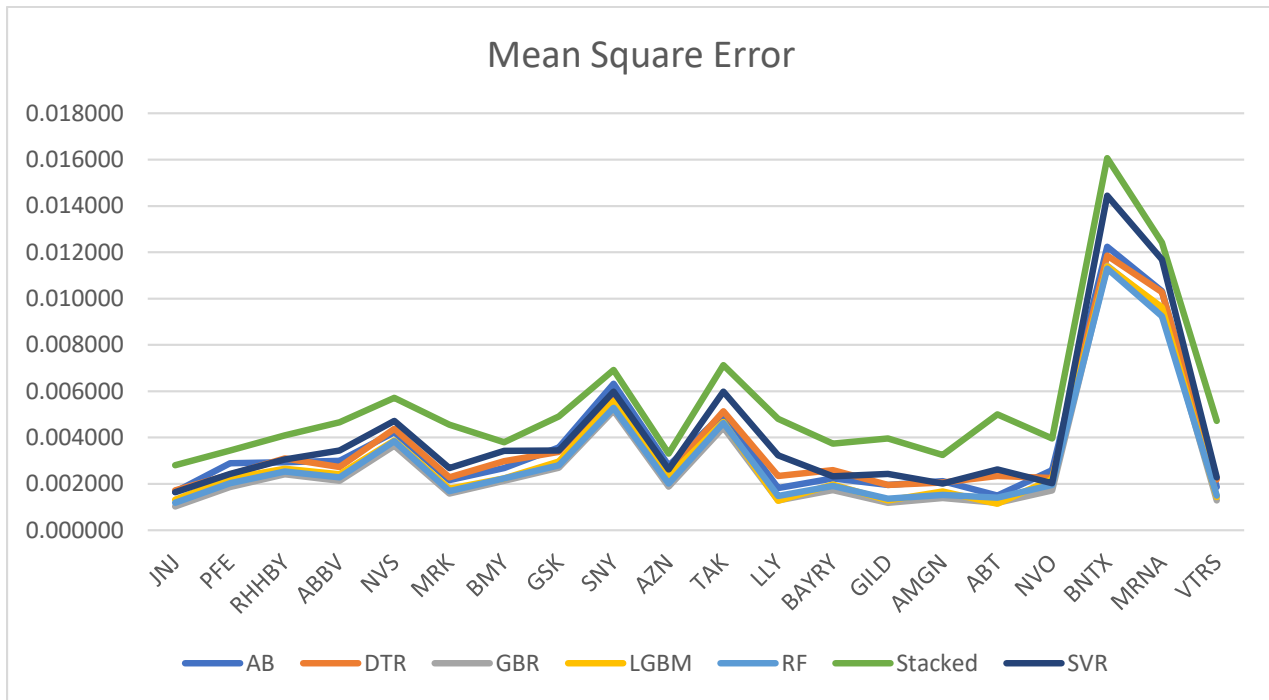


Figure 6: Mean Squared Error (MSE for 5-day prediction)

Figure 6 represents the pre-processing data of GSK for five-day prediction. It is important that training, validation, and testing data remain separate.

Table 2: Mean Square Error (MSE for 5-day prediction models)

Company Tickers / Models	AB	DTR	GBR	LGBM	RF	Stacked	SVR
JNJ	0.001666	0.001721	0.001028	0.001321	0.001188	0.002808	0.001642
PFE	0.002891	0.002399	0.001864	0.002236	0.002028	0.003444	0.002432
RHHBY	0.002941	0.003094	0.002411	0.002655	0.002542	0.004090	0.003061
ABBV	0.003001	0.002731	0.002142	0.002421	0.002280	0.004658	0.003438
NVS	0.004237	0.004372	0.003645	0.003870	0.003838	0.005713	0.004719
MRK	0.002172	0.002287	0.001579	0.001800	0.001689	0.004562	0.002688
BMJ	0.002690	0.002989	0.002135	0.002243	0.002241	0.003793	0.003428
GSK	0.003575	0.003378	0.002698	0.002968	0.002808	0.004908	0.003446
SNY	0.006331	0.005883	0.005163	0.005568	0.005282	0.006920	0.005988
AZN	0.002784	0.002459	0.001885	0.002337	0.002014	0.003302	0.002623
TAK	0.005028	0.005139	0.004432	0.004676	0.004625	0.007129	0.005986
LLY	0.001829	0.002347	0.001294	0.001278	0.001478	0.004811	0.003230
BAYRY	0.002235	0.002599	0.001740	0.001969	0.001919	0.003745	0.002326
GILD	0.001958	0.001955	0.001188	0.001291	0.001363	0.003969	0.002430
AMGN	0.002113	0.002065	0.001386	0.001681	0.001522	0.003244	0.002023
ABT	0.001498	0.002348	0.001178	0.001143	0.001409	0.005009	0.002619
NVO	0.002597	0.002261	0.001725	0.002206	0.001954	0.003958	0.002032
BNTX	0.012238	0.011855	0.011418	0.011389	0.011295	0.016063	0.014444
MRNA	0.010320	0.010279	0.009533	0.009622	0.009237	0.012422	0.011682
VTRS	0.001864	0.002197	0.001288	0.001433	0.001491	0.004715	0.002282

Table 2 shows the MSE table for each of the transfer learning models for each of the 20 companies. Based on the metrics of the table and the graphs, we learn that GBR performed the best, as they can fit all the data models the best, this is represented by low MSE metric. Stacked Model has the highest among the MSE for the five-day. But the next best performer here was Random Forest (RF) a difference from the one-day predictions, so that means that along with GBR, RF's performance was commendable.

4.3 Ten-day Prediction

Aside from the 5-day prediction, we extended to the 10-day future prediction.

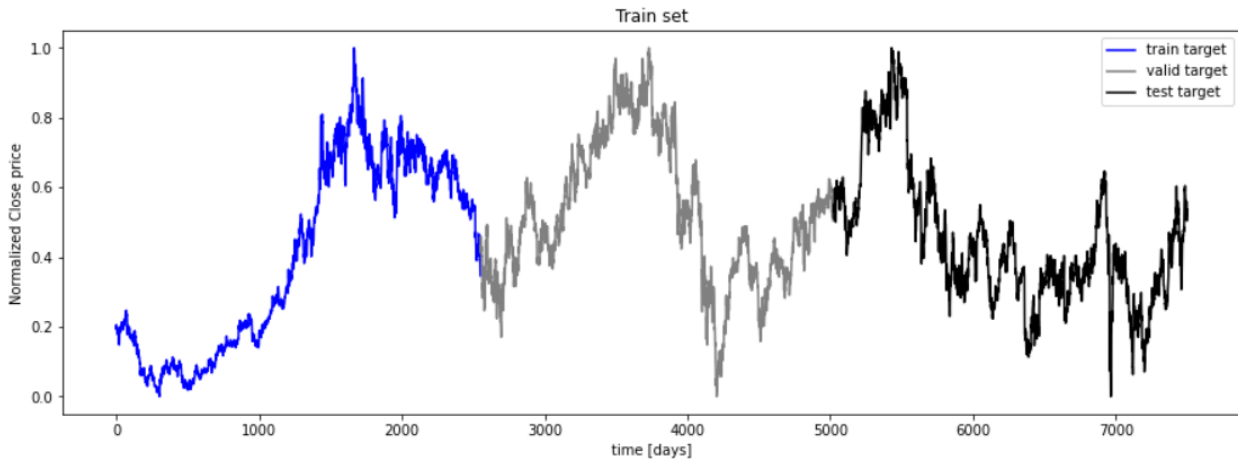


Figure 7: Data Split for 10-day prediction

Figure 7 shows the data split for GSK into distinct train, validation, and testing, for the 10-day prediction.

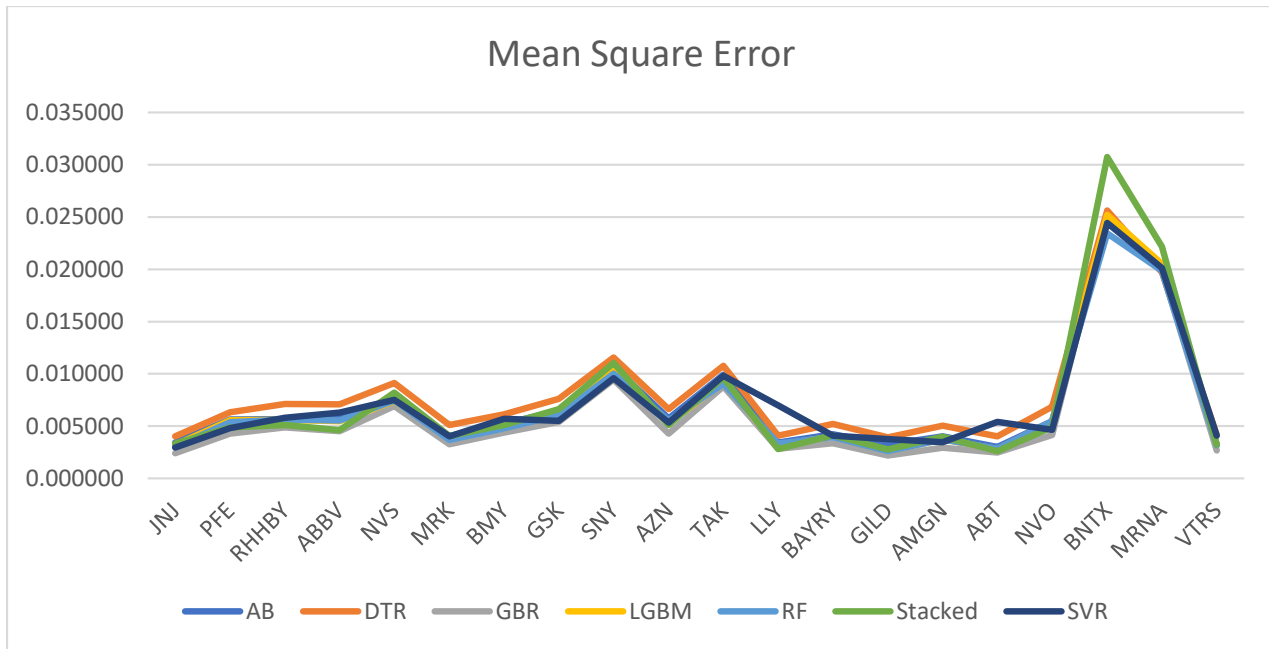


Figure 8: Mean Squared Error (MSE for 10-day prediction)

Figure 8 represents the mean square error for all the 20 companies with the models used in transfer learning, and we can observe that Gradient Boosted Regression did well with the lowest MSE scores. Even unusual from the earlier models is that DTR or Decision Tree Regression’s MSE are the highest rather than Stacked model,

noticed in 5-day prediction. After GBR the next best model turned out to be Stacked, quite similar to one day prediction model. This metric is also visible in Table 3, where the MSE of these models (GBR and Stacked) were lower than the other competitors.

Table 3: Mean Square Error (MSE for 10-day prediction)

Company Tickers / Models	AB	DTR	GBR	LGBM	RF	Stacked	SVR
JNJ	0.003426	0.004019	0.002402	0.003182	0.003041	0.003324	0.002948
PFE	0.005621	0.006324	0.004274	0.005584	0.005361	0.004863	0.004818
RHHBY	0.005658	0.007103	0.004860	0.005588	0.005642	0.005108	0.005801
ABBV	0.005829	0.007067	0.004514	0.005460	0.005520	0.004598	0.006294
NVS	0.007649	0.009140	0.006916	0.007380	0.007458	0.008191	0.007509
MRK	0.003839	0.005109	0.003247	0.003949	0.003675	0.004054	0.004036
BMJ	0.005251	0.006132	0.004394	0.004786	0.004790	0.005091	0.005696
GSK	0.006450	0.007602	0.005410	0.006258	0.006064	0.006622	0.005517
SNY	0.010709	0.011546	0.009459	0.010327	0.010012	0.011021	0.009596
AZN	0.005747	0.006636	0.004300	0.005306	0.005538	0.005114	0.005336
TAK	0.009924	0.010770	0.008806	0.009171	0.009050	0.009653	0.009813
LLY	0.003430	0.004078	0.002827	0.003166	0.003330	0.002786	0.006993
BAYRY	0.004218	0.005204	0.003363	0.004023	0.003957	0.004116	0.004086
GILD	0.003224	0.003925	0.002190	0.002632	0.002607	0.002774	0.003773
AMGN	0.004020	0.005027	0.002943	0.003708	0.003730	0.004002	0.003475
ABT	0.003002	0.004033	0.002476	0.002801	0.002850	0.002595	0.005390
NVO	0.005482	0.006856	0.004150	0.005422	0.005463	0.004904	0.004638
BNTX	0.025297	0.025625	0.025119	0.025206	0.023437	0.030739	0.024431
MRNA	0.019947	0.019694	0.019883	0.020526	0.019844	0.022154	0.020106
VTRS	0.003246	0.004144	0.002674	0.003211	0.003163	0.003222	0.004086

Prediction:

Predictions (Figure 9 and Figure 10) also show that Gradient Boosted Regression and Stacked performed well.

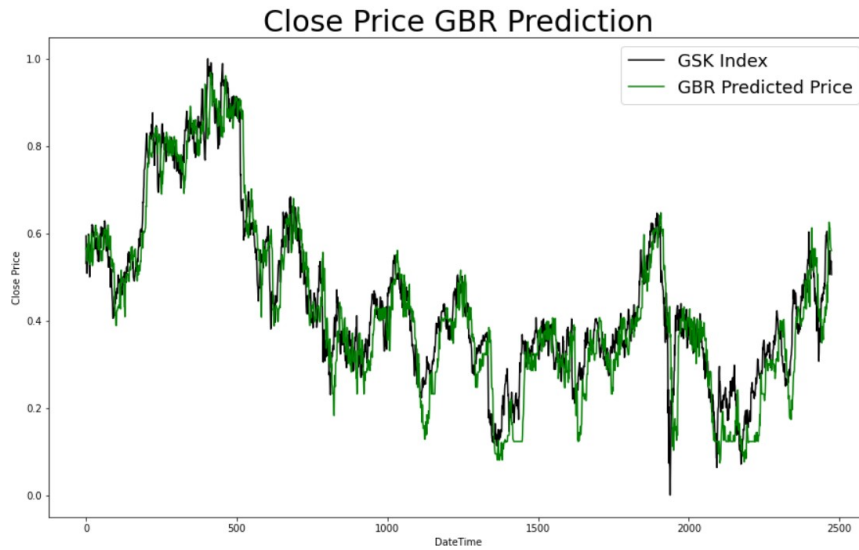


Figure 9: Prediction Using GBR (10-day prediction)

Figure 9 and Figure 10 show the price prediction by GBR and Stacked models, with respect to actual price of GSK – that looks like a good and realistic performance for a 10-day prediction. A close perusal shows that GBR smoothens more relative to Stacked model. The Stacked model captures the fluctuations better, but possibly at a cost of performance.

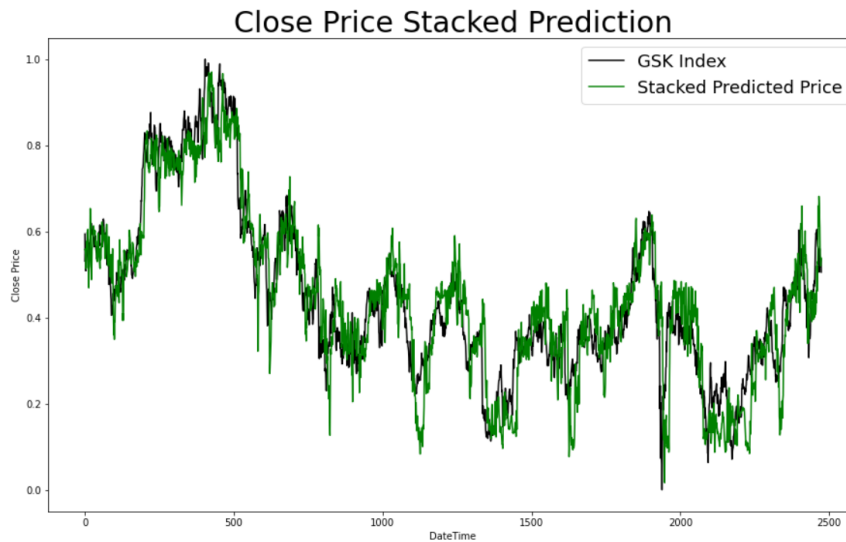


Figure 10: Prediction Using Stacked (10-day prediction)

We notice differences between the one-day, five-day, and ten-day models. Expectedly, there is an increase in the error because of the accumulation of the error through the days.

Also, we noticed that different models would work better in different scenarios. For example, RF showed

exemplary performance (2nd Place) in the 5-day prediction model when compared to Stacked model. Stacked model showed (2nd Place) performance in 1-day and 10-day predictions.

5. Summary and Conclusion

In conclusion, Transfer Learning is a viable option to estimate the future stock prices of the individual pharma companies, because the MSE values are low. What is interesting and amazing is that the models saved from training on large data of 64 years of S&P 500 index, could be used to predict the individual stock prices in the pharmaceutical domain. Transfer Learning can work with low amount of data. For one company all we had is just very little data over a year, but it still performed well with a very low error rate. Upon performing the five-day and ten-day prediction, slightly higher error rate was observed, as expected. In future research, we would like to explore the performance of different TL base models in different scenarios of time series features.

6. References

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SUSTAINING THE BUSINESS OF MINOR LEAGUE BASEBALL

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ABSTRACT

The COVID-19 global pandemic greatly impacted the sports industry as leagues had drastic budget reductions and were forced to compensate for the lost revenues. In Minor League Baseball (MiLB), teams were forced to come up with creative ways to develop new revenue streams as well as finding much-needed cost reductions in order to maintain operations during and after the pandemic. This research examines the strategies used by Minor League Baseball teams to ensure their viability in the short-term and to sustain the operations in a post-COVID environment over the long-term.

INTRODUCTION

Professional baseball was not immune to the effects of the COVID-19 global pandemic. In June 2020, Major League Baseball (MLB) canceled the 2020 season for minor league teams when they alerted their minor league affiliated teams that MLB would not make players available for the 2020 season [3]. At that time, the CEO of Minor League Baseball (known as MiLB) Pat O’Conner described the situation as follows [5]:

"These are unprecedented times for our country and our organization as this is the first time in our history that we've had a summer without Minor League Baseball. While this is a sad day for many, this announcement removes the uncertainty surrounding the 2020 season and allows our teams to begin planning for an exciting 2021 season of affordable family entertainment."

For their 2020 season, Major League teams played a 60-game schedule with an increased focus on the geographic proximity of team [16]. The league’s Division Series, League Championship Series, and World Series were contested at neutral site locations in Texas (Houston and Arlington) and California (San Diego and Los Angeles) [17].

In Spring 2021, Major League Baseball announced a restructuring of its Minor League system beginning with the 2021 season. The new model provided for increased player salaries, modernized facilities, and reduced travel time and costs. A new Professional Development League (PDL) was organized with four partner leagues: The American Association, Atlantic League; Frontier League; and Pioneer League. The Triple-A affiliate teams (its highest level) were reassigned to be closer to their major league clubs [18]. The restructuring reduced the number of affiliated teams from 160 to 120 [12]. Rob Manfred, MLB Commissioner, described the changes as follows [18]:

"In modernizing our Minor League system, we prioritized the qualities that make the Minor Leagues such an integral part of our game while strengthening how we develop professional athletes on and off the field."

It can be argued that the above changes to Minor League Baseball helped to sustain the longevity of the industry (e.g., its sustainability as a business) in the short-run and may be invaluable in sustaining the business over the long-term. This study examines the recent strategies undertaken by Minor League Baseball teams and leagues to survive the COVID-19 pandemic and to ensure their long-term viability as

business entities. First, an overview of the organization of Minor League Baseball and their affiliates is provided. Second, a review of the actions taken by Minor Leagues teams and leagues to ensure their ability to operate is presented. Finally, some summary comments are offered.

THE ORGANIZATION OF MINOR LEAGUE BASEBALL

There are currently 30 Major League Baseball teams operating in the United States. Each of these teams has an affiliated Triple-A, Double-A, High-A, and Low-A team. Additionally, MLB operates two leagues for first-year player or rookie players: the Arizona Complex League (ACL) and the Florida Complex League (FCL), where games take place at the Spring Training sites of MLB teams. Additional teams bring the total to 179 teams across 17 leagues in 43 states and 4 provinces [18]. The current organization of Major League Baseball and its Affiliated Minor League teams is presented in **Table 1**.

Table 1: Major League Baseball and Minor League Affiliates

Major League	Triple-A	Double-A	High-A	Low-A
Arizona Diamondbacks	Reno Aces	Amarillo Sod Poodles	Hillsboro Hops	Visalia Rawhide
Atlanta Braves	Gwinnett Stripers	Mississippi Braves	Rome Braves	Augusta GreenJackets
Baltimore Orioles	Norfolk Tides	Bowie Baysocks	Aberdeen IronBirds	Delmarva Shorebirds
Boston Red Sox	Worcester Red Sox	Portland Sea Dogs	Greenville Drive	Salem Red Sox
Chicago Cubs	Iowa Cubs	Tennessee Smokies	South Bend Cubs	Myrtle Beach Pelicans
Chicago White Sox	Charlotte Knights	Birmingham Barons	Winston-Salem Dash	Kannapolis Cannon Ballers
Cincinnati Reds	Louisville Bats	Chattanooga Lookouts	Dayton Dragons	Daytona Tortugas
Cleveland Guardians	Columbus Clippers	Akron RubberDucks	Lake County Captains	Lynchburg Hillcats
Colorado Rockies	Albuquerque Isotopes	Hartford Yard Goats	Spokane Indians	Fresno Grizzlies
Detroit Tigers	Toledo Mud Hens	Erie SeaWolves	West Michigan Whitecaps	Lakeland Flying Tigers
Houston Astros	Sugar Land Skeeters	Corpus Christi Hooks	Asheville Tourists	Fayetteville Woodpeckers
Kansas City Royals	Omaha Storm Chasers	Northwest Arkansas Naturals	Quad Cities River Bandits	Columbia Fireflies
Los Angeles Angels	Salt Lake Bees	Rocket City Trash Pandas	Tri-City Dust Devils	Inland Empire 66ers
Los Angeles Dodgers	Oklahoma City Dodgers	Tulsa Drillers	Great Lakes Loons	Rancho Cucamonga Quakes
Miami Marlins	Jacksonville Jumbo Shrimp	Pensacola Blue Wahoos	Beloit Snappers	Jupiter Hammerheads
Milwaukee Brewers	Nashville Sounds	Biloxi Shuckers	Wisconsin Timber Rattlers	Carolina Mudcats
Minnesota Twins	St. Paul Saints	Wichita Wind Surge	Cedar Rapids Kernels	Fort Myers Mighty Missals

Major League	Triple-A	Double-A	High-A	Low-A
New York Mets	Syracuse Mets	Binghamton Rumble Ponies	Brooklyn Cyclones	St. Lucie Mets
New York Yankees	Scranton/Wilkes-Barre RailRiders	Somerset Patriots	Hudson Valley Renegades	Tampa Tarpons
Oakland Athletics	Las Vegas Aviators	Midland RockHounds	Lansing Lugnuts	Stockton Ports
Philadelphia Phillies	Lehigh Valley IronPigs	Reading Fightin Phils	Jersey Shore BlueClaws	Clearwater Threshers
Pittsburgh Pirates	Indianapolis Indians	Altoona Curve	Greensboro Grasshoppers	Bradenton Marauders
San Diego Padres	El Paso Chihuahuas	San Antonio Missions	Fort Wayne TinCaps	Lake Elsinore Storm
San Francisco Giants	Sacramento River	Richmond Flying Squirrels	Eugene Emeralds	San Jose Giants
Seattle Mariners	Tacoma Rainiers	Arkansas Travelers	Everett AquaSox	Modesto Nuts
St. Louis Cardinals	Memphis Redbirds	Springfield Cardinals	Peoria Chiefs	Palm Beach Cardinals
Tampa Bay Rays	Durham Bulls	Montgomery Biscuits	Bowling Green Hot Rods	Charleston RiverDogs
Texas Rangers	Round Rock Express	Frisco RoughRiders	Hickory Crawdads	Down East Wood Ducks
Toronto Blue Jays	Buffalo Bisons	New Hampshire Fisher Cats	Vancouver Canadians	Dunedin Blue Jays
Washington Nationals	Rochester Red Wings	Harrisburg Senators	Fredericksburg Nationals	Fredericksburg Nationals

Source: [18].

SUSTAINING THE BUSINESS OF MINOR LEAGUE BASEBALL

Professional sports teams have implemented strategies to overcome the losses incurred during the 2020 and 2021 seasons due to the COVID-19 pandemic. Unfortunately, professional sports teams, especially Minor League Baseball teams, had very little revenue in 2020 without games to play and tickets to be sold. Then, they saw reduced revenues in 2021 while playing a reduced schedule in front of smaller numbers of fans buying tickets due to both social distancing requirements and fear among some possible ticket-buyers about attending events with large numbers of people present. Teams and leagues had to be creative in developing new revenue streams and cutting costs just to survive after the COVID-19 pandemic. Their responses are listed in **Table 2**.

Table 2: Overview of Minor League Baseball's Survival Strategies

Developing New Revenue Streams	Identifying Cost Reductions
<ul style="list-style-type: none"> • Ticket Revenues • Sponsorships • Broadcasting and Media Rights • Naming Rights • Monetization of Activities • Hosting Non-Sporting Events 	<ul style="list-style-type: none"> • Smaller Leagues • Salaries and Staff Sizes • Game Scheduling • Reduced Roster Size and Player Compensation • Team Travel

Developing New Revenue Streams

Minor League sports and their respective teams have put numerous practices in place to develop new revenue streams to counteract the adverse effects the COVID-19 pandemic. The key revenue streams for minor league sports team tend to be: (1) ticket revenue; (2) sponsorship; (3) broadcasting and media rights; (4) naming rights; (5) monetization of the experience; and (6) hosting non-sporting events and facility rentals.

Ticket Revenues. Ticket sales are often the most significant revenue driver in sports, especially in Minor League sports that do not have as large a fan following and play in smaller stadiums compared to their Major League parent clubs. On average, the top 20 MiLB teams pulled in \$9.8 million in revenue per team, of which 49% (approximately \$4.8 million) came from ticket sales [21]. Minor League teams do not have the television and sponsorship monies of the major league parent teams. They must play the games, sell the tickets, sell the merchandise, sell the food & beverages, and entertain the fans to ensure their revenue.

Sponsorships. Sponsorships in Minor League Baseball have been a local tradition as local businesses proudly affiliate and sponsor their local teams. Now, sponsorships in Minor League Baseball have become increasingly important as a means to grow team revenue. Minor league baseball clubs can make between \$3 and \$25 million a year from sponsorships, according to the MiLB [19]. With the COVID-19 pandemic, these numbers fell during 2020 but rebounded in the 2021 season and 2022 seasons. Digital media sponsorships also proved beneficial, particularly during the COVID-19 pandemic when teams could not host fans. Many teams offered their sponsors the opportunity to continue promotions through the teams on their websites and social media.

Broadcasting and Media Rights. Broadcasting and media rights have become a fundamental part of minor league sports. Broadcasting rights allow fans to view the game without being physically present, allowing the hosting league to earn substantial amounts of revenue through subscriptions and media deals. Minor League Baseball previously held a media rights deal with TuneIn on the audio side and to MLB (which then puts them on streaming service MiLB.tv) for what John Ourand of *Sports Business Journal* cites as “*a rights fee in the low seven figures,*” but that seems set to change, with Ourand reporting that MiLB has now hired sports agency Octagon to shop their rights around elsewhere [9]. Ourand also states, “*Given the number of direct-to-consumer services currently in the market, that fee easily could double, even as Major League Baseball has discussed contracting up to 42 minor league teams.*”

Naming Rights. Naming rights to stadiums has been a solid revenue stream for sports teams for generations, the first being Budweiser Stadium of the St. Louis Cardinals in 1953 [24]. Currently, naming rights can bring in revenues of up to \$5 million for a 20-year naming rights deal for a minor league sports team [15].

There are many advantages and disadvantages to brands buying the naming rights of sports stadiums, which has both revenue and cost implications. Some teams have even decided not to renew their naming rights deals, specifically the Frisco RoughRiders, after being named Dr. Pepper Ballpark has been renamed Riders Field in 2017 as the team didn't want to spend the money to replace stadium signage [7].

Since the COVID-19 pandemic, some teams have opted to auction their naming rights in more creative ways to increase fan engagement and to further their community connections. For example, the Beloit Snappers said goodbye to their old Pohlman Field by auctioning the naming rights for every home game in the 2021 season before the team's new downtown ballpark opened. The winning bidder for each game was able to choose the ballpark's name for the night and received eight tickets to the game, two vinyl signs displayed at the stadium featuring their stadium name, public address announcements throughout the game, a radio interview during an inning, inclusion of their stadium name on the team website, the opportunity to lead the singing of the seventh-inning stretch, and a group photo with team mascot Snappy [23]. All the

proceeds earned from the naming rights auction were donated to the Stateline Boys and Girls Club, and though it was not an additional revenue stream, it did allow them to engage more of their community and bring in other fans throughout the season.

Monetization of Activities. Many minor league teams have developed creative ways to find additional revenue at each event when games can be played. Some strategies for monetizing the in-game experience include jersey auctions, 50/50 raffles, and theme nights, all which bring in additional revenue that can be used to support various departments, especially marketing and fan engagement.

Teams have long utilized jersey auctions to generate revenue, specifically on themed or promotional nights. Jersey auctions allow patrons to bid and purchase game-worn jerseys, most going above the average price of a jersey sold in the team Pro Shop. Jersey auctions begin at a set price, which is usually slightly below the price for a custom jersey to be made, but as the game proceeds, bid prices rise to often double the price of a regular jersey. Many teams have multiple jersey auctions throughout the season, which bringing in thousands of dollars in revenue.

Most Minor League teams utilize another strategy during games: holding a 50/50 raffle. Again, it is not a substantial revenue stream, but it helps to support various departments in their day-to-day activities. 50/50 raffle tickets are typically sold for \$5-\$10 depending on the level of the team and generate at least \$1,000 per game. With larger audiences and fans willing to pay higher prices, the payout for minor league teams can increase substantially. In addition, since 50/50 raffles are held at every home game, the profits multiply throughout the season and can be used as supplemental income for various departments.

Lastly, theme nights can draw increased fan support, thus raising revenue through increased ticket, merchandise, and food and beverage sales. MiLB teams use a combination of specialized jerseys and merchandise, in-game experiences, and themed attractions, food and drinks to provide unique themed gameday experiences.

Hosting Non-Sporting Events. Teams are hosting non-sporting events at their facilities to diversify their revenue streams. Winston [26] notes that minor league baseball stadiums offer a cost-effective and unique meeting options for company and community groups:

“From Albuquerque, N.M., to Akron, Ohio; from Lancaster, Pa., to Louisville, Ky.; and from Tacoma, Wash. to Trenton, N.J., minor-league baseball stadiums are proving they can host productive meetings, provide first-class service and offer reasonable rates. And they’re heeding the calls of planners for new types of meeting and event spaces by adapting their facilities for groups or creating new facilities specifically for the meetings trade. There’s something about a ballpark that seems to bring out creativity that might well be stifled in the usual meeting room back at the office. Perhaps it’s the green grass, the field of dreams, the American pastime or the fact that thousands of empty seats will be filled with excited fans in a few hours.”

One team, the Pensacola Blue Wahoos, even listed their stadium on Airbnb as a rental to generate income during the COVID-19 pandemic [1].

According to a *Sports Business Journal* analysis of hundreds of sports venues and musical acts’ schedules and recent box office data from Pollstar, more than 500 concerts scheduled for arenas and stadiums in 2020 (representing nearly \$1 billion in total projected revenue), were canceled, or postponed by the COVID-19 pandemic. Now that many restrictions have been lifted, teams can re-enter this importance business category [8].

The most recent figures provided by the 2014 Economic Impact of Meetings to the U.S. Economy by the Convention Industry Council (CIC) estimated a \$115 billion value for the events and meetings industry,

which account for \$10.36 billion in spending on venue rental [22]. Additionally, with these events taking place, there is often additional income from food and beverage to be included with many events, which adds to the support stadiums and ballparks receive by hosting these events.

Identifying Cost Reductions

Amid the COVID-19 pandemic, minor league sports teams had to find new ways to cut costs to ensure the sustainability of their businesses while also maintaining functionality to ensure life after the pandemic. The cost-cutting strategies chosen included: (1) reorganizing into smaller leagues; (2) reducing staff size and salaries; (3) implementing new game scheduling formats; (4) reducing player roster size and compensation; and (5) adjusted team travel patterns with new game schedule format.

Smaller Leagues. Beginning with the 2021 season, Major League Baseball reduced the number of affiliated teams from 160 to 120. These remaining 120 teams were reorganized into new, smaller divisions that were geographically clustered, thus offering a cost-effective and efficient mode of player development. Affiliated short-season and rookie leagues in the Northeast, the Rockies, and the Appalachians were also absorbed into collegiate and draft-showcase leagues during the process [16].

Salaries and Staff Size. As noted earlier, the 2020 MiLB season was cancelled. Since the season's cancellation meant no ticket revenue, teams were forced to furlough or lay-off employees or to cut staff salaries to survive the pandemic and resume play in the 2021 season. Many positions were also cut, including offering fewer internships and giving more responsibilities to those employees who remained. With an estimated \$12.3 billion in earnings lost during the COVID-19 pandemic, approximately 1.3 million sports jobs were furloughed, reduced, or erased [11]. As the effects of the pandemic lessened, leagues were able to resume play and rehire many employees.

In a study on the popular sports job posting site, TeamWork Online, it is stated that jobs on the site have rebounded over the past three quarters, nearly reaching the average number of job postings within the data set in Q1 2021. The number of new postings increased 67.2% from Q3 2020 to Q4 2020, and then 36.0% from Q4 2020 to Q1 2021 [14]. It can be concluded that the job market in sports has been on the rebound since play resumed, but it will take time for teams in all areas of sports to make a complete comeback after the COVID-19 pandemic.

Game Scheduling. Another result of the COVID-19 pandemic was a reworking of game schedules to reduce travel and (assumedly) try to contain outbreaks of the COVID-19 virus. Minor League Baseball team schedules were regionalized and included six-game series to reduce travel and cut expenses. The game schedule structure for 2021 and the league alignment have continued into the 2022 season since COVID-19 and its variants are still a threat [4]. The two Triple-A Minor League Baseball divisions featured 142 regular-season games per team, while clubs in the Double-A, High-A, and Low-A divisions played 120 games apiece [10]. In 2022, the Triple-A schedule would expand from 144 to 150 games to “help Triple-A baseball better align with the Major League season” [13].

Reduced Roster Size and Player Compensation. In 2020, the Major League Baseball Players Association (MLBPA) reduced the 2020 draft from 40 rounds to five, deferred large portions of draft bonuses, and lowered the bonus cap for undrafted free agents from \$125,000 to \$20,000 [5]. This change made it possible for teams to save money during desperate times as MLB teams saved a few million per franchise [5]. These strategies continued into 2021 when the MLB draft was cut in half, offering 20 rounds to continue the money-saving strategy in a post-COVID world. The 2022 player draft will also have 20 rounds [2].

Team Travel. As previously noted, MiLB was reorganized into geographic clusters to reduce travel costs. Some Minor League teams even changed their parent-team affiliation to further reduce travel costs. For example, the Myrtle Beach Pelicans in South Carolina, previously a High-A affiliate of the Chicago Cubs,

were dropped down into the Low-A division, while the South Bend Cubs in Indiana were raised from Low-A to High-A. With the realignment of Minor League Baseball, the new schedule format (6-game series each week with Monday's off) cut scheduled travel mileage by 28 to 56% and reduced expenses in their first season of operations under Major League Baseball after the pandemic [6]. The games were still played but it cost less to move, house, and feed the players.

CONCLUDING REMARKS

The COVID-19 pandemic caused a complete cancellation of the 2020 Minor League Baseball season. For the 2021 season, teams played a reduced schedule in front of smaller crowds due to social distancing restrictions. But, all teams and leagues survived. This outcome was not assured as the world began to grapple with the impact and implications of the COVID-19 global pandemic.

As the 2022 season dawned, the business entities that own and operate Minor League Baseball teams took an income statement approach to their very survival: Find **NEW REVENUE STREAMS** while concurrently finding **NEW COST REDUCTIONS**. The tactics needed to ensure their very short-term survival have the potential to ensure the long-term sustainability of their teams and leagues. As a result, Minor League baseball fans can continue to enjoy cost-effective family entertainment while watching the next generation of Major League players work through the player development process with stops in their communities.

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What happens when firms engage in Diversity, Equity, and Inclusion through Social Media?

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Dr. Jared Hansen – Utah State University

Abstract

Over the last several years, the topic of social media has been studied in business fields, the humanities, and social-behavioral sciences. While many insights have been discovered, many questions still exist. For example, which organizational practices or elements positively or negatively impact what happens when organizations attempt to use social media to announce views on issues related to diversity, equity, and inclusion? This research contrasts the associations between simple usage and fiscal performance versus engaging in dialogic social listening (DSL) in social media and fiscal performance. Associations are examined between (a) Twitter data associated with specific equity related events occurring during the last two years (February 2020 through July 2022), (b), Tobin's Q, (c) Net Promoter scores, and (d) other performance indicators. The results indicate that there are nuanced findings. Future research is needed that examines the topic in greater detail. Implications for future research and managerial practice are outlined.

Introduction:

First, within current empirical literature, few studies have tested the connection of dynamic exchange within social media and the influence when firms engage in hot topics within social media. Extant literature have highlighted the need to engage in social media since the inception of Web 2.0. However, the connection to extant theoretical explanations and more specifically topical engagement has been limited. This research will first align topical firm discussion to equity theory and specifically to brand equity to demonstrate the influence of dialogic social listening (DSL) to fortify perceived customer and investor sentiment.

Second, extant studies use empirical examination of client sentiment collected via questionnaires, whereas by nature social media is ripe to observe and collect the directly from the source, social media platforms. This work undertook the task to identify and collect indicating words and phrases which reflect DEI to quantitatively assess engagement in times of need; rendering a baseline DEI dictionary for future analysis.

Third, we matched firm engagement on social media with the lens of DEI when social inequity events occurred and evaluated the influence of perceived customer Net Promoter Score (NPS) and investor sentiment (Tobin's Q)

The article proceeds as follows. The first section describes the theoretical model and contains hypotheses for empirical testing. The second section outlines the methodology used to test the hypotheses. The third section presents the results of the empirical analysis. The fourth and concluding section discusses the limitations and interesting implications of the findings.

Why this is important

This research advances knowledge related to the increased customer expectations for firm participation and support of Diversity, Equity and Inclusion (DEI) in social media platforms. Social media is characterized as an inherently dynamic two-way conversation in which firms listen and respond to public comment (Collins, 2020, Kaplan & Haenlein, 2010.) Thus, a notable biproduct of the pandemic was the increased use social media. The number of unique daily users of social media rose by 1.08 Billion between 2019 and 2022 (Dixon, 2022.) As the use of social media rose, expectations for firm social media engagement have also risen and such sentiment persists today. According to recent publication of a Harris Poll conducted by SproutSocial, 68% of consumers rely on social media to interact with firms; in addition, 2 in 5 consumers note increased brand loyalty when firms like the consumers posts (Cover, 2022.)

In parallel, the 2020 through today, 2022, have seen a significant increase in public awareness and distain displayed through social media for events which have jeopardized basic human equity rights. Such events, took center stage for 2021 as evidenced by the most retweeted post

of 2021 being *#StopAsianHate* from the music artist BTS (Twitter Data, 2021.) Yet, there is limited research available that investigates company engagement in DEI topics on social media. This research will address this gap to align extant theory and extend the implications of DEI conversational engagement.

Theory and Hypothesis Development

To begin we will discuss the relationship between equity theory and brand equity. Equity theory for the purpose of this article is defined as it pertains to distributive equity. Distributive equity posits that the customer will review the treatment of other customers who are similar to themselves to assess their own interactions and intentions (Oliver and Swan, 1989; Xia et al., 2004.) Furthermore, such treatment is readily available for review and public comment by anyone willing to review recent social media news. The outcome of the perceived firm position is thus up to the interpretation of the reader. However, for this study we will measure brand equity by proxy of Tobin's Q.

Tobin's Q, is defined as the value over and above the assets on the books of the firm (Tobin, 1969); so for those firms with increased perceived value e.g., highly regarded quality or bolstered by positive news of good will, are valued at a ratio of greater than 1 for assets to equity. Thus, it is hypothesized that firms behaviors on social media that provide support for marginalized individuals in the face of social inequity will garner increased brand equity. Results have evidenced growing influence of social media for brand equity (Bruhn and Schafer, 2012; Wang and Kim, 2016) further emphasized by the shift to digital.

H1: If firms actively acknowledge and support groups or individuals which have fallen victim to social inequity, brand equity will be positively influenced

Likewise, current research indicates that firms perception is positively influenced by acts of support in these turbulent times (Johnson and Bonds, 2021.) Therefore, to extend the research which mentions social media channel to discuss such acts of support the logical connection warrants further investigation. Therefore, it is hypothesized that firms behaviors on social media which demonstrate support to right the wrongs of social inequity may positively influence customer sentiment. Testing will evaluate using Net Promoter Score as a proxy for customer sentiment. NPS for our purpose responds to the question of if a customer would recommend to a friend, and has been used as a proxy for firm sentiment since its inception in 2003 (Reichheld, 2003.). Measurement of the customer perceptions as well as indicators of brand equity has been studied with regard with social media marketing efforts.

H2: If firms actively acknowledge and support groups or individuals which have fallen victim to social inequity, perceived customer sentiment will be positively influenced

Methodology

This research examines content of the firm managed Twitter platform conversations extracting empirical data gathered from 29.9K messages which originated from primary firm accounts of

the DOW 30. To begin the examine the Twitter accounts of the DOW 30 were sourced from the Twitter platform. While some firms maintain multiple accounts, such as @AskîFirmNameî these accounts were determined to be primarily used for customer questions around products and services, e.g., @AskAmex detailed questions around special services such as concert ticket promotions and account billing practices (American Express, 2021)

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The following primary firm Twitter accounts were examined.

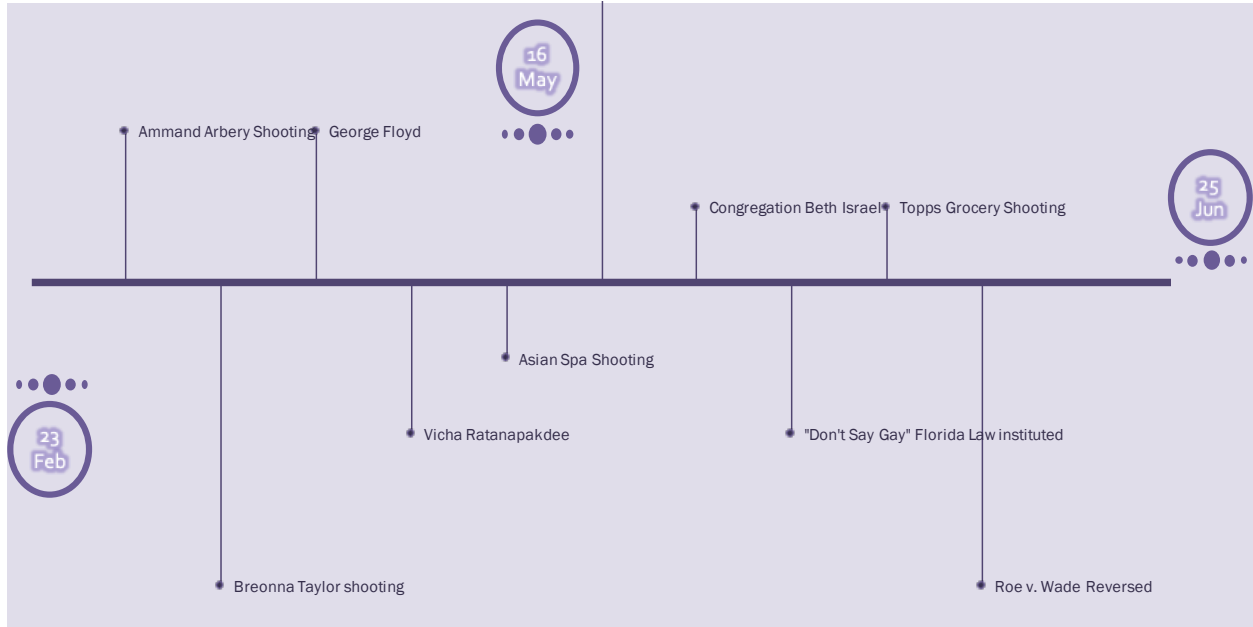
Firm	Ticker	Twitter handle	Twitter URL
American Express Co	<u>AXP</u>	@AmericanExpress	https://twitter.com/AmericanExpress
Amgen Inc	<u>AMGN</u>	@Amgen	https://twitter.com/Amgen
*Apple Inc	<u>AAPL</u>	@Apple	https://twitter.com/Apple
Boeing Co	<u>BA</u>	@Boeing	https://twitter.com/Boeing
Caterpillar Inc	<u>CAT</u>	@CaterpillarInc	https://twitter.com/CaterpillarInc
Cisco Systems Inc	<u>CSCO</u>	@Cisco	https://twitter.com/Cisco
Chevron Corp	<u>CVX</u>	@Chevron	https://twitter.com/Chevron
Goldman Sachs Group Inc	<u>GS</u>	@GoldmanSachs	https://twitter.com/GoldmanSachs
Home Depot Inc	<u>HD</u>	@HomeDepot	https://twitter.com/HomeDepot
Honeywell International Inc	<u>HON</u>	@honeywell	https://twitter.com/honeywell
International Business Machines Corp	<u>IBM</u>	@IBM	https://twitter.com/IBM
Intel Corp	<u>INTC</u>	@intel	https://twitter.com/intel
Johnson & Johnson	<u>JNJ</u>	@JNJNews	https://twitter.com/JNJNews
Coca-Cola Co	<u>KO</u>	@CocaCola	https://twitter.com/CocaCola
JPMorgan Chase & Co	<u>JPM</u>	@jpmorgan	https://twitter.com/jpmorgan
McDonald's Corp	<u>MCD</u>	@McDonalds	https://twitter.com/McDonalds
3M Co	<u>MMM</u>	@3M	https://twitter.com/3M
Merck & Co Inc	<u>MRK</u>	@Merck	https://twitter.com/Merck
Microsoft Corp	<u>MSFT</u>	@Microsoft	https://twitter.com/Microsoft
Nike Inc	<u>NKE</u>	@Nike	https://twitter.com/Nike
Procter & Gamble Co	<u>PG</u>	@ProcterGamble	https://twitter.com/ProcterGamble
Travelers Companies Inc	<u>TRV</u>	@Travelers	https://twitter.com/Travelers
UnitedHealth Group Inc	<u>UNH</u>	@UHC	https://twitter.com/UHC
Salesforce Inc	<u>CRM</u>	@salesforce	https://twitter.com/salesforce
Verizon Communications Inc	<u>VZ</u>	@Verizon	https://twitter.com/Verizon
Visa Inc	<u>V</u>	@Visa	https://twitter.com/Visa
Walgreens Boots Alliance Inc	<u>WBA</u>	@Walgreens	https://twitter.com/Walgreens
*Walmart Inc	<u>WMT</u>	@Walmart	https://twitter.com/Walmart
Walt Disney Co	<u>DIS</u>	@Disney	https://twitter.com/Disney
Dow Inc	<u>DOW</u>	@DowNewsroom	https://twitter.com/DowNewsroom

*Twitter search of Apple & Walmart were blocked and therefore were excluded from the study

The longitudinal examination began February 2020 and continued through July 2022. The tweets extracted were taken from the time of specific inequity events plus 5 days and included all firm originated Tweets on the Twitter social media platform.

Events included in the scope of this research are

Date	Event	Description of Equity Disruption
2/23/20	Ahmaud Arbery Shooting	Three white men shot and killed a jogger in a suburban neighborhood
3/13/20	Breonna Taylor Shooting	Killed in a police raid on the wrong apartment
5/25/20	George Floyd Killing	Killed by police officers after detained for passing a counterfeit bill
1/28/21	Vicha Ratanapakdee	Elderly Asian man shoved and died on street
3/26/21	Asian Spa Shooting	Racially motivated attack Atlanta spas resulting in the murder of 8 spa employees
5/16/21	Bucknell University LGBTQ House Attack	Members of LGBTQ community harassed and intimidated by fraternity members
1/15/22	Congregation Beth Israel	Hostages taken at a Jewish synagogue
3/28/22	"Don't Say Gay" Florida Law Instituted	Florida legislation which prohibits teacher engagement in any kind of discussion about sexual orientation or gender identity
5/14/22	Topps Grocery Shooting	Racially motivated killing of 10 people at a supermarket in New York
6/25/22	Roe v. Wade Reversed	Supreme Court reverses abortion rights
7/6/22	Jayland Walker Killing	Traffic stop and car chase, resulting in police shooting and death of an unarmed suspect



Next, the collected data was analyzed to identify elements which signal Diversity, Equity and Inclusion through a custom dictionary. The dictionary taxonomy was created categorized as set forth below. Words and phrases for each category were curated from public social media discussions, Ted Talks, news and other media. The LWIC application was used to extract counts of occurrences of the words and phrases. The LWIC tool The use of the semantics in social media event general DEI or social equity and identifying words and phrases to identify the presence of topic discussion. The tweets were then aggregated then analyzed understand overall contributions related to DEI as compared to overall messaging composition as a part of general firm messaging; frequency was used as a proxy for engagement.

Analysis:

<correlation>

<MVRegression>

<Descriptive statistics>

Results

Discussion

Practical Implications

Limitations and future research opportunities

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USING THE INSTRUCTIONAL AND OCCUPATIONAL CLASSIFICATION CROSSWALK TO ESTIMATE DEGREE OR CREDENTIAL WORTH

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University of Tennessee at Chattanooga

Keith White
Public Education Foundation

ABSTRACT

Providing public school students accurate information about degree or credential worth has the potential to act as an equity lever. This paper details the process of employing the Classification of Instructional Programs (CIP) code to Standard Occupational Classification (SOC) code crosswalk and linking those results to local National Student Clearinghouse (NSC) major and degree data to provide potential salary projections. Additionally, a retrospective analysis of degree worth and credential attainment by high school and postsecondary site typologies was combined with the CIP to SOC crosswalk. The resulting dataset will be used to build an application to advise students on college match and instructional program fit, leading to more equitable postsecondary opportunities and outcomes.

INTRODUCTION

The Public Education Foundation (PEF) is a non-profit organization that provides training, research, and resources to students, principals, and schools in Hamilton County, TN. PEF has been working to improve education in the Chattanooga area for over 30 years. Their focus is to increase student achievement by supporting learning and proving opportunities for lifelong success. PEF is committed to creating and implementing programs that will empower students to choose their pathway to success in college, career, and life.

One of their initiatives is to communicate the importance of the connection between postsecondary education and the job market to students. To support this initiative, PEF creates resources that are provided to students, school counselors, teachers, and parents to help further student success. Currently, PEF is developing an application to aid guidance counselors, students and parents in college choice and career decisions. Multiple variables were investigated in a student's pathway from high school to the major(s) they select in college to the jobs.

The goal of this work was to predict a student's economic success based on the student's attributes, college, and major(s) they select. To accomplish this, we identified three objectives. The first objective was to create a model that predicts whether a student will have a projected salary above the MIT Tennessee Living Wage (\$44,594). The second objective is to use the model to analyze what variables are important in a student's pathway to the target variable. The third objective consists of using descriptive analytics to emphasize the validity and importance of the model. This model will ultimately be included in an application developed for a wide audience including students, school counselors, school administration, and PEF donors. It is imperative that the model be easy to understand and can convey how different experiences influence success.

DATA SOURCES

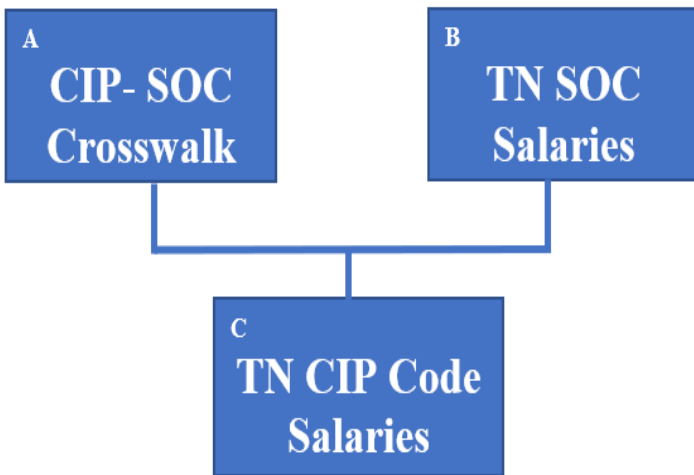
Public Education Foundation provided four data sources that were used to create and train a model that can predict a student’s ultimate education and earning potential. The four sources were: (1) The Hamilton County Department of Education Student Information System, (2) The National Student Clearinghouse, (3) National Center for Education Statistics Classification of Instructional Programs, and (4) The Federal Bureau of Labor Statistics. The data provided, allowed examination of the 2012, 2013, and 2014 cohorts of high school graduates through six years of post-secondary experiences.

The Hamilton County Department of Education data includes variables such as: a unique student identifier, gender, ethnicity, Limited English Proficiency (LEP), the student’s high school economic disadvantaged category, the student’s school attendance rate, cumulative GPA, ACT composite and sub-scores. National Student Clearinghouse data includes, student unique identifier (correlates to HCDES) post-secondary site type, pathway type, degree, and the student’s listed major(s). The National Center for Education Statistics’ Classification of Instructional Programs (CIP) serves as a link between the students' post-secondary school, major, and degree type and the Standard Occupational Classification (SOC) code. This is provided through the CIP to SOC crosswalk. Finally, the Federal Bureau of Labor Statistics’ Standard Occupational Classification data includes the employment outlook for job categories on both national and local scales as well as a projected salary range for all SOCs.

In total, the data made available by PEF included ~3,369 student- level degree items among 2,720 students from twenty Hamilton County high schools. These students earned 222 unique degree titles with 714 majors which relates to 1600 CIP codes, and ~1,000 SOC codes. The major challenge to this work was deciphering the connection between the CIP and SOC codes. It should also be noted that the student data was limited to those students who earned post-secondary education.

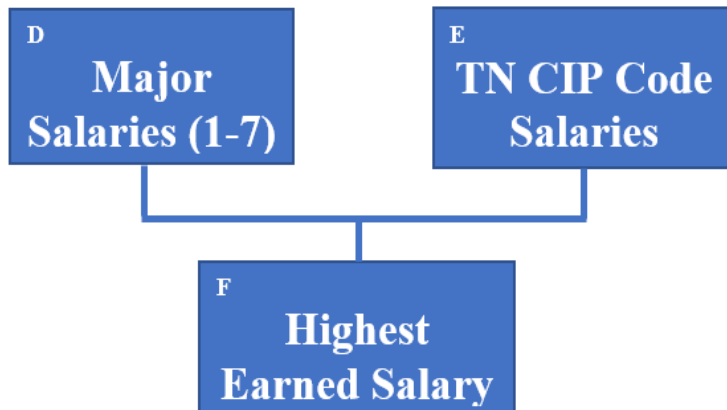
DATA PREPARATION

Part 1: Creating a dataset to map each CIP code to an average salary.



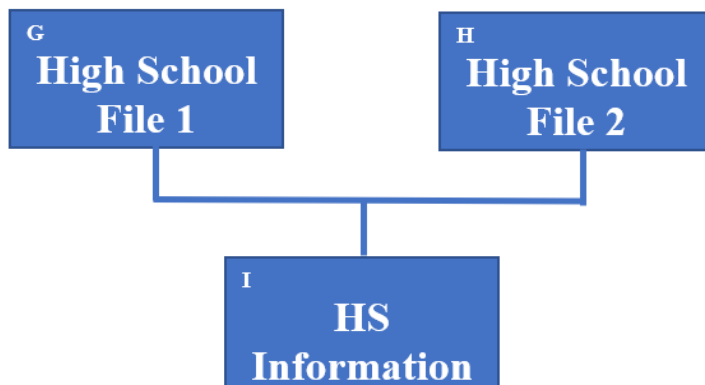
The purpose of the CIP to SOC crosswalk[A] is to provide data users with a resource for relating the Classification of Instructional Programs (CIP) and the Standard Occupational Classification (SOC). Using the power query tool in Excel, a CIP- SOC relationship was constructed, allowing each CIP code (program of study) to correspond to one or more SOC code(s) (classified job). By extracting and calculating the Tennessee average salary per SOC code and percentile [B] and using the CIP-SOC Crosswalk[A], the TN CIP Code Salaries dataset[C] was constructed. This dataset created a mapping from a CIP code to an average projected salary percentile.

Part 2: Obtaining the highest earned salary per student ID.



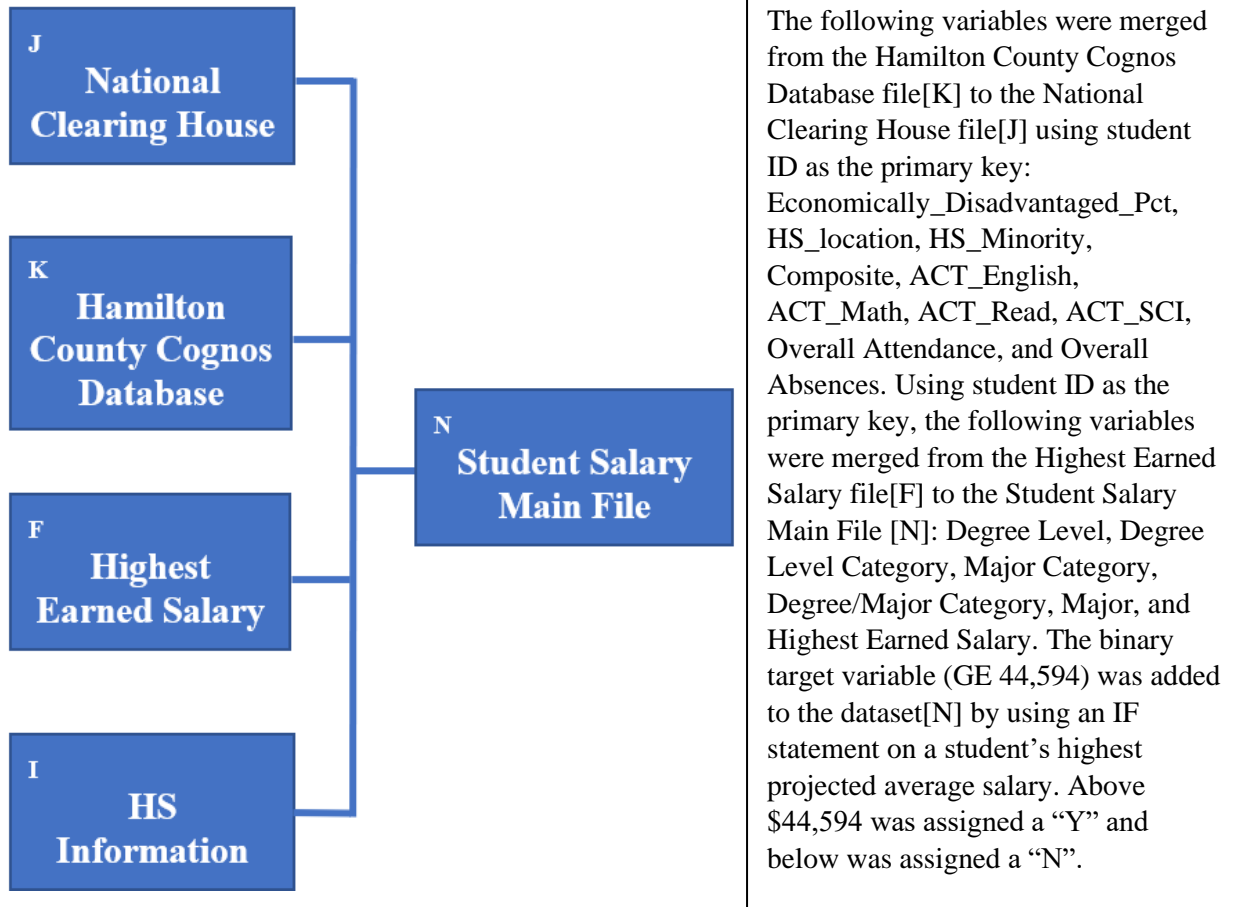
There were many instances where students had one or more majors listed with different levels of achievement. For every instance of a major per student ID, a CIP code and degree level was assigned. Degree level categories are associates, certificate, or diploma, (1) bachelors (2), masters (3), and doctoral (4). Using the TN CIP Code Salaries[E] and assigned degree level, a salary was assigned to every major per student ID. Multiple functions in Excel were used to capture the highest earned salary per student ID[F]. Furthermore, for descriptive & predictive modeling purposes, an additional variable, major category, was assigned to each CIP code. Major categories are Math & Engineering (A), Sciences (B), Business (C), Art, Language, or Education (D), Trades (E), and Social Sciences (F).

Part 3: Creating a dataset with all high school information per ACT high school code.



The Public Education Foundation provided two files containing demographic[G] and economic[H] data for all public high schools in Hamilton County. Using the ACT high school code as the primary key, all data was merged into one file[I].

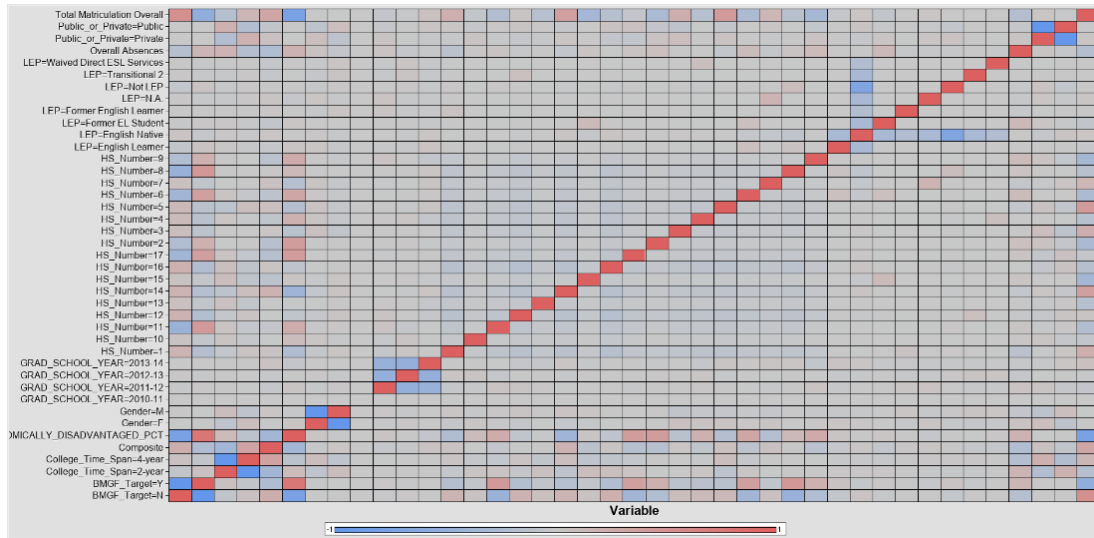
Part 4: Creating the final dataset using student ID & ACT high school code as primary keys.



VARIABLE SELECTION

Before modeling, variable selection was needed to remove redundant information and irrelevant inputs. Many techniques were used during the variable selection process: domain knowledge, a correlation matrix, stepwise regression, and a decision tree. This helped reduce the risk of overfitting and improve prediction performance. Most of the variables were selected based on discussion with domain experts at PEF. Since PEF strives to seek out the disparities between each school, the following variables were included as inputs: gender, total matriculation, overall absences, BMGF, economic disadvantage percent, and LEP. It was important to understand how gender, economic disparities, and matriculation affected the model.

To reduce biases and redundancy, variables such as majors, degree levels, and categories *were not* included as input variables because they were factors in calculating the projected salaries discussed in the above section. Looking further into the Correlation Matrix, the dark shades of blue and red indicate highly correlated variables. It is important to note that economic disadvantage percent, minority, HS income band, and total matriculation were highly correlated with one another, the economic disadvantage percent was chosen as the main input variable for the models. This decision was based on input from PEF.



Out of thirty variables, eleven input variables were selected. The target variable for this analysis was based on MIT’s living wage study. According to Carey Anne Nadeau[5], “The living wage model is an alternative measure of basic needs. It is a market-based approach that draws upon geographically specific expenditure data related to a family’s likely minimum food, childcare, health insurance, housing, transportation, and other necessities costs. . . the living wage is perhaps better defined as a minimum wage covering necessary costs for persons living in the United States.” The target variable of \$44,594 for Hamilton County, Tennessee was calculated specifically by:

$$\text{Basic needs budget} = \text{Food cost} + \text{childcare cost} + (\text{insurance premiums} + \text{out of pocket health care costs}) + \text{housing cost} + \text{transportation cost} + \text{other necessities cost} + \text{civic engagement} + \text{broadband}$$

$$\text{Living wage} = \text{Basic needs budget} + (\text{basic needs budget} * \text{tax rate})$$

For this work, the MIT living wage salary was determined to be appropriate measure of success.

Variable	Type	Description
Gender	Binary	The gender of the student
College Time Span	Binary	Two Year or Four Year
Graduate School Year	Nominal	2012, 2013, 2014 cohorts
Composite	Interval	American College Testing (ACT) standardized testing score
Total Matriculation	Interval	The percentage of High School Graduates who continued to Post Secondary Education
Overall Absences	Interval	The percentage of high school absences for all four years.
High School Number	Nominal	High School the student attended.
BMGF	Binary	Bill and Melinda Gates Foundation supported school indicator.
Economic Disadvantage Percent	Interval	Percent of students who are economically disadvantaged at their high school.
LEP	Nominal	Limited English Proficiency of the Student.

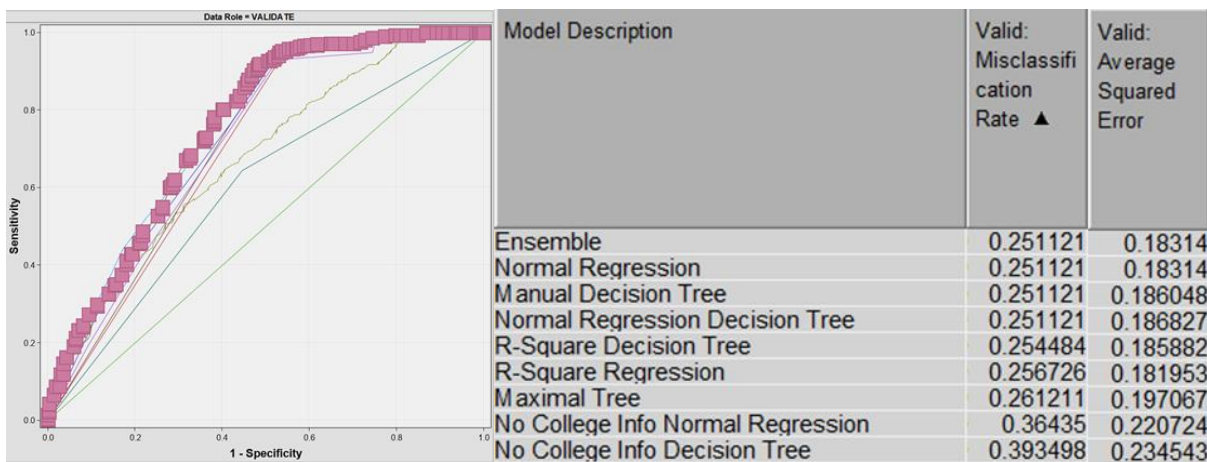
Public or Private	Binary	Whether the terminal degree was earned from a public or private school.
Salary \$44, 594	Target (Binary)	Based off the Updated MIT Living Wage Study 2018.

MODELS AND RESULTS

The models in this analysis were developed using SAS Enterprise Miner. Models include Ensemble, Normal Regression, Manual Decision Tree, Normal Regression Tree, R-Square Decision Tree, R-Square Regression, Maximal Tree, and a Normal Regression and Decision Tree excluding college information (ex. college time span and public or private). In this section, the Normal Regression and Decision Tree models are described. Further discussion of models is in Appendix.

It is important to note that all models were set to random sampling where every observation in the main data set was partitioned to a 60% training set and 40% validation set. This allows the model fitting process to suit the training data to obtain a realistic estimate of how a model would perform with unseen data. The goal of running various models is to determine which variables are strong indicators in determining whether a student will earn above the \$44,594 salary mark indicating success. The focus of the project is to predict the likelihood for each student making *above* or *below* the target MIT Living Wage.

Performance of these models were measured by the misclassification rate and average squared error. In the Fit Statistics of the Model Comparison node, we first look at the Normal Regression model. The overall rate is 0.251121. It is consistent with other models such as the Ensemble, Manual Decision Tree, and Normal Regression Decision Tree. For this project, the Ensemble option was removed. Since the Normal Regression’s misclassification rate was the same as others. The Normal Regression model has the lowest average squared error rate of 0.18314. In the ROC chart shown, the Regression model is highlighted in pink. Essentially, the higher the curve, the better the model is.



Normal Regression

Specifically, Stepwise Regression was used for explanatory and predictive purposes of the project. A sequential selection method was implemented in the Regression node for the analysis. The use of stepwise selection assisted us in choosing inputs for our prediction model. The result of stepwise selection is provided below.

Summary of Stepwise Selection

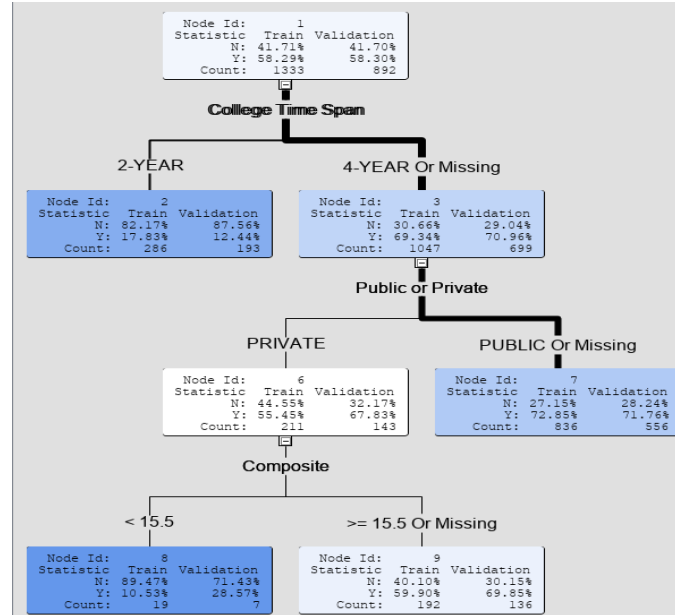
Step	Effect		DF	Number In	Score Chi-Square	Wald Chi-Square	Pr > ChiSq
	Entered	Removed					
1	College_Time_Span		1	1	227.2969		<.0001
2	Composite		1	2	41.1859		<.0001
3	Public_or_Private		1	3	24.0668		<.0001
4	Gender		1	4	8.1749		0.0042
5	GRAD_SCHOOL_YEAR		2	5	2.6115		0.2710
6		GRAD_SCHOOL_YEAR	2	4		2.6072	0.2716

The selected model is the model trained in the last step (Step 6). It consists of the following effects:

Intercept College_Time_Span Composite Gender Public_or_Private

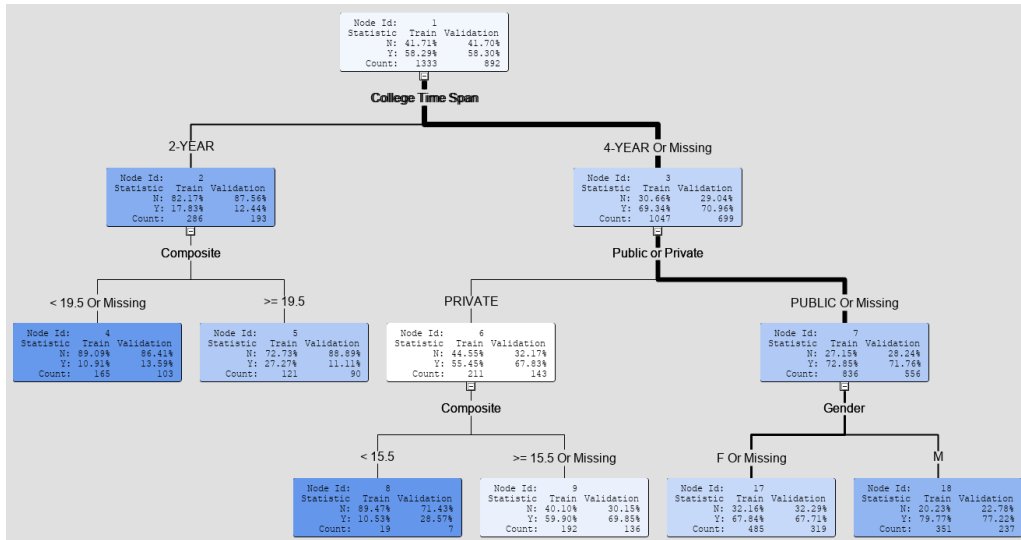
Decision Tree Model

Next, the results of Decision Tree model are presented. While it is not the most accurate model, it helps describe the rationale behind the predictions. The tree below shows the first split occurred on College Time Span. Those who choose the 4-year route have a stronger chance of earning above \$44,594 compared to those who choose a 2-year path. Public or private was the next highest split followed by composite. Notice a gender split is not included in this model.



Normal Regression Model

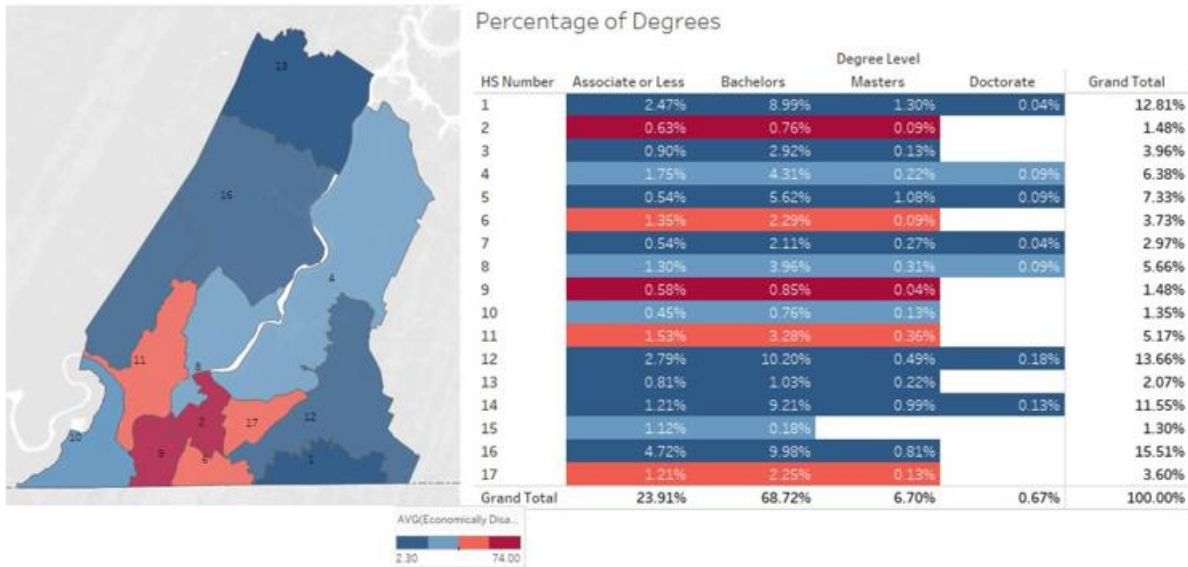
To make the model easy to understand and visualize the Normal Regression Tree was chosen as the prediction model in determining a student’s pathway of achieving the \$44,594 target mark. This model was a combination of the results from the Normal Regression and Decision Tree models explained above. Based on domain knowledge, gender was included. Adding an extra split, the misclassification rate stayed at 0.251121 with an average squared error increasing by 2%.



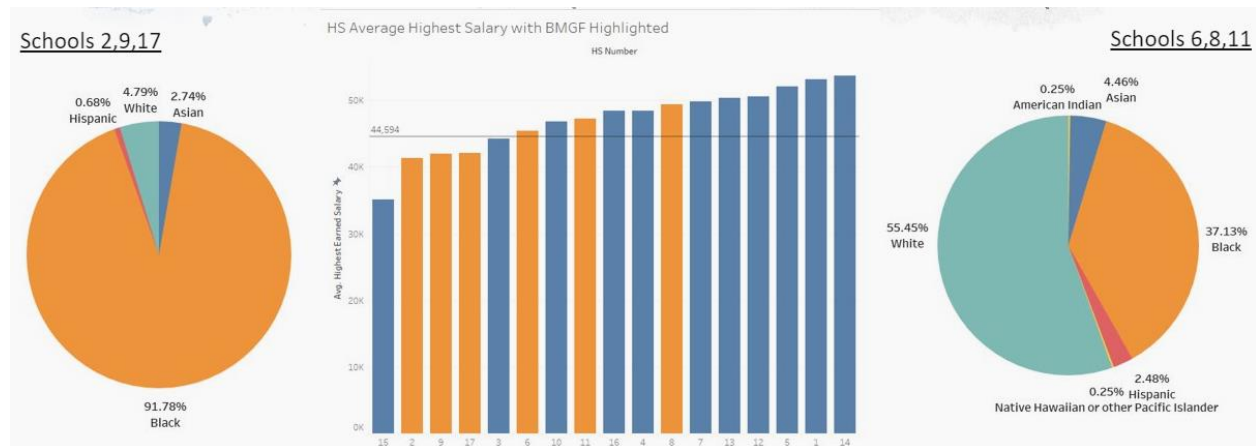
DISCUSSION AND DESCRIPTIVE ANALYTICS

Economic Disadvantaged Percent

Economic Disadvantage Percent is correlated with many other variables. Because of this multicollinearity, it was hypothesized that Economic Disadvantage Percent would be an important split in the model. This variable did not become a factor in the model. However, due to the work that PEF does in the Hamilton County community, it is important to discuss these relationships in detail. Economic Disadvantage Percent is a measure of the percent of students who are on the government subsidized lunch program at a given school. It is, therefore, not just a representation of the socio-economic status of the students but also represents the surrounding community that influence students at a given school. The map below shows that higher rates of economic disadvantaged students is concentrated in the inner-city schools while the schools in the suburban areas have much fewer occurrences of economic disadvantaged students. The table below shows that the more Economic Disadvantaged the school, the fewer post-secondary degrees were earned in six years after high school graduation. For instance, the two darkest red schools having 57% or greater economic disadvantage percent, together only produced 3% of the total number of post-secondary achievements in six years post high school graduation. Not surprising, these schools also have the lowest matriculation rates.



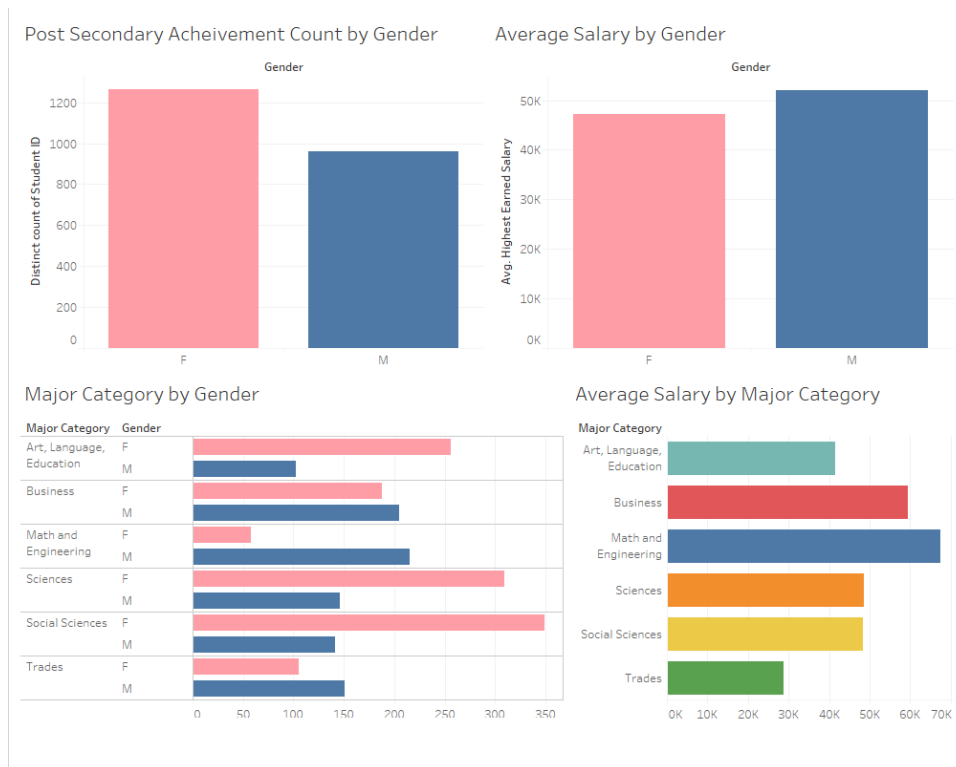
To further discuss the correlation and disparity between income, ethnicity, and the ability to achieve higher education and in turn, higher salaries the graph below shows the highest average salary by school. Schools that receive Bill and Melinda Gates Grant assistance are shown in orange. PEF does additional reporting on these schools to insure grant continuation. Notice that schools 2, 9, and 17 falls below the MIT Living Wage target income and schools 6, 11, and 8 are above the Living Wage target income. The demographic breakdown of post-secondary achievement earners from these schools is also shown. It is easy to see that the predominantly minority schools fall below the Living Wage. It should also be noted that school 15 is a dedicated vocational school and therefore is an outlier.



Gender

Gender was included in the stepwise regression model. It was the fourth step in the regression model with a low Chi-Square score of 8.1749. On the regression tree, split comes off the branch following College Time Span of 4-year, public school, lastly the gender split. Interestingly, when looking at descriptive statistics, many more females earn post-secondary education than males. However, the males who do earn post -secondary achievements, earn more than females on average. This is largely due to more females earning degrees that relate to lower paying jobs. Females earn more degrees in fields such as the Social

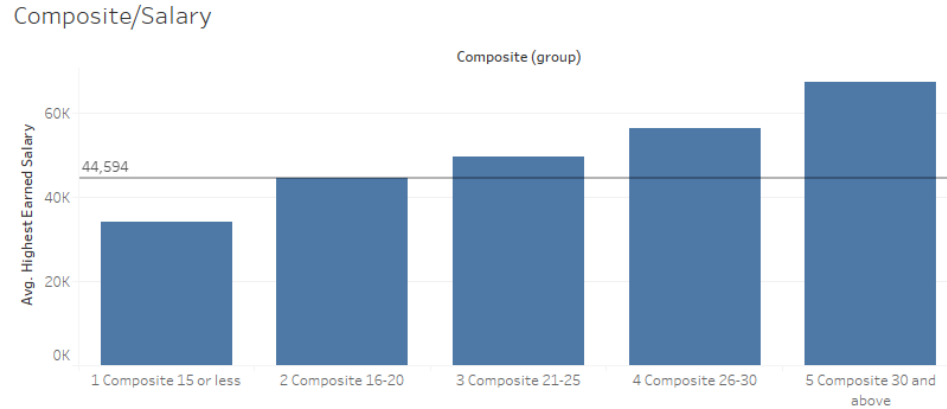
Sciences, Art, Language and Education and the Sciences which are lower paying sectors than Math and Engineering and Business, where more males earn degrees.



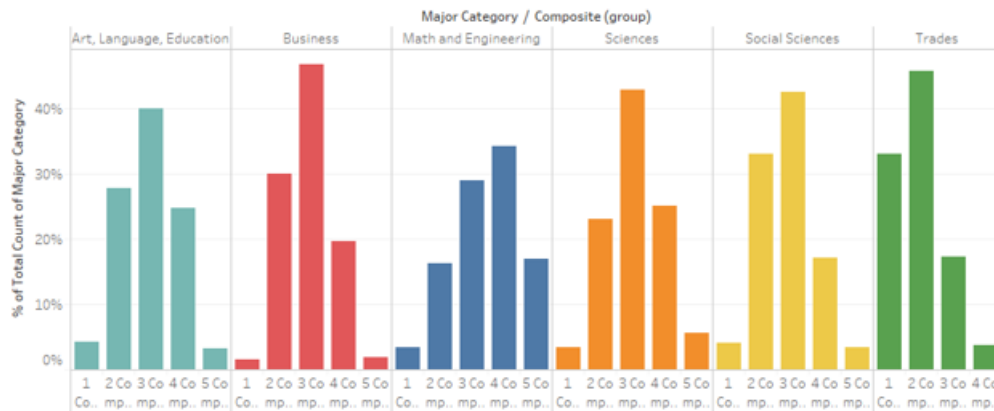
Composite ACT

Composite ACT was a very important variable to the model with the second highest Chi-Square Score of 41.1859. This points to the composite ACT being a good indicator of college readiness and eventual job success. Recently validity of Composite ACT scores as a strong indicator of college graduation have been questioned, it is argued that cumulative GPA may be a better indicator of college success (Morrison 2020). In this study, composite ACT was a very important indicator of success in determining average salaries for those students who earned post-secondary achievements. It should be noted that this study does not include cumulative GPA since student level data were not available.

The graph below shows that the higher a student’s composite ACT score, the more likely they are to earn a higher salary. It’s important to note that those students who score a composite ACT score of 21 or higher are above the MIT Living Wage target. This is important because it is Tennessee’s benchmark score for the ACT and a goal for the Tennessee Department of Education “that the average ACT composite Score in Tennessee will be a 21” (tn.gov). the State of Tennessee also has the goal that most students will go on to complete a post-secondary certificate or degree. (tn.gov).



The composite ACT may also be an indicator for the type of degree category a student might choose. This is also reflected in the distribution of composite ACT scores by Major Category. Math and Engineering students tend to have higher composite ACT scores where those students who earned a Trade typically have lower ACT scores. For Art language and Education, Business, Science, and the Social Sciences composite ACT scores are normally distributed.

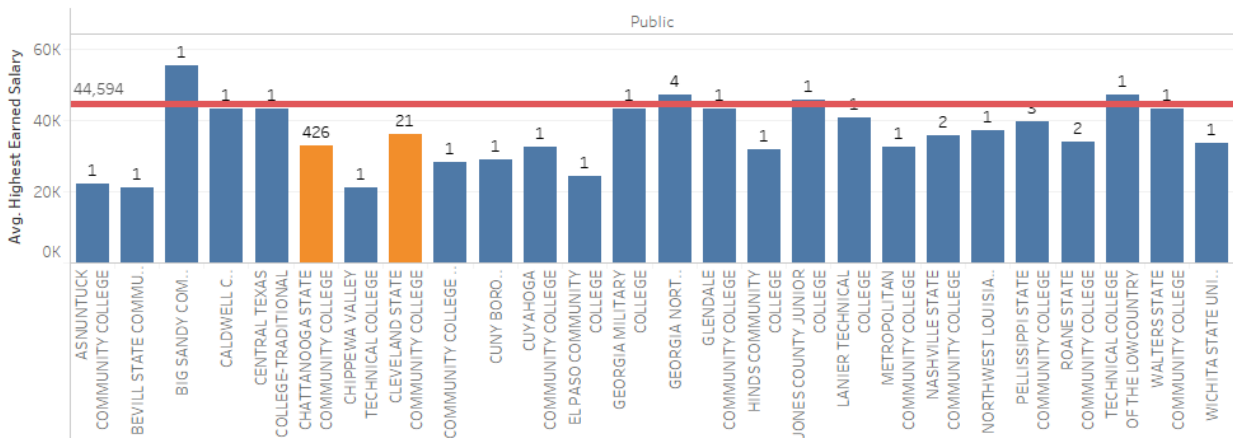


These findings raise the question about standardized testing in schools and how funding and resources are being allocated. Tennessee’s goal is to have more students earn post-secondary education achievements and to raise the average ACT score to a 21. However, funding, and other resources are distributed based on the TNReady testing. The research on the ACT suggests that “If your state’s standards represent the knowledge and skills that prepare students for college and career, then ACT Aspire and the ACT measure that knowledge and those skills.” (act.org).

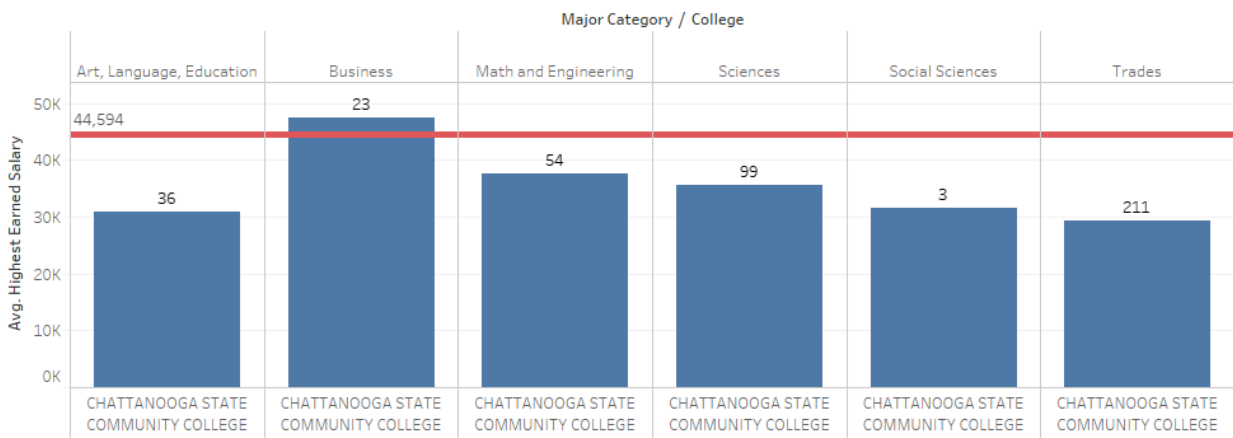
College Time Span

The first, largest and most influential split occurred at college time span. This variable represents those students who earned their highest post-secondary achievement in six years from a 2-year college or 4-year university. Most of the two-year college related salaries fall well below the MIT Living Wage target. Also, it should be noted that most of the students in Hamilton County who go to a 2-year college go to in-state, local schools: Chattanooga State Technical College and Cleveland State. The next graph shows that at Chattanooga State, only those who’s major related to business should expect to earn an average salary over the MIT Living Wage target.

Avg Salary by 2 Year College



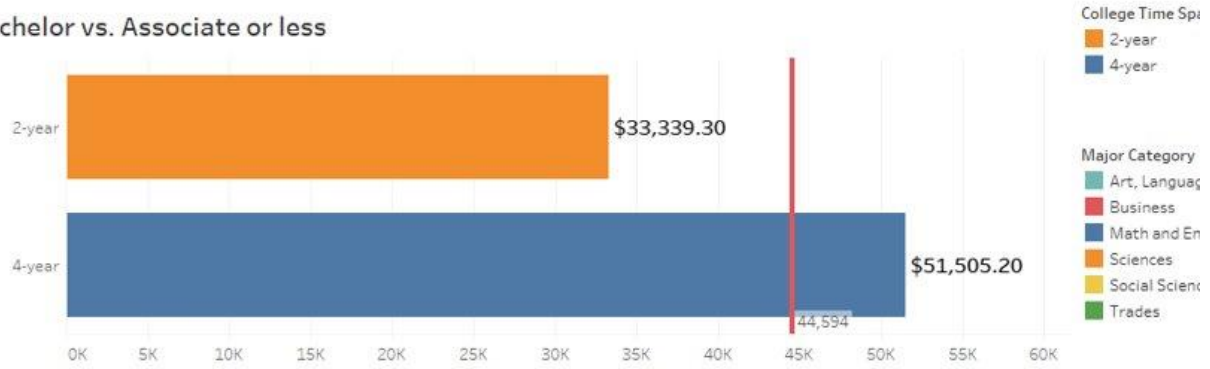
Avg Salary for Chatt State Major Categories



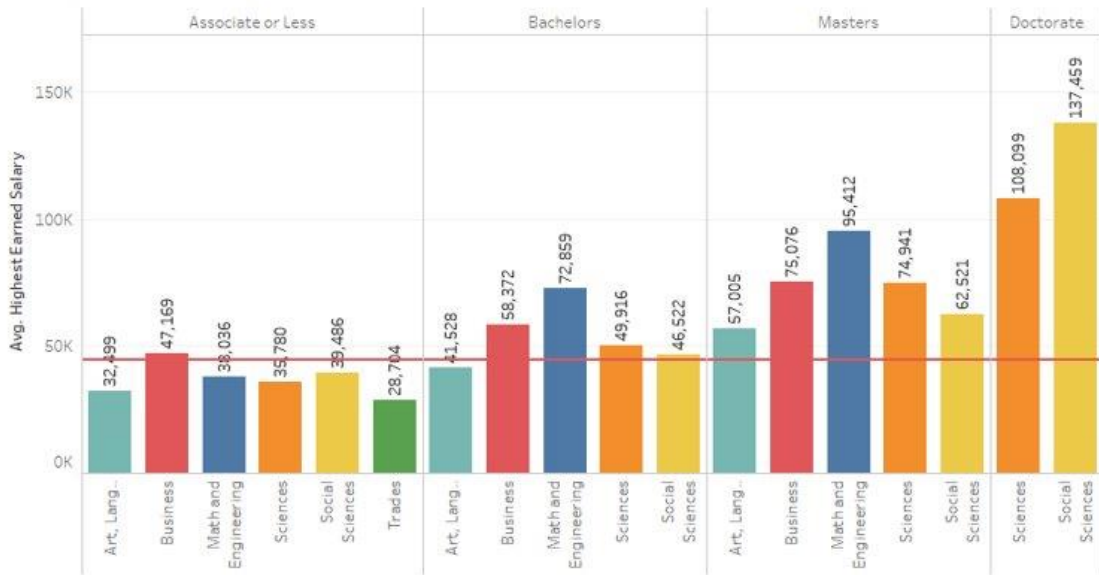
It should also be noted that 141 students went to Chattahoochee State and earned a transfer degree. That is, they matriculated to Chattahoochee State with the intent to transfer to a four-year university in the future. After six years these students had not earned both the 2-year transfer degree and a bachelor’s degree.

Also, with incentives such as Tennessee Promise, which offers free in state tuition for 2-year college programs, it is important for high school students to understand that a two-year achievement may not be enough for them to thrive financially after completion of their program. It is our recommendation that if a student is “on the fence” between attending a two-year school vs. a four-year school, the four-year school is most likely a better choice.

Bachelor vs. Associate or less



Degree/Major Average Salary



Students who achieve a bachelor’s degree have almost \$20,000 higher earning potential after college graduation than students who achieve an Associate Degree or less. Associate or less salaries also fall \$11,255 short of the MIT Living Wage target. Again, it should be noted that on average, only a Business-related major produces an average entry level salary at or slightly above the MIT Living wage. When students are deciding on a career path, it is also important to note that even some Bachelor programs relate to jobs at or below the MIT Living Wage. For some careers/ degree paths, if earning potential is of major concern to the student, post Bachelor achievements should be considered. All Master’s degree and above achievements relate to jobs with salaries above the MIT Living Wage. So, the higher the education a person achieves, the higher the salary they can expect to earn.

CONCLUSION

The significant accomplishment of this study is creating a new dataset and method for linking National Student Clearinghouse data with Federal Bureau of Labor statistics job and salary information. Educational institutes wanting to follow their student’s post-graduation could use this new method to link the student record, college information, and job & salary projections. This is a notable advancement for the study of subjects such as standardized testing, job placement, credential & degree worth, matriculation, and student debt.

To further this work, it is proposed that a larger, more inclusive student dataset be used in the model. This data set should be inclusive of all high school graduates in Tennessee, not just those who earn post-secondary achievements who live in Hamilton County Tennessee. A study of the larger student population could cause other variables to have more importance in the model such as economic disadvantage percent, matriculation, race, location (such as inner city, suburban, rural). A college index should also be developed to see what role college ranking has on salary. This index would be based on college graduation rate and the cost of education at that college or university. Lastly, average salary information would not be influenced by the number of students earning that degree but would only rely on the subsequent job category a major is related to.

This study also includes a preliminary model that can be used in an application that aids students, parents, and guidance counselors in college choice decisions. Department of Education (the LEA), the Public Education foundation collects and maintains data related to postsecondary enrollment, persistence, and completion. As part of that work, they are in the process of developing a mobile application for students and their families, with guidance from Hamilton County's embedded College and Career Advisory system, to identify postsecondary sites that:

1. Are a strong academic match (meaning the site has a graduation rate >50% for students within the same demographic category), and

2. Fit students' financial and location preferences.

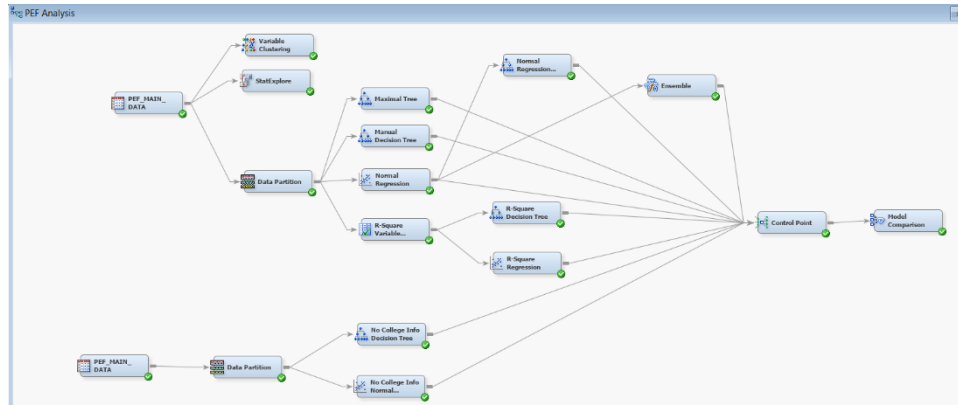
One of the eventual goals of the mobile application is to provide students with workforce information as part of the "fit" component so that they may make the most informed decisions possible to increase their chances of graduating from a postsecondary site within six years of high school graduation with a degree or credential that will put them in a career that meets or exceeds the local or national living wage threshold based on MIT's living wage calculator. This study will play a key role into meeting the goal of the mobile application by taking the TN CIP Code Salaries dataset and incorporating into the mobile postsecondary match and fit algorithm processes.

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Appendix: Further Model Discussion

This appendix will focus on the R-Square and No College Info Regression nodes seen in the process flow diagram below. These two models the decision-making process.



R-Square Regression

For this model, a chi-square selection criterion was used where the partition with the highest chi-square value is considered the input's best partition. A Stepwise Selection model was implemented using the R-square. College Time Span and Composite were the two indicators for reaching the target. This validates how strong College Time Span and Composite have on predicting a student's pathway of making above \$44,594.

Summary of Stepwise Selection

Step	Entered	Effect	Removed	DF	Number	Score	Wald	Pr > ChiSq
					In	Chi-Square	Chi-Square	
1	College_Time_Span			1	1	227.2969		<.0001
2	Composite			1	2	41.1859		<.0001
3	G_HS_Number			6	3	12.7257		0.0476
4		G_HS_Number		6	2		12.0499	0.0609

The selected model is the model trained in the last step (Step 4). It consists of the following effects:

Intercept College_Time_Span Composite

Looking at the Fit Statistics, the misclassification rate and average squared error were higher compared to the Normal Regression model. The performance of this model does not improve. This shows how input variables Private or Public and Gender creates a more accurate prediction.

Target	Target Label	Fit Statistics	Statistics Label	Train	Validation
GE 44 594	GE 44,594	AIC	Akaike's Informat...	1539.139	-
GE 44 594	GE 44,594	ASE	Average Squared ...	0.195217	0.181953
GE 44 594	GE 44,594	AVERR	Average Error Fu...	0.575071	0.545317
GE 44 594	GE 44,594	DFE	Degrees of Freed...	1330	-
GE 44 594	GE 44,594	DFM	Model Degrees of ...	3	-
GE 44 594	GE 44,594	DFT	Total Degrees of ...	1333	-
GE 44 594	GE 44,594	DIV	Divisor for ASE	2666	1784
GE 44 594	GE 44,594	ERR	Error Function	1533.139	972.8455
GE 44 594	GE 44,594	FPE	Final Prediction Er...	0.196098	-
GE 44 594	GE 44,594	MAX	Maximum Absolut...	0.882708	0.85074
GE 44 594	GE 44,594	MSE	Mean Square Error	0.195657	0.181953
GE 44 594	GE 44,594	NOBS	Sum of Frequencies	1333	892
GE 44 594	GE 44,594	NW	Number of Estima...	3	-
GE 44 594	GE 44,594	RASE	Root Average Su...	0.441833	0.42656
GE 44 594	GE 44,594	RFPE	Root Final Predict...	0.442829	-
GE 44 594	GE 44,594	RMSE	Root Mean Squar...	0.442332	0.42656
GE 44 594	GE 44,594	SBC	Schwarz's Bayesi...	1554.725	-
GE 44 594	GE 44,594	SSE	Sum of Squared E...	520.4481	324.6046
GE 44 594	GE 44,594	SUMW	Sum of Case Wei...	2666	1784
GE 44 594	GE 44,594	MISC	Misclassification ...	0.28057	0.256726

No College Regression

Since the Normal Regression was highly affected by College Time Span and Private or Public, a Stepwise Selection model was implemented with those two variables taken out. Composite, was then the highest predictor variable, followed by overall absences. To reach optimal complexity, only two steps were determined.

Summary of Stepwise Selection

Step	Entered	Effect	Removed	Number		Score	Wald	Pr > ChiSq
				DF	In	Chi-Square	Chi-Square	
1	Composite			1	1	123.2139		<.0001
2	Overall_Absences			1	2	7.7189		0.0055
3	HS_Number			16	3	21.6121		0.1562
4		HS_Number		16	2		20.9096	0.1820

The selected model is the model trained in the last step (Step 4). It consists of the following effects:

Intercept Composite Overall_Absences

In the Fit Statistics below, notice how the misclassification rate drastically increases to 0.36435. Compared to the Normal Regression model that had the college information, the misclassification rate jumped 11%. The performance of this model decreased; therefore, we exclude this model from the analysis and keep college information as input variables for our final model.

Target	Target Label	Fit Statistics	Statistics Label	Train	Validation
GE 44 594	GE 44,594	AIC	Akaike's Informati...	1678.213	.
GE 44 594	GE 44,594	ASE	Average Squared ...	0.218977	0.220724
GE 44 594	GE 44,594	AVERR	Average Error Fu...	0.627237	0.632049
GE 44 594	GE 44,594	DFE	Degrees of Freed...	1330	.
GE 44 594	GE 44,594	DFM	Model Degrees of ...	3	.
GE 44 594	GE 44,594	DFT	Total Degrees of ...	1333	.
GE 44 594	GE 44,594	DIV	Divisor for ASE	2666	1784
GE 44 594	GE 44,594	ERR	Error Function	1672.213	1127.576
GE 44 594	GE 44,594	FPE	Final Prediction Er...	0.219965	.
GE 44 594	GE 44,594	MAX	Maximum Absolut...	0.88141	0.875822
GE 44 594	GE 44,594	MSE	Mean Square Error	0.219471	0.220724
GE 44 594	GE 44,594	NOBS	Sum of Frequencies	1333	892
GE 44 594	GE 44,594	NW	Number of Estima...	3	.
GE 44 594	GE 44,594	RASE	Root Average Su...	0.46795	0.469812
GE 44 594	GE 44,594	RFPE	Root Final Predicti...	0.469005	.
GE 44 594	GE 44,594	RMSE	Root Mean Squar...	0.468478	0.469812
GE 44 594	GE 44,594	SBC	Schwarz's Bayesi...	1693.799	.
GE 44 594	GE 44,594	SSE	Sum of Squared E...	583.7939	393.7708
GE 44 594	GE 44,594	SUMW	Sum of Case Wei...	2666	1784
GE 44 594	GE 44,594	MISC	Misclassification ...	0.357089	0.36435

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