

# **Book of Proceedings**

### Fifty-Third Annual Meeting — February 21 - 23, 2024 Southeast Decision Sciences Institute

Charleston, South Carolina



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# Accounting

#### IMPACT OF COVID-19 ON MULTINATIONAL CORPORATIONS' EXCHANGE RATE RISK ASSESSMENT

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#### ABSTRACT

Multinational corporations (MNCs) operate across different countries, they have exposure to exchange rate risk. The potential impacts of exchange rate risk, and how well multinationals manage it, is a key determinant of their long-run success. It is important to realize, however, the problem of exchange rate risk started in August 1971, when President Nixon announced a New Economic Policy ("Nixon shock.") In February 1973 speculative market pressure led to a significant devaluation of the dollar. Subsequently, the convertibility of dollar to gold was suspended and in March of 1973, the Bretton Woods fixed exchange rate system was formally abandoned and the current system of floating exchange rates was born. Under the new system, the volume of daily foreign exchange transactions reached \$0.14 trillion by 1985 and then \$7.5 trillion by 2022. The main contributors to these daily transactions are international trade, foreign investment, and speculation (which dominates daily trading). Hence, the dawn of new type of risk (exchange rate risk). In this new environment, MNCs are required to utilize a variety of tools to mitigate that risk. Notwithstanding different types of exchange rate risk (economic & translation which are evaluated based on yearly results), this study focuses specifically on the ongoing exposure of cash flow transactions denominated in the currencies of ten different countries (developed and developing) with highest GDPs. They are Eurozone, Japan, United Kingdom, Canada, and Australia, as well as India, Brazil, South Korea, Mexico, and Thailand. The "modified" Value-at-Risk (MVaR) model is employed due to its superiority over the traditional Value-at-Risk (VaR) model, to estimate the maximum one-period losses during the eighteen months prior to the onset of the Covid-19 and the eighteen months following the onset of the Covid-19 pandemic. The predicted losses are then compared with the actual ex-post results for both periods. Our objective is to analyze the extent of the transaction exposure and provide practical insights to MNCs as they decide whether or not to hedge this risk. This analysis will answer an important question for MNCs operating across these ten developed and developing economies: given that the costs of hedging a currency's ongoing exposure is high, should MNCs attempt to mitigate (hedge) their currency exposure during black swan events like the pre- and post-Covid-19 time periods, or alternatively, should their hedging strategy be altered during such events (assuming a firm decision has been made to hedge)? The results uncover a noteworthy decision criterion for MNCs with respect to their inflow/outflow transactions. Specifically, while the maximum one-period loss surged by nearly 41% post-COVID-19, the realized gain plummeted by nearly 96.5%. MNCs now have a better understanding when deliberating their global strategy, and whether hedging their currency risks makes sense under these circumstances.

#### INVESTORS' TOLERANCE FOR AMBIGUITY AND AUDITORS' ASSOCIATIONS WITH CLIENTS WHO HAVE HAD RESTATEMENTS AND REGULATORY ENFORCEMENT ACTIONS

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#### ABSTRACT

This research examines investing decisions when the company under consideration has an auditor with other clients who have had financial statement restatements and regulatory enforcement actions. Another issue addressed is whether investors' tolerance for ambiguity affects these investing decisions. Participants were given a questionnaire involving an investment decision and were asked to provide risk assessments and investment amounts. Results indicate that knowledge about an audit firm's associations with other clients did not significantly impact either investors' risk assessments or investment amounts. This research also did not find evidence that participants' tolerance for ambiguity influences investing judgments.

### IMPACT OF THE UKRAINE WAR ON EXCHANGE RATE RISK: A MODIFIED VALUE AT RISK APPROACH.

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#### ABSTRACT

Multinational enterprises (MNEs) 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. The volume of currency trades has grown along with international trade, reaching an approximate daily trading volume of \$7.5 trillion in 2022. Unanticipated systemic events may result in a significant change in exchange rate risk, and impact the risk exposure of MNEs, possibly causing a shift in currency risk management strategies for MNEs. In this study, we examine the impact of the Russia-Ukraine war on the currency exchange rates in developed and emerging economies. To represent developed economies, we examine the exchange rates vs the US Dollar for Euro, Japanese Yen, British Pound, Canadian Dollar and Australian Dollar. To represent emerging economies, we examine the exchange rate vs the US Dollar of Indian Rupee, Brazilian Real, South Korean Won, Mexican Peso and the Thai Baht. These selected currencies represent the countries with the highest GDP in each category.

Managing exchange rate risk requires quantifying the risk. 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 compared to the traditional VaR approach.

We use the MVaR model to estimate the maximum one-day loss for each currency during a oneyear period spanning the six months before and after the commencement of the war. The Brazilian Real has the widest range, the largest standard deviation, the largest MVaR and the largest actual maximum daily loss (AMDL) in both the pre-war and war periods. The trading range was wider for nine of ten currencies in the war period. The standard deviation, MVaR and AMDL was larger for all ten currencies during the war period. The average MVaR and AMDL across the ten currencies increased by 43.2% and 39.1% respectively during the war period. Finally, the realized average return for the ten currencies was relatively flat at -.0084% during the pre-war period, compared to -0.332% during the war period. The increased currency risk during the war period is indicative of the need for hedging strategies by MNEs to mitigate risks during similar global crises.

#### Exploring Financial Instability in America through the lens of Financial Education

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#### ABSTRACT

Financial instability in America is a large problem and one worth examining because of its vast social costs. People assume that financial education is the antidote to this problem yet less than half of the states in America mandate it in High school. Using the 2018 National Financial Capability Study (NFCS), this thesis explores the links between financial education and financial instability using financial literacy as a mediating factor. This thesis used descriptive statistics to give an overview of all important variables and logistic regression to test the hypotheses made. The results showed that financial education and financial literacy are positively related. Furthermore, results showed that financial literacy is negatively associated with financial instability. Policy implications are aimed at the high school level because that is where most amounts of people have potential access to financial education. This study is integral in pushing the notion that financial education is underutilized in America which has resulted in a vast majority of the population becoming financially unstable.

#### PRESIDENCY AND STOCK MARKET

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#### ABSTRACT

There is a strand of literature examining the impact of presidents' party affiliation on stock market performance. For example, Santa-Clara and Valkanov (2003) document that excess stock market returns are significantly higher under Democratic than under Republican presidents. Nofsinger (2004), however, does not find similar evidence. NovyMarx (2014) discovers that the party of the US presidents predicts the performance of popular anomalies, as do some other variables such as weather patterns and astronomical events. To shed light on the debate of presidential party affiliation affecting stock market performance, this paper further investigates if the relation exists by compiling and examining a large dataset covering the United States and international countries.

This research not only sheds lights on our understanding of the relation between president's political party affiliation and the stock market, but also provides practical implications for investors and policymakers aiming to make informed decisions in a constantly changing economic and political landscape.

Because the dynamic between politics and stock market is complex, it is imperative to take the findings with caution, since many factors influence stock market performance, such as economic conditions, global events, and specific policies of some presidents. In addition, some presidents take actions which are against their espoused party ideology, and in other cases, some presidents are thwarted in their policy implementation by a dissenting Congress. With that in mind, this study enriches our understanding of the interaction between politics, economics, and stock market, which is potentially helpful to generate better investment strategies and economic policies.

#### IMPORTANCE OF PEER-TO-PEER PERSONAL FINANCE COACHING IN HIGHER EDUCATION INSTITUTIONS

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#### ABSTRACT

The significant increased cost of higher education in the United States has contributed to an exponential increase of student debt that many Americans perceive as inescapable. Much of this debt is currently held by the US Government and will likely be passed on to taxpayers if loan defaults rise. Thus, the student debt crisis has become an issue that impacts all Americans, not just students. The need for personal finance coaching of college students has become recognized by universities due to the United States Financial Literacy and Education Commission's report [39]. This paper discusses the importance of higher education peer-to-peer financial coaching for U.S. college students.

Key words: Financial literacy, financial education, peer coaching, personal finance.

#### Purpose

In the past two decades, student debt on U.S. college campuses has become an alarming issue. University students have increasingly taken on debt to pay for college. According to the Federal Reserve [15], from the end of 2016 until the end of 2020, outstanding student loan debt grew from \$1.4 to \$1.7 trillion. The Federal Government owns most of the debt at \$1.57 trillion [27]. Figure 1 shows student loan debt growth of 356% from 2003–2020 [36].



Figure 1 Percent Change in Household Debt 2003–2020 Adjusted for Inflation

More than six in ten (62%) college seniors who graduated from public or private nonprofit colleges in 2019 had student loan debt and they owed an average of \$28,950 [21]. The U.S. Department of Education (2023) data shows an even larger average debt of over \$38,000 per borrower, which includes loans for graduate and professional schools[39]. Many of these students are making decisions that will negatively affect their financial futures in ways they do not understand when they agree to the loan [1], [17]. This lack of financial literacy is evident well beyond college and in the workforce. Financially related stress and anxiety have become increasingly prevalent among college students. Financial stress on students leads to lower academic performance, poor productivity, leaving college to work additional hours to manage debt, and an adverse effect on retention rates that can hinder these students' career potential [18]. On March 27th, 2020, the U.S. Department of Education paused student loan payment requirements and set interest rates on student loans to 0% [39]. However, current students and college graduates were informed that loan payment requirements would restart on October 1<sup>st</sup>, 2023. The temporary reprieve in restitution may have reduced some anxiety, but the actual debt and need for financial literacy persist.

The purpose of the paper is to show the importance of peer-to-peer personal financial coaching in institutions of higher education. The aim of these programs is to stimulate knowledge sharing, discourse, and interaction among finance faculty and institutional leaders to consider starting peer-to-peer personal financial coaching programs at their respective schools. Further intent of this publication is to provide suggestions for students and for peer-to-peer coaches, as accountability partners, in addressing (a) the mounting student debt issues, (b) financial stress among college students, (c) student attrition related to financial issues, and (d) the consequences of allowing access to money created by student loans.

#### **Key Terms**

For this paper, the key terms are defined as the following:

*Financial education* - the attainment of financial literacy through a seminar, module course, semester course, or program that enables the learner to acquire essential financial knowledge, skills, and practices facilitated by an instructor.

*Financial literacy* - the basic knowledge, a set of skills, and access to money management tools that allow an individual to think, act, and communicate wisely in making informed financial decisions to achieve a sense of contentment and well-being.

*Financial stress* - is an emotional issue resulting from a lack of knowledge and skills because of insufficient funds, rising debt, unanticipated expenses, and poor money management decisions. *Peer-to-peer financial coaching* - students are educated, trained, and empowered to engage in effective listening to assist in problem-solving and accountability with peers. Peer coaches can use basic tools to make informed financial decisions to help others. The terms financial coaching and financial counseling are used interchangeably in the paper.

#### **Financial Literacy and Education Commission**

The USFLEC (2019) released a report titled, "*Best Practices for Financial Literacy and Education at Institutions of Higher Education*" as mandated by the Economic Growth, Regulatory Relief, and Consumer Protection Act [38]. This report established recommendations for higher education institutions based on quantitative and qualitative data from academics, nonprofit financial education providers, state and local governments, and financial service firms to name a few. The report provides five target recommendations for higher education institutions designed as best practices to incorporate financial literacy and financial decision making. The target recommendations provide clear, timely, and customized information (a) to inform student borrowing; (b) effectively engage students in financial literacy and education; (c) target different student populations by use of national, institutional, and individual data; (d) communicate the importance of graduation and major on repayment of student loans; and (e) prepare students for financial obligations upon graduation [38].

Former U.S. Treasury Secretary Steven Mnuchin said, "It is vital for our higher education institutions to offer students the resources and information they need to make financial decisions that best fit their needs and career aspirations" [23]. According to the report from the U.S. Financial Literacy and Education Commission, colleges should provide lessons in mandatory financial literacy courses as well as financial aid letters that itemize the actual costs of attendance. Additionally, the Treasury Department recommended 'mandatory' financial literacy courses for college students. Helping students and their families avoid the pitfalls associated with financing higher education, and empowering them to make optimal financial choices, should be a priority of all higher education institutions [38].

The USFLEC Report recommended that financial literacy programs adopt the Consumer Financial Protection Bureau's [11] *Five Principles of Effective Financial Education*, which details the individuals and families to be served, provides actionable, relevant, and timely information, improves key financial skills, builds on motivation, and makes it easy to make good decisions and follow through on financial matters. Higher education institutions should adopt the specific best practices to engage students in financial literacy and education that include mandatory financial literacy courses, peer educators, integration of financial literacy into core curricula, and enhance the frequency and timing of communication with students [38].

#### **Student Debt Issues**

A 2021 U.S. Department of Education and the College Board report detailed data into student loan issues. The median loan amount per borrower was less than \$20,000, with 55% of borrowers having less than \$20,000 in debt [37]. However, some students borrowed more significant amounts and skewed the average up significantly. Moreover, 45% of the total loan debt amount is held by only 10% of borrowers who owe more than \$80,000 [37].

At the end of the 4th quarter of 2019, before the COVID-19 event, the Department of Education reported that 9.6% of the direct loan amount outstanding was in default [37]. At that time, 19 million Federal Direct Loan borrowers were in repayment, but only 15.7 million were current with their repayment. An additional 12 million were in default, deferment, or forbearance. This data suggests that almost 50% of borrowers were having trouble making payments on time even before the COVID-19 event and relief efforts started [37]. The Federal Reserve Bank of New York in 2019 noted the following [16]:

As explained in a 2012 report, delinquency rates for student loans are likely to understate effective delinquency rates because about half of these loans are currently in deferment, in grace periods or in forbearance and therefore temporarily not in the repayment cycle. This implies that among loans in the repayment cycle delinquency rates are roughly twice as high." [16].

Therefore, although some data may suggest a smaller percentage of student loan recipients are in arears, that information may be vastly underestimated.

Looney and Yannelis examined changes in the market for federal student loans with a particular focus on the sources of rising default rates, the roles played by educational institutions, and the labor market outcomes of borrowers [27], [28]. They found the increasing default rates concentrated among 'nontraditional' borrowers who attended for-profit schools and, to a lesser extent, two-year institutions, and certain other nonselective institutions. This student demographic borrowed substantial amounts to attend institutions with low completion rates and after enrollment, experienced poor labor market outcomes that made their debt burdens challenging to overcome. Of all the students who left school, started to repay federal loans in 2011, and had fallen into default by 2013, about 70 percent were nontraditional borrowers.

Despite these great concerns about student debt, not all student loan borrowers' struggle. Indeed, many thrive because the education financed with their loans provides employment opportunities that result in financial viability after graduation. Looney examined data from the Department of Education's College Scorecard data by institution and by field of study which revealed the programs Americans have borrowed to attend and how borrowers from those programs fare in the workforce after graduation [27]. Looney identified the data that explains why student loans can be a good investment and why they may not be a good investment. This evidence is critical

as policymakers examine ways to reduce the burden of student debt on those who struggle the most. The Scorecard data shows that the struggles of borrowers are often related to the programs they enroll in and how much those programs cost. Accordingly, students and policymakers may want to consider using the College Scorecard to better understand the consequences of their enrollment choices.

#### **Financial Literacy**

Over the past two decades, financial literacy has received considerable attention in the media and academic literature. In 2008, the President's Advisory Council on Financial Literacy established a definition for financial literacy as: "the ability to use knowledge and skills to manage financial resources effectively for a lifetime of financial well-being" [20]. Atkinson and Messy defined financial literacy from a global perspective and established the following definition, "a combination of awareness, knowledge, skill, attitude, and behavior necessary to make sound financial decisions and ultimately achieve individual financial well-being" [2, p.14].

In 2009, a Sallie Mae survey reported that 84% of college students desired more education on managing their finances, and 40% stated they would have appreciated that information as a freshman [35]. Similarly, 64% percent of the respondents expressed a need for financial management topics in high school. The desire for financial information and education coincides with Xiao et al. findings that objective knowledge reduced risky credit behaviors among first-year college students [40]. Much of this education and training may be provided from resources already organic to the institution. Colleges and universities that offer personal finance in their curriculum can provide financial knowledge to their students.

Goetz, Cude, et al. found that students who take a personal finance course were more likely to engage in additional personal finance offerings [18]. These offerings included on-campus financial counseling centers, peer coaching, and online financial management resources. There has been an increase in the number of colleges and universities offering peer-to-peer guidance or coaching. Peer-to-peer financial counseling positively affected one's subjective financial knowledge and attitudes [8].

#### **Financial Education and Financial Counseling**

Financial literacy, financial education and financial counseling are methods for changing financial behaviors. More than forty studies revealed that financial education and counseling can improve money management knowledge and decision-making [10]. Additionally, Newton and Ender found that peer counseling appears to be especially effective at changing personal finance decisions [30]. Financial counseling and financial education are separate but related concepts. Financial counseling centers on a face-to-face interaction in a coaching setting that helps the client make better financial decisions. Financial education most often takes place in a workshop, education course or program that enables the learner to acquire knowledge, skills and experiential practices facilitated by an instructor [10].

Financial education and financial coaching change the way many students think, act, and communicate about personal finance and related decisions [4]. Financial counseling and peer-to-

peer coaching demonstrated a statistically significant association with changes in objective financial literacy as it relates to credit reports, investments, financial knowledge, financial satisfaction, financial anxiety, and awareness of money owed. Therefore, these programs should be considered as a method to enhance financial decision making, especially in first-year students.

Many faulty financial decisions begin with first year students but seem to improve over time. College Sophomores, Juniors and Seniors reported lower financial-related stress than Freshmen [8]. This discrepancy could be explained by the reality that college may be the first-time freshmen need to manage their personal finances. The stress of paying for food, rent, tuition, fees, textbooks, and socializing could be overwhelming for the average 18-year-old entering college [8]. Help-seeking studies confirm that freshmen are more likely to seek help than more advanced students [26]. The openness of young students to pursue assistance, coupled with their propensity to make poorly informed financial decisions, indicates that financial education and counseling should be provided to students as early as possible in their academic careers.

#### **Financial Stress and Student Attrition**

University leaders frequently report that more students drop out of college due to financial stress than from academic failure [7]. This suggests that universities that offer personal finance in their curriculum can improve financial literacy in their students. Financial stress, generally understood as the emotional impact of one's inability to manage money, limit debt, or make informed financial decisions [5]. Poor practices often result in individuals spending more than they earn, taking on debt, and experiencing financially related stress and other psychological issues. Financial stress is a known contributor to college student attrition [7], below average academic performance [12], student retention [22], and general health and well-being of college students [31].

As early as 2000, Drenta found that anxiety about finances is highest among younger consumers because of their high debt-to-income ratio [13]. Credit card debt is incredibly stressful for college students [24]. A National Endowment for Financial Education (NEFE) poll of young adult students found that of those with debt, 30% worried about it often, 29% decided to put off or not further their education because of debt, and 22% took a job that they otherwise would not have because of debt [29]. Additionally, financial stress among college students links to harmful consequences related to health, well-being, academic performance, and relationships which can all lead to poor academic performance or increased attrition rates [31].

In contrast, financial satisfaction resulting from healthy financial behaviors leads to positive academic performance and greater satisfaction with life for college students. Lowering financial stress and increasing financial satisfaction are keys to improved academic performance, relationships, and retention [40]. It is imperative that educators and institutional administrators research and develop services that can help reduce financial stress to meet the needs of their respective college students. The research findings indicate that universities should give special attention to first-year students transitioning to new roles and responsibilities as college students because all grade levels showed lower financial stress than first-year students. Targeting first-year students with mandated financial education, financial counseling, and peer-to-peer coaching may increase their financial satisfaction and reduce their anxiety in managing money [40].

Students who reported completing a personal finance course and/or managed money well also expressed greater interest in a financial counseling center [32].

#### **Peer-to-Peer Financial Coaching**

Universities building comprehensive campus-based education programs would do well to invest in personal finance courses for incoming students allowing these students to take advantage of financial counseling, peer coaching, and online financial education modules as they matriculate through college [18]. However, given the scarcity of available resources at many higher education institutions, peer counseling programs may provide a more viable alternative that can also be quite beneficial. Students participating in financial education and financial counseling, or peer-to-peer coaching, change their attitudes toward money management, increase financial literacy, and improve financial behaviors because of their engagement [32]. Financial education and financial coaching help students think, act, and communicate about their personal finance [4]. Newton and Ender shared that peer counseling is effective because peers can relate on a generational level and coach fellow students toward effective financial behavior through positive peer coaching [30]. Students receiving peer financial coaching reported higher financial satisfaction two months after their initial coaching session. Students experiencing the highest levels of financial stress, particularly first-year students, should seek or be directed to peer financial coaches [18].

Parker explained that peer coaching is a low-cost resource and powerful tool with high impact, just-in-time delivery, a self-renewing resource, and easily learned [32]. Students learn from peers they see as themselves and are likely to respond positively to questions and coaching support [14]. Peer-to-peer coaching is a unique type of relational learning that focuses on relationships between individuals of equal status who support each other's personal and professional development goals. Peer coaching uses a three-step process to include: how to build effective relationships in peer groups, how to use peer coaching to create successful experiences for the students by honing their relational skills, and how to make peer coaching a habit [32]. Through this three-step process, individuals develop and learn attitudes and behaviors that foster mutual learning in relationships with their peers [32]. Ultimately, peer coaching is an underutilized developmental tool and low-cost resource to facilitate success that can be effective in personal and professional relationships [32].

Peer-to-peer coaching models also provide benefits to the peer educators themselves. Badura research indicated that students who participate in peer education training and become peer educators derive a heightened sense of leadership and increased knowledge of their peer education topic [3]. Consequently, several universities should develop and conduct peer-to-peer personal finance coaching for students.

#### Conclusion

Students at higher education institutions may use student loans out of necessity for funding their education to obtain their higher education degree, but this form of financial assistance may lead to a lifetime of unnecessary debt. These student loans are relatively easy to obtain, often requiring no credit checks and no co-signers. To a young student, loan repayments appear in the

distant future. The interest rates are hard to understand for most students, and students are not questioned on how they will use the money. Sometimes the student may not even understand the details and requirements of the loan repayment process. Young adults with little to no financial literacy education have been willing to use the readily available money without understanding the consequences, which has resulted in a national student loan debt crisis.

Lawmakers have established financial literacy as a public policy objective to improve college student welfare, as well as financial well-being, through better financial decision-making. Institutional decision-makers need to make concerted efforts to focus on financial education and financial coaching for freshmen to attack the student debt crisis. Universities creating comprehensive campus-based financial education programs may do well to invest in personal finance courses for first-year students to ensure a formal, well-supported, and structured core. The peer-to-peer model seems particularly effective in influencing lower-level undergraduate students and may be less resource intensive. College students are often influenced by peer learning in a way that is different from classroom settings. Not only does it provide students with a basis for better financial decisions as they matriculate through college, but also there are likely positive externalities as graduates move into the workforce. In the end, financial peer-to-peer coaching programs establish an essential foundation for a financially sound and service-driven life.

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### DOES DIVERSITY IN THE BOARDROOM WORK? AN EXAMINATION OF THE IMPACT OF DEI IN CORPORATE BOARDS ON EARNINGS QUALITY.

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#### ABSTRACT

This study examines whether firms' diversity, equity, and inclusion (DEI) at the board level, as proxied by racial and ethnic composition, influence firms' earnings quality. Our study focuses on the racial and ethnic composition of the directors and whether these diverse directors influence a company's earnings quality. Using a sample of firms publicly traded in the U.S. and employing quantile regression analysis, we find that the impact of underrepresented minorities (URM) on the board on earnings quality is nonuniform. Specifically, as the proportion and number of URM increases, earnings quality improves as proxied by the absolute value of discretionary accruals. Further, we find that URM expertise is essential as a firm's earning quality deteriorates – in higher quantiles of earnings management. These findings support our hypotheses that racial and ethnic diverse boards are associated with improved earnings quality and provide a business case for increased firm board diversity.

Keywords: Earnings quality, racial and ethnic diversity, discretionary accruals, quantile regression.

#### **INTRODUCTION**

This study examines whether board racial and ethnic diversity is associated with earnings quality. The corporate board has a fiduciary duty of responsibility for the corporation's assets and shareholders' interests. This fiduciary duty involves financial and legal requirements whereby the board ensures an effective mechanism that contributes to higher earnings and guards the company's reputation. One of the ways to facilitate the fulfillment of the board's duties is to provide opportunities to integrate the corporation's culture with the fiduciary duty. The integration may entail the board being intentional during recruitment to have a diverse board. Board diversity encompasses many facets, including gender, race, class, skills, talents, and perspectives. This study focuses on the impact of corporate board racial and ethnic diversity on corporate earnings quality.

Following the civil unrest in the death of George Floyd and other African Americans, the issue of diversity, equity, and inclusion (DEI) gained a renewed eminence. This social unrest also heightened the disparities in the corporate boardrooms, accelerating the need for corporations to review their DEI efforts. Recently, numerous calls have been made from stakeholders, institutional shareholders, regulators, employees, and customers for corporations to implement or improve DEI, specifically by increasing and disclosing their boards' demographic composition.

The issue of board diversity and its impact on corporate performance, such as fewer cases of bribery, corruption, fraud, risk, and shareholder battles, is not new. However, the recent focus is on the board's racial and ethnic diversity and corporations' steps to ensure the equity and inclusiveness of under-represented minorities (URM<sup>1</sup>). In recent years, board racial and ethnic diversity disclosures and representations have increased significantly. For instance, in 2022, 72.3 percent of the S&P 500 disclosed racial board composition, up from 24 percent in 2020. Russell 3000's disclosure was 41.3 percent in 2022, up from 7.7 percent in 2020<sup>2</sup>. For the Russell 3000 companies, this increase represents a 7 percent increase for URM (URM held 19 percent of board directorship in 2022, up from 12 percent in 2020). In the words of Susan Angele, Senior Advisor, KPMG Board Leadership Center, "diverse boards are more effective, and disclosure drives action."

Several existing studies have examined the association between board diversity and various firm outcomes. The majority focuses on gender diversity, and little is known about the impact of racial and ethnic board diversity. Board racial and ethnic diversity reflects a firm's

<sup>&</sup>lt;sup>1</sup> We follow Bogan, Potemkina, and Yonker's (2021) method of determining URM – we aggregate race and ethnicity data for all directors who are not Caucasian or White.

<sup>&</sup>lt;sup>2</sup> https://conferenceboard.esgauge.org/boardpractices/dashboard/boardcomp/6/8

culture and values, influencing the firm's outcomes, such as earnings quality. The argument is that racial and ethnic directors improve board governance, aligning the company's culture with its strategic and business goals, likely improving earnings quality. The choice of earnings quality measures is based on the extent to which current earnings can predict future earnings and cash flows because board monitoring induces the managers to exert more effort and exhibit greater caution in estimating accruals more reflective of future performance.

To examine whether board racial and ethnic diversity promotes improved earnings quality, we evaluate the association between board racial and ethnic diversity and the following earnings quality proxies: the core earnings quality. We control for firm-level variables that previous research found related to earnings quality. We also include industry-fixed and yearfixed effects to control for industry and year-unobserved heterogeneity. Specifically, we regress these proxies on a normalized diversity index derived using Blau (1977). Using firm data at the intersection of RiskMetrics, Compustat, Audit Analytics, and CRSP from 1996 to 2020, we find a significantly negative coefficient on the diversity index, indicating ceteris paribus racial and ethnic diverse boards are associated with improved earnings quality<sup>3</sup>. As a robustness check, we use other proxies for diversity, proportion, and the number of racial and ethnic directors on the board to measure earnings quality. We also run a placebo test to help provide an alternative explanation to our observation.

This study contributes to the stream of literature on corporate governance and diversity. Specifically, this study informs investors and other stakeholders of increased racial and ethnic board diversity motivation and benefits. Increased board diversity may indicate to investors the

<sup>&</sup>lt;sup>3</sup> We define earnings quality as the absolute value of earnings management, which decreases in both incomedecreasing and income-increasing earnings management. Hence, a negative coefficient suggests lower earning management and better earnings quality.

firm's commitment to engaging a diverse and robust governing body (Fama and Jensen 1983). On the other hand, firms may increase board racial/ethnic diversity to boost their reputation. Finally, this study contributes to the debate on the proposed diversity bill in Illinois by examining whether increased board racial/ethnic diversity affects earnings quality.

#### THEORETICAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

The population and buying power of the United States (US) have increasingly become diverse<sup>4 5</sup>. There is a need to reflect this diversity in the board room; racial and ethnic minorities are significantly underrepresented in the board rooms. Prior studies show that racial and ethnic directors possess comparable characteristics with female directors desirable for managerial positions (e.g., Hillman et al. 2002). According to the 2020 National Center for Education Statistics, of the bachelor's degrees conferred in 2018-2019, women earned 57.4 percent, yet only 26 percent hold board seats in S&P 500 companies (2019 U.S. Spencer Stuart Board Index)<sup>6</sup>.

Despite this imbalance in the proportion of female directors, studies suggest that companies with gender-diverse boards exhibit better financial performance, disclosures, and fewer cases of bribery, corruption, fraud, and shareholder battles (Lee, Marshall, Rallis, and Moscardi 2015; Gul, Srinidhi, and Ng 2011). Nevertheless, in a 2020 corporate board census by the Missing Pieces Report, only 17.5 percent of racial and ethnic minorities hold board seats in the Fortune 500, despite their rising educational attainment (Biernat and Kobrynowicz 1997;

<sup>&</sup>lt;sup>4</sup> https://www.mckinsey.com/featured-insights/diversity-and-inclusion/a-300-billion-dollar-opportunity-serving-theemerging-black-american-consumer

<sup>&</sup>lt;sup>5</sup> United States Census Bureau. (2020). Annual estimates of the resident population by sex, race, and Hispanic origin [Data set]. 2019 Population Estimates by Age, Sex, Race, and Hispanic Origin.

<sup>&</sup>lt;sup>6</sup> According to the National Center for Education Statistics, during the academic year 2018-2019, 40.9 percent of the bachelor's degrees were conferred to people who self-identified as racial and ethnic minorities (African American, Hispanic/Latin American, Asian/Pacific Islander, and American Indian/Alaska Native.)

Hillman, CannellA Jr., and Harris 2002; Singh, Rerjesen, and Vinnicombe 2008; Bureau of Labor Statistics 2020).

The upper echelon theory (e.g., Hambrick and Mason 1984; Post and Byron 2015) suggests that board characteristics affect organizational and strategic decisions. Specifically, Boukattaya and Omri (2021) note that board composition defines its quality. Board homogeneity may result in repeat assessment errors, a phenomenon less likely in a diverse board (Phillips, Liljenquist, and Neale 2009). Hence, increased board diversity may lead to a broad breadth of strategic options (e.g., less groupthink, consideration of more options, improved decision-making) beneficial to a firm, and one benefit may be improved earnings quality. Whether the recent spike in board diversity disclosure and increased board representation stems from pressure from institutional investors, state legislatures, or awareness that there is a business case for board diversity remains an open empirical question.

#### **BOARD DIVERSITY AND EARNINGS QUALITY**

This study explores the impact of the URM on corporate earnings quality. The primary responsibility of the financial information product lies in the management. However, through the audit committee, the board of directors oversees a firm's financial statements and reporting, the audit process, the company's system of internal controls, and compliance with laws and regulations. These fiduciary duties suggest that the board of directors has a significant role in ensuring the integrity of the accounting numbers and the quality of earnings. Further, Agrawal and Knoeber, 2020 document that the board is an important internal governance control mechanism essential in aligning the interests of managers and all stakeholders in a firm.

Prior literature suggests the importance of board heterogeneity in reducing collusion between management and the board, increasing monitoring, and reducing agency costs (Hillman and Dalziel 2003; Cavaco, Crifo, Rebérioux, and Roudaut 2017).

Further, psychology studies show that diversity ensues in moderated decisions (Bernile, Bhagwat, and Yonker 2017; Sah and Stiglitz, 1986, 1991.) Thus, we conjecture that a homogeneous board lacks an internal governance mechanism - scrutiny, leading to less desirable earnings quality. This literature implies that a heterogeneous board is essential in curbing opportunistic managerial behavior.

Agency theory suggests that in the absence of effective monitoring, managers pursue their self-interest at the expense of shareholders (Jensen and Meckling 1976). Prior literature provides evidence that corporate managers manage earnings through discretionary accruals (Jones 1991; Dechow, Sloan, and Sweeney 1995; Dechow and Dichev 2002) and accounting misstatements that trigger financial statement restatements, among other methods. Krishnan (2005) also argues that sound internal controls are a precursor of proper financial reporting. Firms manage earnings for contractual purposes (Healy 1985), avoid debt contract violations (DeFond and Jiambalvo 1994), and obtain highly seasoned equity valuations (Teoh, Welch, and Wong 1998). In such circumstances, corporate boards' expertise and heterogeneity are vital in mitigating opportunistic managerial behavior. Additionally, Berger, Kick, and Schaeck (2014) and Phan and Yu (2022) contend that an executive's experiences and personality traits significantly influence their interpretations and corporate decisions. Thus, it is important to analyze how the board's composition impacts the earnings quality.

However, there are reasons to believe that board racial and ethnic diversity is not associated with high earnings quality. Racial and ethnic diverse directors are perceived as

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outsiders. Thus, there is potential for conflict with the management that could lead to information deficiency, compromising their monitoring and advisory roles (Cavaco et al. 2017; Bernile et al. 2017; Arrow 1951). Additionally, the "black sheep" effect suggests that the dominant group tends to discount the opinions of the minority group members and, thus, disregard their positions (Marques, Abrams, and Serôdio 2001; Erkut, Kramer, and Konrad 2008). Field, Southern, and Yoore (2020) document that stereotype, bias, and homophily (McPherson et al. 2001) may hinder URM from contributing significantly to the board's fiduciary role. Consistent with information scarcity and the black sheep effect, the influence of board diversity on earnings quality could also be neutral or even negative, necessitating the empirical investigation of this issue. Based on the above discussion, we form the following hypothesis, stated in the alternative form:

# *H1: There is no association between racial and ethnic board diversity and earnings quality, ceteris paribus.*

Langin (2019) highlights the pervasive nature of gender, race, and ethnic biases. Notably, women of color tend to be doubly disadvantaged. Guest (2019) provides evidence that URM directors possess different traits from white directors that positively impact their monitoring and advisory roles. Specifically, Guest (2019) documents that URM directors will likely face bias and stereotypes. Thus, they are sensitive to unfair treatment, oppose opportunistic managerial behavior such as rent extraction and misreporting, and are less likely influenced by group thinking. In line with the argument on the positive effects of gender and URM directors, we argue that having both diversity categories may have a positive incremental effect on earnings quality.

#### **RESEARCH DESIGN**

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#### **URM Measures**

In this section, we describe the URM measures based on the racial and ethnic diversity of the board of directors. *BINDEX* is a diversity index advanced by Blau (1977). Blau's (1977) index is widely used in linguistics, ecology, and economics. It approximates diversity as a variety – the extent to which a board represents all races and ethnicities, and balance – how equally all races/ethnicities are represented. We compute Blau's diversity index, *BINDEX*, as follows:

$$BINDEX_{i,t} = 1 - \sum_{k=1}^{n} P_k^2, \tag{1}$$

where P is the proportion of board members in each race/ethnicity, k represents the different groups of race/ethnicity in a board, and n is the total number of board members. To eliminate the effect of board size on the index, we normalize *BINDEX* with its theoretical maximum (1-1/k). We also measure URM as the number of racial and ethnic directors divided by the total number of directors on the board, *BDIV*. Finally, we also measure URM as the number of unrepresented directors on each board, *BODIV*.

#### **Earnings Quality Measures**

To investigate the effect of URM on earnings quality, we use an accruals-based proxy for earnings quality based on the accrual model developed by Dechow and Dichev (2002) and modified by McNichols (2002) (*MDD*). Dechow and Dichev (2002) define earnings quality as a function of current, lagged, and future cash flows since accruals reverse in the future when cash is paid or received. McNichols (2002) modifies Dechow and Dichev's (2002) model by including changes in sales and current property, plant, and equipment, thus linking the model to Jones' (1991) discretionary accrual model as follows:

$$\Delta WC_{,t} = \beta_0 + \beta_1 CFO_{i,t-1} + \beta_2 CFO_{i,t} + \beta_3 CFO_{i,t+1} + \beta_4 \Delta REV_{i,t} + \beta_5 PPE_{i,t} + \varepsilon_{i,t},$$
(2)
where  $\Delta WC$  is the changes in working capital accruals from year *t*-1 to *t*, computed as  $\Delta Accounts$ *Receivable* +  $\Delta Inventory - \Delta Accounts Payable - <math>\Delta Taxes Payable + \Delta Other Assets; CFO$  is the cash flow from operations;  $\Delta REV$  is the change in revenue from year *t*-1 to year *t*; and *PPE* is the current period level of property, plant, and equipment. We scale all variables by average total assets. Following Francis et al. (2005), we estimate Eq. (2) cross-sectionally by industry year for each Fama and French (1997) 48 industry groups with at least 20 firms. Consistent with Srinidhi et al. (2011), I use the absolute value of the residual  $\varepsilon_{i,t}$  from Eq. (2). Higher values of *MDD* denote lower earnings quality.

# **Empirical Model**

Our primary model is a panel quantile regression model. While prevalently used in literature, ordinary least squares (OLS) analysis presents a limitation since it provides a point estimate while ignoring the behavior of the dependent variable in the extreme regions. To address the limitation of OLS, we employ a panel quantile regression model in our analysis. We specifically employ Machado and Silva's (2019) regression quantiles estimation since the model is suited for panel models applicable to individual fixed effects with endogenous explanatory variables. Further, the methodology provides insight into how regressors affect conditional quantiles.

In our quantile regression, our primary explanatory variables is URM proxied by three variables: *DIVPROP*, the proportion of underrepresented minorities on the board; *BODIV*, the number of underrepresented minorities on each board; and *BINDEX*, a diversity index by Blau (1977). We also include control variables that prior literature document to influence earnings quality (Dechow and Dichev 2002; Srinidhi et al. 2011; Dou, Hope, and Thomas 2013.) Specifically, we control for firm size *SIZE*, book-to-market ratio *BTM*, and financial leverage

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*LEV*, sale growth *SALEGR*, sale volatility *SALEVOL*, firm age *AGE*, and board size *BOARDSIZE*. We also include director characteristics that are associated with earnings quality (Srinidhi et al. 2011), namely the extent of CEO power on the board *CEOPOWER*, the number of years a director serves on the board *TENURE*, proportion of female directors on the board *PROPFEM*, and the number of boards a director serves *NUMBOARDS*. Our analysis includes year and industry dummies to adjust for year and industry unobserved confounders (Anderson et al. 2004 and Petersen 2009.)

#### **Sample Construction:**

The sample comprises 32,076 firm-year observations from 1996 to 2020, with director data available in Institutional Shareholder Services (ISS). For regression analysis, the sample size is 24,681 after excluding financial services and utility companies, SIC codes 6000 - 6999 and 4000 – 4999, respectively, because these firms operate in a highly regulated industry with accounting rules that differ from nonfinancial firms. The entire sample is an intersection of ISS and Compustat data. Similar to Field et al. (2020), we set unreasonable ethnic identification (e.g., "ACADEMIC," "NULL," "LORD") as missing. (Board size numbers similar to those of Field et al. (2020). Our sample is limited to 1996 – 2020 due to the availability of director data in ISS.

## RESULTS

#### **Descriptive Statistics**

Table 1 provides the distribution statistics for our analysis's entire sample of directors. Table 1 Panel A shows that board directorship increases over the years on average. Table 1 Panel B shows the tabulation of URM and non-URM over the years. These results show an upward trend in the URM representation on the board over the years. Specifically, this trend is noticeable from 2018 – 2020, where the URM increase is higher than that of non-URM.

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Table 1 Panel C shows the board diversity for each industry. Computers, Software, and Electronic Equipment industries are more likely to have diverse boards (651 URM directors) than Consumer Durables (59 URM directors). Why these results do not speak to the reasons for the range of diversity on the boards, we do observe that URM are more likely to be appointed in specific industries than others. Table 1 Panel D the director distribution over the years based on the URM category – African American, Asian, Hispanic and Latino, and Caucasian. The Caucasian directors are the majority over the years, followed by African-American directors. Hispanic and Latino directors comprise the fewest of the URM. There is an increased representation of URM on the board. In 2020, African Americans gained 28 new directors out of the total 31 new directors added during the year, consistent with firms responding to societal pressure to increase diversity following the death of George Floyd (Bogan et al. 2021.)

Table 2 presents the descriptive statistics and the difference between the mean of the variables used in the analysis. On average diverse firms, URM=1 are larger (SIZE = 8.198), older (AGE = 31.265 years), have larger boards (BOARDSIZE = 9.157); and have higher proportion of female directors (PROPFEM = 15.9 percent) than non-diverse firms, URM=0 (SIZE = 7.727; AGE = 28.158 years; BOARDSIZE = 8.542; and PROPFEM = 12.9 percent). Non-diverse firms have a higher growth rate (SALEGR = 8.9 percent), and directors have a longer tenure (TENURE = 9.708 years) than diverse firms (SALEGR = 8.7 percent; TENURE = 9.676 years).

[Insert Table 1]

# URM and Earnings Quality

Table 3 presents the results for H1 – the association between URM and earnings quality. In column (1), we show the OLS results. The OLS regression coefficient for *BINDEX* is -1.101 (p-value < 0.01), suggesting that a diverse board is associated with decreased earnings management and improved earnings quality. However, under quantile regression, the magnitude and significance of *BINDEX* varies across different quantiles of earnings quality. Specifically, we observe that as earning management increases, the impact of URM in improving earnings quality increases in magnitude and significance. The *BINDEX* in the 50<sup>th</sup> quantile is -0.882 (pvalue < 0.01); the 75<sup>th</sup> quantile is -1.492 (p-value < 0.01); the 95<sup>th</sup> quantile is -2.927 (p-value < 0.05). The results of the nonuniform impact of URM suggest that the effect of board diversity varies based on the level of earnings quality. These results are similar to Bernile et al. (2018), who find that a diversified board is associated with better performance, lower risk, and innovation processes than homogenous boards.

# [Insert Table 3]

# **Robustness Checks**

Our primary analysis shows that board racial/ethnic diversity is associated with improved earnings quality (reduced earnings management). Further, we find that racial and ethnic board diversity is more effective in improving earnings quality in higher quantiles of earnings management (lower earnings quality) than in the lower quantiles of earnings management. Therefore, to check the robustness of our analysis, we perform several sensitivity analyses, namely, alternative measures of our diversity index, placebo test, and entropy balancing.

# Alternative Measure of Racial and Ethnic Board Diversity

In the primary analysis, we use a diversity index by Blau (1977) that estimates board diversity as the extent of the variety of various race and ethnicity groups within a board. To deal with concerns of bias that this diversity index may induce, we use *BDIV* (*BODIV*), the proportion (number) of racial and ethnic diverse directors on the board. In Table 4, we show the results for the alternative measures of diversity – *BDIV* and *BODIV*. Consistent with our main results, we

observe the importance of racial and ethnic board diversity in improving earnings quality. *BDIV* and *BODIV* are negative and significant, implying that board racial and ethnic diversity is essential in improving earnings quality.

[Insert Table 4]

# Placebo Test

So far, the analysis points toward the effectiveness of board diversity in improving earnings quality (reduced instances of earnings management). In this section, we use a placebo test to ensure the reliability and validity of our statistical analysis. We specifically use the *PERCENT\_WHITE*, the proportion of white directors on the board. Since we attribute the improved earnings quality to racial and ethnic board diversity, we do not expect a relationship between *PERCENT\_WHITE* and the earnings quality proxy - *MDD*. That is, if the observation in the primary analysis is due to the racial and ethnic directors on the board, we expect the coefficient of *PERCENT\_WHITE* to have no statistical significance or an opposite impact on the firm's earnings quality.

In Table 5, we find a positive and statistically significant coefficient for *PERCENT\_WHITE*, supporting that the results we observe in our primary analysis are not spurious. Specifically, we find that declining earnings quality may be partly attributable to the proportion of caucasian directors on the board.

# [Insert Table 5]

# Entropy Balancing

We employ an entropy balancing methodology to assess whether differences in our covariates drive the results we observe. The results we observe between earnings quality and racial and ethnic board diversity may be driven by some correlated omitted variables significantly different between firms that are racial/ethnic diverse and those that are not. To alleviate these concerns, we use entropy balancing (Hainmueller 2012; Hainmueller and Xu 2013) to generate a comparison group similar to the firms with diverse boards that feature statistically identical firms in their means and variances. Entropy balancing achieves the "balancing" of controls by assigning each control variable a weight based on a pre-specified level of covariate moment conditions.

Table 6 Panel A shows the descriptive statistics of our covariables before and after entropy balancing. In Panel B, we show the regression results after "balancing" the covariates used in the analysis. We continue to observe negative and statistically significant results, suggesting that racial and ethnic board diversity is associated with improved earnings quality (decreased earnings management.)

# [Insert Table 6]

# Conclusions

This study investigates the impact of board racial and ethnic composition on the firm's earnings management. We collected 32,076 (3,126 URM and 28,950 caucasian directors) firm-year observations from 1996 to 2020 with ISS data on race and ethnicity. We calculated our diversity proxies using measures widely used in prior literature, Blau's (1977) diversity index, the proportion of minorities (racial and ethnic directors), and the number of URM. Our findings indicate that firms with racial and ethnic board diversity have improved earnings quality. Further, this relationship is not linear – at higher levels of earnings management, lower earnings quality, board racial and ethnic diversity acts as a form of governance necessary to curb opportunistic managerial behavior. Our findings conflict with Guest's (2019), who fails to find an association between board racial and ethnic board diversity and board monitoring. We find that

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the choice of board diversity proxy influences the results, necessitating a broad range of diversity proxies.

With the rise in the disclosure of racial and ethnic diversity disparities in board participation, this study shows that diversity contributes to board oversight that enhances earnings quality. These findings are significant given the move by Nasdaq Inc. to file a proposal with the SEC in December 2020 requiring firms listed in the exchange to have a racial and gender-diverse board. With more than three-quarters of the Nasdaq's Inc. listed companies falling short of this proposal requirement, this study supports the proposal.

While our study provides valuable insights into the importance of board racial and ethnic diversity, it is equally important to acknowledge some limitations than limit the interpretations of our findings. Endogeneity concerns, such as correlated omitted variables and simultaneity bias, may likely exist and impact the study's findings even after controlling for similar biases through entropy balancing tests. Thus, econometric problems may still exist. Even though ISS carefully reports directors' race and ethnicity, it is impossible to identify directors with mixed race and ethnicity, making it hard to perform unbiased analysis on these directors. Finally, it is difficult to disentangle the shareholders' intent for appointing a racial and ethnic director – is it a business case, or is it a form of tokenism?

Despite the limitations, the study documents the link between racial and ethnic board diversity and earnings quality. Future research may examine the effect of diversity on other firm outcomes and use other diversity measures, such as the DeepFace machine-learning algorithm. Moreover, it is interesting to examine whether the diversity of the audit committee, which is primarily responsible for earnings quality, has a stronger effect on earnings quality than the board diversity as a whole.

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	Table Sample Dis	e 1 tributions						
Pane A: Sample Distribution by Year								
Year	Frequency	Percent	Cumulative					
1996	1.140	3.55	3.55					
1997	1.287	4.01	7.57					
1998	1,404	4.38	11.94					
1999	1.408	4.39	16.33					
2000	1,390	4.33	20.67					
2001	1.431	4.46	25.13					
2002	1.162	3.62	28.75					
2003	1,184	3.69	32.44					
2004	1,190	3.71	36.15					
2005	1.181	3.68	39.83					
2006	1,138	3.55	43.38					
2007	1.062	3.31	46.69					
2008	1.215	3.79	50.48					
2009	1.243	3.88	54.36					
2010	1 249	3 89	58.25					
2011	1 267	3.95	62.2					
2012	1,286	4 01	66.21					
2012	1 304	4 07	70.27					
2013	1 310	4.08	74 36					
2015	1 313	4 09	78.45					
2015	1 342	4.09	82 63					
2010	1,342	4.16	86.89					
2017	1,360	4.20	91.16					
2010	1,307	4.27	05 54					
2019	1,403	4.37	100					
Total	32 076	4.40	100					
Donal D: Sample Distribution h	32,070	$\mathbf{UDM} = 0$						
Voor	$\frac{y \cup Kw - 1 v}{UPM - 0}$	$\frac{S \text{ UKW} = 0}{\text{ UBM} = 1}$	Total					
1006	1.062	OKW = 1	1 140					
1990	1,002	104	1,140					
1997	1,103	104	1,207					
1990	1,309	9J 119	1,404					
2000	1,290	110	1,400					
2000	1,200	110	1,390					
2001	1,290	155	1,431					
2002	1,033	107	1,102					
2005	1,070	114	1,104					
2004	1,000	102	1,190					
2005	1,000	113	1,101					
2006	1,024	114 01	1,138					
2007	901 1.004	01 121	1,002					
2008	1,094	121	1,213					
2009	1,125	118	1,240					
2010	1,135	114	1,249					
2011	1,139	128	1,20/					
2012	1,164	122	1,280					
2013	1,177	127	1,304					

2014	1,164	146	1,310
2015	1,174	139	1,313
2016	1,200	142	1,342
2017	1,196	170	1,366
2018	1,215	154	1,369
2019	1,230	173	1,403
2020	1,231	201	1,432
Total	28,950	3,126	32,076
	,		· · ·

	,		
Panel C: Sample Distribution by Industry			
Industry	URM = 0	URM = 1	Total
Consumer Non-Durables	1,717	244	1,961
Consumer Durables	799	59	858
Manufacturing	3,834	300	4,134
Energy Oil, Gas, and Coal Extraction and Products	1,104	76	1,180
Chemicals and Allied Products	975	110	1,085
Computers, Software, and Electronic Equipment	4,648	651	5,299
Telephone and Television Transmission	472	76	548
Utilities	1,453	210	1,663
Wholesale, Retail, and Some Services	3,474	326	3,800
Healthcare, Medical Equipment, and Drugs	2,167	214	2,381
Finance	5,148	584	5,732
Other	3,159	276	3,435
Total	28,950	3,126	32,076

YearAAASIANHISPANICCAUCASIANT19964620121,062119975334171,1831199047221612001200	Total ,140 ,287
1996       46       20       12       1,062       1         1997       53       34       17       1,183       1         1990       47       22       16       1200       1200	,140 ,287
1997         53         34         17         1,183         1           1992         47         32         16         1,233         1	,287
1000 17 20 16 1 200 1	404
1998 4/ 32 16 1,309 1	,404
1999 57 35 26 1,290 1	,408
2000 54 38 18 1,280 1	,390
2001 53 54 26 1,298 1	,431
2002 49 35 23 1,055 1	,162
2003 53 36 25 1,070 1	,184
2004 57 29 16 1,088 1	,190
2005 50 44 21 1,066 1	,181
2006 60 37 17 1,024 1	,138
2007 35 34 12 981 1	,062
2008 61 46 14 1,094 1	,215
2009 64 38 16 1,125 1	,243
2010 50 42 22 1,135 1	,249
2011 49 46 33 1,139 1	,267
2012 50 41 31 1,164 1	,286
2013 52 52 23 1,177 1	,304
2014 64 60 22 1,164 1	,310
2015 53 44 42 1,174 1	,313
2016 67 54 21 1,200 1	,342
2017 59 71 40 1,196 1	,366
2018 59 63 32 1.215 1	,369
2019 58 66 49 1,230 1	,403

2020	86	70	45	1,231	1,432
Total	1,386	1,121	619	28,950	32,076

Notes: Table 1 presents sample distribution by year, industry, and racial and ethnic categories. Panel A shows the number of firms by year, Panel B shows distribution by year comparing racial and ethnic directors with caucasian directors, panel C shows distribution based on the Fama-French 12 industry classification, and Panel D shows the number of firms by fiscal year and each racial and ethnic category. All variables are defined in the Appendix.

TABLE 2 Summary Statistics							
URM = 1 (N= 3.126) $URM = 0$ (n = 28.950)							
			,				p-value
							for t-
							statistic
Variables		Mean	Median	Mean	Median	Mean Diff.	of Means
MDD	0.081	0.074	0.044	0.072	0.044	0.002	0.210
SIZE	7.665	8.198	8.075	7.727	7.604	0.471	0.000
LEV	0.232	0.245	0.229	0.239	0.223	0.006	0.104
MTB	3.389	3.363	2.227	3.084	2.190	0.279	0.000
SALEGR	0.088	0.077	0.054	0.089	0.065	-0.012	0.004
SALEVOL	0.109	0.087	0.053	0.092	0.059	-0.005	0.004
AGE	28.134	31.265	27.000	28.158	24.000	3.107	0.000
BOARDSIZE	8.210	9.157	9.000	8.542	9.000	0.615	0.000
CEOPOWER	0.045	0.033	0.000	0.045	0.000	-0.012	0.002
TENURE	9.696	9.676	9.670	9.708	9.701	-0.032	0.004
FOREIGN	0.341	0.367	0.000	0.307	0.000	0.060	0.000
LOSS	0.168	0.146	0.000	0.146	0.000	0.000	0.971
BIG4	0.348	0.301	0.000	0.328	0.000	-0.027	0.002
PROPFEM	0.127	0.159	0.154	0.129	0.125	0.030	0.000
NUMBOARDS	1.570	1.678	1.000	1.524	1.000	0.154	0.000

Notes: In the dataset, there are 3,126 firm-year observations for racial and ethnic directors (9.74%) and 28,950 firm-year observations for Caucasian directors (90.25%). The p-value is derived from an independent t-test comparing the racial and ethnic directors with the Caucasian directors (\*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.10). In the regression analysis, we exclude financial and utility companies.

Table 3: Test of the Relationship between URM and Earnings Quality							
	(1)	(2)	(3)	(4)	(5)	(6)	
VARIABLES	Pooled Regression	Q_0.05	Q_0.25	Q_0.50	Q_0.75	Q_0.95	
Intercept	4.076***						
Ĩ	-9.940						
BINDEX	-1.101***	-0.171	-0.479	-0.882***	-1.492***	-2.927**	
	(-3.299)	(-0.380)	(-1.468)	(-2.935)	(-2.717)	(-2.114)	
SIZE	0.173***	0.0870	0.115***	0.152***	0.209***	0.341*	
	-3.904	(1.461)	(2.670)	(3.829)	(2.866)	(1.856)	
LEV	-1.926***	-0.188	-0.763***	-1.516***	-2.654***	-5.334***	
	(-6.700)	(-0.493)	(-2.755)	(-5.931)	(-5.685)	(-4.530)	
MTB	0.165***	0.0213	0.0687***	0.131***	0.225***	0.446***	
	-12.912	(1.102)	(4.900)	(10.09)	(9.495)	(7.470)	
SALEGR	0.579**	0.529	0.546**	0.567**	0.600	0.676	
	-2.329	(1.421)	(2.020)	(2.278)	(1.318)	(0.589)	
SALEVOL	5.400***	-1.847**	0.550	3.690***	8.439***	19.62***	
	-11.323	(-2.548)	(1.044)	(7.548)	(9.460)	(8.724)	
AGE	-0.033***	-0.0114**	-0.0184***	-0.0276***	-0.0415***	-0.0741***	
	(-9.285)	(-2.549)	(-5.676)	(-9.223)	(-7.591)	(-5.383)	
BOARDSIZE	-0.095***	-0.0507*	-0.0653***	-0.0844***	-0.113***	-0.181**	
	(-4.166)	(-1.810)	(-3.214)	(-4.508)	(-3.312)	(-2.101)	
CEOPOWER	-0.029	0.0723	0.0388	-0.00517	-0.0716	-0.228	
	(-0.124)	(0.247)	(0.183)	(-0.0264)	(-0.200)	(-0.253)	
TENURE	-0.021*	-0.00356	-0.00942	-0.0171	-0.0287	-0.0560	
	(-1.662)	(-0.218)	(-0.796)	(-1.568)	(-1.441)	(-1.115)	
FOREIGN	0.305***	0.239	0.261**	0.289***	0.332*	0.433	
	-2.811	(1.636)	(2.460)	(2.961)	(1.860)	(0.962)	
LOSS	3.527***	0.429*	1.454***	2.796***	4.826***	9.606***	
	-24.605	(1.903)	(8.845)	(18.22)	(17.27)	(13.64)	
BIG4	0.438***	0.163	0.254**	0.373***	0.553***	0.977**	
	-4.203	(1.195)	(2.567)	(4.093)	(3.322)	(2.327)	
PROPFEM	-0.129	0.442	0.253	0.00578	-0.368	-1.249	
	(-0.277)	(0.731)	(0.577)	(0.0143)	(-0.498)	(-0.670)	
NUMBOARDS	0.085	0.0150	0.0382	0.0687	0.115	0.223	
	-1.524	(0.219)	(0.770)	(1.500)	(1.370)	(1.056)	
Observations	24,681	24,681	24,681	24,681	24,681	24,681	
R-squared	0.091						
Industry FE	YES	YES	YES	YES	YES	YES	
Year FE	YES	YES	YES	YES	YES	YES	

Note: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.10. Table 3 presents the association between racial and ethnic board diversity (*BINDEX*) and earnings quality. *BINDEX* is a variety index computed following Blau (1977). z-statistics are based on standard errors adjusted for industry clustering effects. Variable descriptions are provided in Appendix Table A.1.

Table 4: Test of t	he Relationship betw	ween URM and	d Earnings Qu	ality		
	(1)	(2)	(3)	(4)	(5)	(6)
	Pooled					
VARIABLES	Regression	Q_0.05	Q_0.25	Q_0.50	Q_0.75	Q_0.95
Intercept	3.998***					
	(9.671)					
BODIV	-0.159***	-0.0855	-0.110**	-0.142***	-0.190**	-0.303
	(-2.864)	(-1.156)	(-2.046)	(-2.864)	(-2.100)	(-1.329)
SIZE	0.172***	0.0934	0.120***	0.154***	0.205***	0.327*
	(3.889)	(1.563)	(2.759)	(3.853)	(2.819)	(1.780)
LEV	-1.927***	-0.171	-0.753***	-1.513***	-2.662***	-5.368***
	(-6.703)	(-0.449)	(-2.719)	(-5.927)	(-5.713)	(-4.567)
MTB	0.165***	0.0210	0.0685***	0.131***	0.225***	0.446***
	(12.907)	(1.087)	(4.888)	(10.09)	(9.507)	(7.483)
SALEGR	0.581**	0.523	0.542**	0.567**	0.605	0.694
	(2.337)	(1.405)	(2.008)	(2.281)	(1.333)	(0.606)
SALEVOL	5.394***	-1.851**	0.548	3.685***	8.427***	19.59***
	(11.308)	(-2.556)	(1.040)	(7.549)	(9.469)	(8.733)
AGE	-0.033***	-0.0109**	-0.0181***	-0.0275***	-0.0416***	-0.0750***
	(-9.272)	(-2.443)	(-5.580)	(-9.189)	(-7.634)	(-5.453)
BOARDSIZE	-0.088***	-0.0440	-0.0585***	-0.0774***	-0.106***	-0.173**
	(-3.776)	(-1.539)	(-2.819)	(-4.050)	(-3.038)	(-1.969)
CEOPOWER	-0.027	0.0793	0.0442	-0.00181	-0.0713	-0.235
	(-0.114)	(0.271)	(0.208)	(-0.00929)	(-0.200)	(-0.261)
TENURE	-0.02	-0.00520	-0.0101	-0.0166	-0.0263	-0.0492
	(-1.569)	(-0.320)	(-0.858)	(-1.524)	(-1.325)	(-0.983)
FOREIGN	0.303***	0.241*	0.262**	0.288***	0.328*	0.423
	(2.793)	(1.653)	(2.471)	(2.956)	(1.844)	(0.942)
LOSS	3.527***	0.426*	1.453***	2.796***	4.825***	9.605***
	(24.600)	(1.892)	(8.845)	(18.24)	(17.30)	(13.66)
BIG4	0.435***	0.163	0.253**	0.371***	0.548***	0.967**
	(4.173)	(1.199)	(2.563)	(4.076)	(3.302)	(2.308)
PROPFEM	-0.143	0.460	0.260	-0.000522	-0.395	-1.323
	(-0.306)	(0.761)	(0.594)	(-0.00130)	(-0.536)	(-0.712)
NUMBOARDS	0.084	0.0147	0.0378	0.0680	0.114	0.221
	(1.510)	(0.214)	(0.761)	(1.486)	(1.360)	(1.049)
Observations	24681	24,681	24,681	24,681	24,681	24,681
<b>R-Squared</b>	0.091					
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Table 5: Robustness check results - Alternative Measure of Diversity							
Panel A - Numbe	er of racial and ethnic di	rectors on the	e board				
	(1)	(2)	(3)	(4)	(5)	(6)	
VARIABLES	Pooled Regression	Q_0.05	Q_0.25	Q_0.50	Q_0.75	Q_0.95	
Intercept	3.998***						
	(9.671)						
BODIV	-0.159***	-0.0855	-0.110**	-0.142***	-0.190**	-0.303	
	(-2.864)	(-1.156)	(-2.046)	(-2.864)	(-2.100)	(-1.329)	
CONTROLS	YES	YES	YES	YES	YES	YES	
Industry FE	YES	YES	YES	YES	YES	YES	
Year FE	YES	YES	YES	YES	YES	YES	
R-Squared	9.10%						
Observations	24681	24,681	24,681	24,681	24,681	24,681	
Panel B - Proport	tion of racial and ethnic	directors on	the board				
Intercept	4.160***						
	(10.168)						
BDIV	-0.853**	-0.616	-0.694*	-0.796**	-0.951	-1.316	
	(-2.117)	(-1.088)	(-1.688)	(-2.106)	(-1.381)	(-0.756)	
CONTROLS	YES	YES	YES	YES	YES	YES	
Industry FE	YES	YES	YES	YES	YES	YES	
Year FE	YES	YES	YES	YES	YES	YES	
<b>R-Squared</b>	9.10%						
Observations	24681	24,681	24,681	24,681	24,681	24,681	
Year FE R-Squared Observations	YES 9.10% 24681	24,681	YES 24,681	24,681	24,681	24,681	

Note: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.10. Panel A presents the association between *BODIV* - number of minority directors and earnings quality, replacing the independent variable in the main analysis. Panel B presents the association between *BDIV* - proportion of minority directors and earnings quality. Standard errors are adjusted for industry clustering effects. Variable descriptions are provided in Appendix Table A.1.

Table 6: Robustness check results								
Placebo Test (Percentag	Placebo Test (Percentage of Caucasian Directors)							
	(1)	(2)	(3)	(4)	(5)	(6)		
VARIABLES	Pooled Regression	0.05	0.25	0.50	0.75	0.95		
Intercept	4.846***							
-	(8.068)							
PERCENT_WHT	0.937**	0.648	0.743*	0.868**	1.058	1.503		
	(2.330)	(1.147)	(1.810)	(2.298)	(1.540)	(0.868)		
CONTROLS	YES	YES	YES	YES	YES	YES		
Industry FE	YES	YES	YES	YES	YES	YES		
Year FE	YES	YES	YES	YES	YES	YES		
R-Squared	9.10%							
Observations	24681	24,681	24,681	24,681	24,681	24,681		
Note: ***p < 0.01, **p < 0.05, *p < 0.10. Variable descriptions are provided in Appendix Table A.1.								

Tanel A - Sample L				py Dalanci	ng .			
Before Entropy Balancing					A	After Entrop	by Balanc	ing
	UR	$\mathbf{M} = 1$	UR	$\mathbf{M}=0$	UR	M = 1	UR	$\mathbf{M}=0$
	Mean	Variance	Mean	Variance	Mean	Variance	Mean	Variance
SIZE	8.198	2.665	7.727	2.271	8.198	2.665	8.198	2.454
LEV	0.245	0.036	0.239	0.036	0.245	0.036	0.245	0.034
MTB	3.363	20.020	3.084	13.970	3.363	20.020	3.363	17.180
SALEGR	0.077	0.043	0.089	0.045	0.077	0.043	0.077	0.042
SALESVOL	0.087	0.010	0.092	0.011	0.087	0.010	0.087	0.010
AGE	31.270	345.600	28.160	286.200	31.270	345.600	31.260	339.300
BOARDSIZE	9.157	10.830	8.542	9.354	9.157	10.830	9.156	9.395
CEOPOWER	0.033	0.032	0.045	0.043	0.033	0.032	0.033	0.032
TENURE	9.089	13.360	9.842	16.270	9.089	13.360	9.091	12.920
FOREIGN	0.367	0.232	0.308	0.213	0.367	0.232	0.367	0.232
LOSS	0.146	0.125	0.146	0.125	0.146	0.125	0.146	0.125
BIG4	0.301	0.211	0.328	0.220	0.301	0.211	0.301	0.211
PROPFEM	0.159	0.016	0.129	0.014	0.159	0.016	0.159	0.016
NUMBOARDS	1.678	1.182	1.524	0.771	1.678	1.182	1.678	1.018

# Table 7: Robustness Check Results - Entropy Balancing test Panel A - Sample Descriptives before and after Entropy Balancing

Panel B: Regression Results using Entropy Balancing

Balancing		
BINDEX		-0.010*
		(-1.823)
CONTROLS	YES	YES
Industry FE	YES	YES
Year FE	YES	YES
Adj. R-squared		19.90%
Observations		24,681

Note: \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.10. Variable descriptions are provided in Appendix Table A.1.

# GOLD AS A HEDGE AND SAFE HAVEN, CORRELATION CYCLES AND RISK AVERSION: EVIDENCE FROM GLOBAL ECONOMIC SECTORS

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# ABSTRACT

We investigate (i) variation of gold's hedging, safe haven and diversification features across correlation distributions and global sector equities (ii) the impact of risk aversion and global crisis events on dynamic conditional correlation (DCC) between gold and each sector. Using eleven global sector returns spanning from January 1995 to May 2023, we find that gold is consistently a strong hedge in the low DCC cycle but a strongly effective diversifier at high DCC cycles. Linear models provide biased and unreliable results. Economically, hedging defensive sectors such as healthcare, consumer staples and utility with gold yield marginal utility loss unlike cyclical global sectors. Risk aversion is inversely related with sector-gold DCC. Generally, global crisis events such as the COVID-19, global financial crisis and European sovereign debt crisis amplify the impact of risk aversion on DCC, consistent with non-cash flow-related factors driving DCC. The evidence has implications on investors' behavior and portfolio allocation decisions.

# I. Introduction

Many economic sectors exhibit idiosyncratic properties and risk-return profiles regardless of their geographic location. Sector-based investment strategies offer diversification benefits while enabling institutional investors to target economic and market segments that closely align with their capital allocation views. The performance of diverse economic sectors differs across business cycles (Novy-Marx, 2014; Ngene 2021). Fernandes, 2020; Ramelli and Wagner, 2020 show that the effects of uncertainty caused by Black swan events such as the global pandemic, are heterogeneous across the sectors. For example, while global hospitality and travel industries activity plunged by over 90% in response to COVID-19-related volatility, the global real estate sector experienced a boost as investors sought safe haven investments (Barker, 2020).Indeed, Smales (2021b) shows that the US energy and consumer discretionary (consumer staples and health care) sectors were the most (least) impacted by COVID-19 related uncertainty. Likewise, geopolitical events such as Russia-Ukraine conflict or Middle East crisis which disrupt oil supply benefit global oil companies due to a spike in oil (energy) prices while hurting the airline and industrial sectors. Constable  $(2020)^1$  shows that demand for precious metalsbased exchange traded funds (ETFs) significantly increased as the COVID-19 pandemic peaked, suggesting that mining (basic materials sector) generated higher cash flows during the COVID-19 pandemic relative to other sectors. Policy-wise, Choi (2020) shows different US industries heterogeneously respond to economic policy uncertainty. Bampinas and Panagiotidis, (2016) and Rooven and Jones (2019) show that the response of sectoral stocks to macroeconomic fundamentals or macro-economic risks may differ. Phylaktis and Xia (2006) show that industry-level portfolio diversification dominates the country-level

portfolio diversification benefits, especially in Europe

 $<sup>^{1}\</sup> https://www.forbes.com/sites/simonconstable/2020/04/08/covid-19-panic-sparks-record-breaking-gold-buying-binge-during-first-quarter/?sh=133b3db43bd9$ 

and North America since 1999. Akhtaruzzaman et al., (2021) and Salisu, Vo, and Lucey (2021) conclude that different sectors will undoubtedly behave differently to the hedging behavior of gold. In policy design and implementation, policymakers may implement short-term or long-term policy shocks such as interest rates and foreclosure moratoriums targeting the banking and real estate sectors, expecting diffusion and shock spillover to other diverse economic sectors and asset classes (Ciner et al., 2013; Baumöhl and Lyócsa, 2017, Ngene, 2021). The findings above suggest that empirical studies using aggregate stock market indices impede heterogeneous profiling of stock market fundamentals, response to panic news and risk aversion (Haroon and Rizvi, 2020b), and generation of sector-level diversification benefits through investment in low-cost sector-based EFTs.

Persuaded by these findings, we investigate the hedging ability of gold against unfavorable movement in equity returns of global sectors. We select gold since past studies have shown it is the most broadly recognized and accepted safe-haven and hedging commodity (Kamal et al, 2022; Lin and Lucey, 2017 and Baur and Lucey, 2010, among others.) Many studies have conducted research focusing on the domestic sector equity returns (see, for example, Ngene, 2021; Salisu, et al, 2021 for the US sectors; You et al., 2017 for Chinese sectors; Mensi, 2019 for Saudi Arabia sectors; Abuzayed, Al-Fayoumi and Bouri, 2022 for the UK sectors, among others). We argue that global sectors offer domestic and international diversification benefits granted that different economies have different monetary policies, resource endowment, regulatory structures, political cycles, population age-structures, consumer bases, and state and stage of economic development, thereby diffusing negative domestic-level shocks for a global portfolio. Sector portfolios improve diversification by accessing hundreds of foreign securities. This is because the rise and fall of foreign and domestic (US) financial markets and economies are not always synchronized. Therefore, including domestic and international stocks can level out some of the portfolio volatility, resulting in higher risk-adjusted returns relative to domestic sector-based

portfolios. We argue that using either aggregate stock market indices or country-level sectors undermine salient attribute of global sectors in a highly integrated global financial market and may result in incorrect conclusions about the response of stocks to the hedging potential of the gold market. Specifically, we seek to answer the following questions. First, does gold's hedge and safehaven features vary across global equity sectors and correlation quantiles? Second, how does risk aversion impact dynamic conditional correlation (DCC) between gold and each sector? Do major global crisis events and periods such as the Asian crisis, the global financial crisis (GFC), European sovereign debt crisis (ESDC) and COVID-19 pandemic amplify the impact of risk aversion on DCC? Third, is the impact of risk aversion and crisis periods nonlinear, asymmetrical varying across DCC cycles and global sectors?

Briefly, we find that (i) gold is consistently a strong hedge in the low DCC cycle but a strongly effective diversifier at high DCC cycles. Therefore, gold's hedging, safe haven and diversification features vary across correlation distributions and global sector equities. Linear models provide biased and unreliable results (ii) Economically, hedging defensive sectors such as healthcare, consumer staples and utility with gold yield marginal utility loss unlike cyclical global sectors. (iii) the global risk aversion is mainly inversely related with DCC across DCC quantiles and sectors Further, global crisis events such as the COVID-19, global financial crisis and European sovereign debt crisis amplify the impact of risk aversion on DCC, consistent with non-cash flow-related factors driving DCC.

The rest of the study flows as follows. Section II details the type and sources of data and the data descriptive and distributional features. Section III explains econometric modeling. Section IV deals with empirical evidence while section V concludes.

# II. Data

The data comprises eleven global sectors, constructed based on the MSCI's Global Industry Classification Standard (GICS) groupings. The data is retrieved from the Bloomberg terminal., namely: Consumer durables (CDI), consumer staples (CSI), energy (ENG), financial (FIN), health care (HCA), industrial (IND), materials (MAT), residential (RES), information technology (TEC), communication services (TEL), utilities (UTL). The daily gold price (Gold) data is collected from the Federal Economic Reserve Database (https://fred. stlouisfed.org/series). Data are daily and stated in US dollars. Our primary sample spans the period from 1 January 1995 to May 31st, 2023, accounting for 7411 daily prices. The continuously compounded percent daily return of each index, *i*, is derived as logarithmic differences of successive index levels. That is,  $R_{i,t} = [\log(p_{i,t}) - \log(p_{i,t-1})].100$ 

Table 1: Descriptive and distributional features of daily returns and other preliminary tests

	Mean	SD	Skewness	Ex.Kurtosis	JB	Q(10)	Q <sup>2</sup> (10)	ARCH (10)	CCC	Corr.
CDI	0.023	1.065	-0.270***	9.053***	25354***	146.33***	2017.19***	165.690***	62.55***	0.046***
CSI	0.025	0.777	-0.482***	10.239***	32607***	36.67***	2992.69***	204.030***	51.28***	0.068***
ENG	0.019	1.477	-0.848***	17.201***	92096***	53.92***	2760.81***	226.089***	106.7***	0.153***
FIN	0.010	1.267	-0.374***	12.454***	47985***	134.48***	3243.26***	217.833***	69.85***	0.043***
HCA	0.032	0.934	-0.296***	7.356***	16791***	68.83***	3090.89***	256.115***	47.09***	0.022*
IND	0.019	1.041	-0.512***	8.593***	23086***	154.77***	3338.93***	245.748***	85.37***	0.074***
MAT	0.015	1.217	-0.519***	9.719***	29451***	262.51***	3717.65***	284.518***	97.30***	0.259***
RES	0.009	1.112	-0.538***	11.452***	40791***	171.42***	3080.25***	220.944***	56.69***	0.108***
TEC	0.038	1.471	-0.128***	5.606***	9710***	24.28***	2460.74***	168.835***	57.21***	0.008
TEL	0.009	1.122	-0.216***	5.882***	10725***	65.05***	3033.79***	201.521***	52.42***	0.068***
UTL	0.012	0.899	-0.425***	17.447***	94067***	32.63***	5160.67***	340.361***	29.66***	0.133***
Gold	0.029	1.008	0.114***	8.179***	20638***	9.88*	429.16***	39 596***		

Notes: SD and Ex.kurtosis are the standard deviation and excess kurtosis, respectively, of daily returns. JB, Q(10),  $Q^2$  (10) and ARCH(10) are the empirical test statistics of the Jarque–Bera test for normality of return distribution, Ljung–Box test for linear return autocorrelation with 10 lags, Ljung–Box test for nonlinear (squared) returns autocorrelation with 10 lags and Engle (1982) test for autoregressive conditional heteroskedasticity (ARCH) effects for 10 lags, respectively. \*\*\*, \*\* and \* signals rejection of null at 1%, 5% and 10% significance level, respectively.

The highest (lowest) average daily return of 0.038% (0.009%) can be observed for the TEC (TEL and RES) global sector over the sample period. Moreover, the highest (lowest) volatility or standard deviation of 1.48% (0.78%) is associated with ENG (CSI). All daily returns are leptokurtic (excess kurtosis) and significantly negatively skewed. Expectedly, the Jarque-Bera test

results confirm that the null hypothesis of normally distributed returns is rejected for all sectors. markets. The Ljung-Box Q and Q<sup>2</sup> statistics reject the null hypothesis of no linear and no nonlinear return autocorrelation in the first 10 lags for all sectors and gold returns. The unconditional contemporaneous correlations (corr.) between sector stock and gold returns are relatively low and noticeably vary across sectors, ranging between zero (gold-TEC) and 26% (gold-MAT). These low correlations naturally imply that investors can gain diversification benefits by adding gold futures to their portfolios of global sectors stocks. The heterogeneity of sector-gold correlations further reinforces the need to investigate the hedging and safe haven features of gold at sector level as opposed to the aggregated national stock indices. Lastly, the null hypothesis of constant conditional correlation (CCC) by Engle and Sheppard (2001) is rejected for each sector-gold pair, affirming the need to adopt a dynamic conditional correlation (DCC) or it's variant.

Figure 1 shows the evolution of daily global sector index returns. Notably, all sectors registered the steepest return decline during the GFC and COVID-19 recession periods (greyed vertical bars). However, there is significant variation in the highest and lowest returns across the eleven sectors. For example, during the GFC and COVID-19 recession, the ENG (CSI) sector daily index returns plunged by as much as 14% and 21% (5.3% and 9.4%), respectively. This compares to 6.1% and 4.7%, 10.2% and 12.5%, and 6.4% and 8.4% decline for Gold, FIN, and HCA sectors, respectively, during the same recession periods. This evidence suggests heterogeneous response to crisis shocks across the sectors. Consequently, the hedging, diversification and safe haven properties of gold are likely to vary across the sectors. These heterogeneities are masked by a global or national stock index.

Figure 1: Daily percent natural log difference index returns of eleven global sectors.



# **III. Econometric methods**

Investors holding any portfolio of global sectoral stocks and wishing to hedge stock returns with gold should combine positions in stock and gold markets. The covariance of each global sector and gold returns will be time-varying. We assume an investor is holding a portfolio of global sector stocks and wish to hedge unfavorable movement in sector returns using gold. Given  $R_{s,t}$  and  $R_{G,t}$  as percent sector and gold returns at time t, hedging would involve going long on stock and going short in  $\mathcal{B}_t$  units of  $R_{G,t}$  to generate returns of hedged portfolio at time t. Following Kroner and Sultan (1993), we derive  $R_{hp,t}$  as follows:

$$R_{hp,t} = R_{S,t} - \mathcal{B}_t R_{G,t} \tag{1}$$

 $\mathcal{B}_t$  is the time-varying hedge ratio. Given an information set,  $\mathcal{F}$ , containing information up to period t - 1, the conditional variance (var) of  $R_{hp,t}$  is derived as follows.

$$var(R_{hp,t}|\mathcal{F}_{t-1}) = var(R_{hp,t}|\mathcal{F}_{t-1} - \mathcal{B}_{t}R_{G,t}|\mathcal{F}_{t-1})$$
(2a)  

$$var(R_{hp,t}|\mathcal{F}_{t-1}) = var(R_{S,t}|\mathcal{F}_{t-1}) + \mathcal{B}_{t}^{2}var(R_{G,t}|\mathcal{F}_{t-1}) - 2\mathcal{B}_{t}Cov(R_{S,t}, R_{G,t}|\mathcal{F}_{t-1})$$
(2b)  
Alternatively,  $var(R_{hp,t}|\mathcal{F}_{t-1}) = var(R_{S,t}|\mathcal{F}_{t-1}) + \mathcal{B}_{t}^{2}var(R_{G,t}|\mathcal{F}_{t-1}) - 2\mathcal{B}_{t}\rho_{R_{S,t},R_{G,t}}\sigma_{R_{S,t}}\sigma_{R_{G,t}}$   
where  $\rho_{R_{S,t},R_{G,t}} - \sigma_{R_{S,t}}(\sigma_{R_{G,t}})$  are correlation between sector and gold returns and standard  
deviation of sector (gold) returns. Taking the first derivative of Eq. (2b) with respect to  $\mathcal{B}_{t}$  will  
wield the following:

$$\frac{\partial var(R_{hp,t}|\mathcal{F}_{t-1})}{\partial \mathcal{B}_{t}} = 2\mathcal{B}_{t}var(R_{G,t}|\mathcal{F}_{t-1}) - 2Cov(R_{S,t}, R_{G,t}|\mathcal{F}_{t-1})$$
(3)

By equating Eq. 3 to zero and doing some rearrangement, we derive, following Kroner and Sultan (1993), Batten et al. (2021, and Salisu et al. (2021) the optimal hedge ratio,  $\mathcal{B}_t$ 

$$\mathcal{B}_t = \frac{Cov(R_{S,t}, R_{G,t}|\mathcal{F}_{t-1})}{var(R_{G,t}|\mathcal{F}_{t-1})} \tag{4}$$

As explained by Batten et al. (2021), the risk-minimizing hedge (optimal hedge ratio) captures how much a long position of one dollar in the stock market should be hedged by a short position of  $\mathcal{B}_t$  dollars in the gold market. We derive and employ in our empirical analysis, an optimal hedge ratio,  $\mathcal{B}_t$ , that minimizes the variance of the hedged portfolio (minimum variance hedge) and which is appropriate for cross-market hedging.

To derive a time-varying  $\mathcal{B}_t$ , we need a model that can generate a time-varying conditional covariances between gold and each sector and conditional variances of each asset. To that end, we asymmetric dynamic conditional correlation (ADCC) model with vector autoregression conditional mean equation. For conditional variance of each return series, we use Glosten,

Jagannathan, and Runkle (1993) generalized autoregression conditional heteroscedastic (GJR-GARCH) model. More generally, we employ VAR-ADCC-GJR-GARCH. Akaike and Schwartz criterion, a VAR (1) model was selected for the mean equation.

$$\begin{cases} R_t = c + aR_{t-1} + e_t \\ e_t = H_t^{0.5} \varepsilon_t \end{cases}$$
(5)

In Eq. (5),  $R_t = (R_{S,t}, R_{G,t})$ , which is 2 × 1 matrix, represents sector equity returns,  $R_{S,t}$  and gold return,  $R_{G,t}$ , respectively, in period t.  $c=(c_1, c_2)$  is a 2 × 1 vector of intercepts (conditional mean) while  $e_t = (e_{S,t}, e_{G,t})$  is a 2 × 1 vector of unstandardized residuals. Specifically,  $e_t = H_t^{0.5} \varepsilon_t$ where  $\varepsilon_t$  is *i.i.d* disturbances and  $E(\varepsilon_t) = 0$ ,  $E(\varepsilon_t \varepsilon'_t) = I$  where I is an identity and  $H_t^{0.5}$  is a 2 × 2 symmetric positive definite matrix.  $H_t = \begin{bmatrix} h_{S,t} & h_{SG,t} \\ h_{SG,t} & h_{G,t} \end{bmatrix}$  is a 2 × 2 conditional variancecovariance matrix with  $h_{S,t}$   $(h_{G,t})$  representing the conditional variance of sector index (gold) returns while  $h_{SG,t}$  is the conditional covariance between sector and gold returns.  $a = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$ is a  $2 \times 2$  matrix of parameter estimates for lagged dependent variables, capturing the impact of lagged global sector and gold returns. The dynamic conditional correlation (DCC) model proposed by Engel (2002) involves two step estimation. First, the residuals from the VAR (1) model are extracted, standardized, and used to estimate a univariate GARCH model which accounts for conditional heteroskedasticity. This involves estimating the conditional variance,  $h_t$ , for each return series. Second, the time varying correlations are estimated using the lagged residuals and covariance matrices.

In Eq. (5),  $e_t|F_{t-1} \sim N(0, H_t)$  where  $F_{t-1}$  is information set at time t - 1. The conditional variance-covariance matrix,  $H_t$  can be further decomposed into the diagonal matrix capturing conditional standard deviation,  $D_t$ , and the conditional correlation matrix,  $K_t$ , of the standardized returns,  $\varepsilon_t$ . Therefore,

$$H_t = D_t K_t D_t \tag{6}$$

 $D_t = diag(h_{S,t}^{0.5}, h_{G,t}^{0.5})$  and  $h_{S,t}^{0.5}$  and  $h_{G,t}^{0.5}$  are conditional standard deviation of sector and gold returns, respectively. Each conditional variance,  $h_t$ , is estimated using GJR-GARCH (1,1) model capture asymmetric impact of bad and good news on conditional variance.

$$h_{t} = \omega_{0} + \alpha \varepsilon_{i,t-1}^{2} + \gamma I_{t-1} \varepsilon_{i,t-1}^{2} + \beta h_{t-1}$$
(7)

where  $I_{t-1} = 1$  if  $\varepsilon_{t-1} < 0$  and 0 otherwise. To attain stationarity and positivity of the volatility process, then,  $\omega_0$ ,  $\alpha$ ,  $\gamma$  and  $\beta > 0$  and  $\gamma/2 + \alpha + \beta < 1$ . Further,  $\varepsilon_{t=}e_t/h_t^{0.5}$ , are standardized residuals or zero-mean white noise to be used in the DCC model. We permit  $\varepsilon_t$  follows skewed Student-t distribution. The  $H_t$  matrix is a multivariate GARCH process modeled using Engel's (2002) DCC model. The DCC can be defined as

$$K_t = \operatorname{diag}(q_{11,t}^{0.5} \dots q_{NN,t}^{0.5}). Q_t. \operatorname{diag}(q_{11,t}^{0.5} \dots q_{NN,t}^{0.5}) = q_{ij,t} / \sqrt{q_{ii,t} q_{jj,t}}$$
(8)

where  $Q_t$  is a positive symmetric definite matrix of  $N \times N$  order which evolves as follows.

$$Q_t = (1 - \alpha - \beta). \bar{Q} + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \beta Q_{t-1}$$
(9)

 $\overline{Q}$  is the time-varying unconditional correlation matrix of standardized residuals,  $\varepsilon_t$ , of stock and gold returns obtained from the first-step univariate GJR-GARCH estimation,  $\alpha$  and  $\beta$  are non-negative parameters that satisfy the condition  $\alpha + \beta < 1$  and are estimated by maximizing the log-likelihood function.

The DCC model is symmetric since it does not allow for asymmetries (lagged negative and positive correlation shocks to differently impact conditional DCC). Cappiello, Engle and Sheppard (2006) improved the DCC model by incorporating the asymmetrical effect and asset specific news impact. According to Capprielo, et al. (2006),  $Q_t$  in equation 5 evolves in an asymmetric generalized DCC (ADCC) process such that.

$$Q_t = (1 - \theta_1 - \theta_2)\overline{Q} - \theta_3\overline{N} + \theta_1\varepsilon_{t-1}\varepsilon_{t-1} + \theta_2Q_t + \theta_3\eta_{t-1}\eta_{t-1}$$
(10)

In Eq. (10),  $\theta_3$  captures the asymmetric impact of lagged shocks (periods when both individual sector and gold experience bad news) on current correlation. That is, negative and positive shocks of equal magnitude at period t - 1 asymmetrically impact sector-gold correlations at period t.  $\overline{N} = E[\eta_t \eta_t]$  where  $\eta_t = min(\varepsilon_t, 0) = I_{\varepsilon_t < 0} * \varepsilon_t$  and  $I_{\varepsilon_t < 0}$  is an indicator function. For the model to be stationary,  $\theta_1 + \theta_2 < 1$  with  $\theta_1$  and  $\theta_2$  being non-negative scalars. The ADCC model is estimated using Quasi Maximum Likelihood (QML) technique based on BHHH optimization algorithm.

## **IV. Empirical results**

Our computations of returns and ADCC are based on daily frequency data. However, Pástor and Veronesi (2013) aptly argue that from an economic standpoint, portfolio adjustment and hedging decisions are neither meaningful nor practical at daily frequency. Consequently, we follow Badshah, Demirer, and Suleman (2019) and Pástor and Veronesi (2013) and use monthly frequency data in our empirical analysis. Following Pástor and Veronesi (2013), the estimated monthly ADCC values are equal to the average daily ADCC values within the month. We do not, like previous studies, observe a significant variation in the daily correlation estimates within the month, further supporting the Pástor and Veronesi (2013) and Badshah et al. (2019) approach which we adopt in our empirical analysis. The monthly returns, equal to the sum of daily returns with the month, are derived from market microstructure theory where daily returns are equal to the sum of intraday returns.

A visual observation from Fig. 2 shows that during economic recessions, particularly the GFC and COVID-19, ADCC<sup>2</sup> declined but at different magnitudes across the global sectors. For example, during the GFC, CDI-gold and FIN-gold (MAT-gold and UTL-gold) ADCC values declined from around 0.30 and -0.44 and 0.29 to -0.39, (0.59 to -0.04 and 0.41 to -0.03), respectively. This compares to a 0.59 to -14 decline in ADCC between ENG and gold during the GFC. During the COVID-19 pandemic, the ADCC was heterogeneously negative such as between RES and gold, (-0.14), FIN and gold (-0.43), TEC and gold (-0.38), TEL and gold (-0.27), CDI and gold and ENG and gold pairs (-0.35).



<sup>2</sup> Our goal is to extract ADCC for subsequent analysis. Therefore, we do not provide the results of VAR-ADCC-GJR-GARCH estimates but the results are available on request.

Statically, the negative ADCCs between gold and each of the eleven sectors during the GFC, COVID-19 and during or after 2001 recessions imply that increase in gold prices is associated with declines in sector indices, indicating potential portfolio hedge.

However, we do note episodic switch from negative to positive correlation during GFC and COVID-19 for all sector-gold pairs. Notably, a spike in sector-gold correlations aligns with prior findings of stronger asset co-movements during stress periods (See, for example, Dutta, Bouri and Noor, 2021). Overall, the low positive or negative correlations demonstrates gold safe-haven properties during extreme market downturns and elevated volatility in global sector markets<sup>3</sup>. This evidence, which buttresses the conjecture that the hedging potential of gold varies across sectors, is also important for portfolio allocation decisions across global sectors.

# Gold as a diversifier, hedge, and safe haven

Combining negatively correlated assets significantly reduces a two-asset portfolio risk. In the present study, we attempt to distinguish among three potential benefits of gold when combined with each of the eleven global sector stocks. First, according to Baur and Lucey (2010) and Baur and McDermott (2010), gold is a diversifier if, on average, it exhibits a weak positive correlation with any of the eleven global sectors.

Second, gold is a strong (weak) hedge if, on average, it is negatively correlated (uncorrelated) with any of the eleven global sectors. Third, gold is a strong (weak) safe haven if, on average, its negatively correlated (uncorrelated) with any of the eleven global sectors during times of distress in financial markets. To assess these features and their variations across correlation structures and

<sup>&</sup>lt;sup>3</sup> According to Merton (1973), risk-averse investors desire to hedge against changes in their investment opportunity set. Changes in portfolio diversification benefits are proxied by time-varying correlation between assets. Therefore, correlation indirectly affects investors' investment opportunity set. However, ...argue that the effect of time-varying inter-asset correlation on the investment opportunity set is dependent on the assets' volatilities. If the assets' volatilities are low, changing inter-asset correlation has insignificant impact on the investment opportunity set.

global equity sectors, we proceed as follows. We extract the ADCC and follow Ratner and Chiu (2013) and Bouri et al. (2017) to assess the hedging and safe haven properties of gold against each of the eleven sectors. By design, ADCC is bounded by [-1, 1]. Therefore, we transform the eleven ADCC series to Fisher correlations,  $FADCC_{i,t} = 0.5 * \ln ((1 - ADCC_{i,t}/1 + ADCC_{i,t}))$ . This manipulation generates a continuous and monotonic series, and there is a one-to-one mapping between the actual ADCC and Fisher-transformed correlations (FADCC). Specifically, we regress FADCC on three dummy (*D*) variables representing the extreme 10<sup>th</sup>, 5<sup>th</sup>, and 1<sup>st</sup> quantile ( $q_{10}, q_5$  and  $q_1$ , respectively) of each sector index return distribution based on the following regression.

$$FADCC_{t} = k_{0} + k_{\rho}FADCC_{t-1} + k_{1}D(q_{10}R_{S}) + k_{2}D(q_{5}R_{S}) + k_{3}D(q_{1}R_{S}) + v_{t}$$
(11)

where FDCC is the pairwise Fisher-transformed asymmetric dynamic conditional correlation between gold and each of the eleven global sector equity portfolios.  $k_{\rho}$  measures the persistence or autoregression of the FDCC.  $R_s$  is the return of each of the eleven global equity sectors and  $v_t$ is the disturbances. Gold is a strong (weak) hedge against unfavorable changes in returns of each global sector if  $k_0$  is significantly negative (statistically insignificant). Gold is a strong (weak) safe haven against unfavorable changes in returns of any of the eleven global sectors if  $k_1$ ,  $k_2$  or  $k_3$ coefficient estimates are significantly negative (not significantly different from zero).

Table 2: Testing for hedging and Safe Haven in linear regression

	$k_0$	Prob.	$k_{ ho}$	Prob.	$k_1$	Prob.	$k_2$	Prob.	k <sub>3</sub>	Prob.	$k_1 = k_2 = k_3 = 0$
CDI	0.011**	0.040	0.809***	0.000	-0.067**	0.022	0.055	0.212	0.006	0.906	1.895
CSI	0.019***	0.001	0.775***	0.000	-0.017	0.430	-0.044	0.201	0.008	0.862	2.554*
ENG	0.023***	0.000	0.865***	0.000	-0.007	0.786	-0.087**	0.039	0.057	0.379	2.712**
FIN	0.010*	0.097	0.820***	0.000	0.012	0.680	-0.096**	0.029	0.146*	0.069	2.059
HCA	0.009*	0.087	0.778***	0.000	-0.037	0.186	-0.002	0.949	-0.081***	0.007	13.027***
IND	0.017***	0.000	0.798***	0.000	-0.005	0.803	-0.102***	0.006	0.176***	0.001	4.637***
MAT	0.044***	0.000	0.837***	0.000	-0.031	0.283	-0.060	0.195	0.028	0.470	8.218***
RES	0.048***	0.000	0.635***	0.000	-0.010	0.736	0.013	0.676	0.047	0.360	0.352
TEC	0.004	0.452	0.815***	0.000	-0.023	0.332	-0.003	0.914	0.023	0.559	0.752
TEL	0.014***	0.000	0.805***	0.000	-0.020	0.290	0.003	0.920	0.038	0.434	0.666
UTL	0.015***	0.000	0.876***	0.000	0.013	0.232	-0.012	0.707	-0.065	0.133	1.885

Notes: The results in Table 2 are based on Eq. (11).  $ADCC_t = k_0 + k_\rho ADCC_{t-1} + k_1 D(q_{10}R_s) + k_2 D(q_5R_s) + k_3 D(q_1R_s) + v_t$ . \*\*\*, \*\* and \* signals rejection of null at 1%, 5% and 10% significance level, respectively.

From Table 2, the linear regression model shows that  $k_0$  is significantly positive, suggesting that gold is an effective diversifier for FIN, HCA, and TEC (weak positive or insignificant correlation). We also observe significant variation in  $k_0$ . The highest significantly positive  $k_0$  estimate of 0.048 for RES is slightly more than 10 folds higher than the lowest  $k_0$  estimate of 0.004 for the TEC sector. The  $k_{\rho}$  estimate exhibits varying persistence or autoregression of FDCC across all sectors, ranging from 0.635 for RES to 0.876 for UTL. is a safe haven against unfavorable changes returns of only 5 global sectors namely CDI at  $10^{\text{th}}$  quantiles returns ( $k_1$ ), ENG, FIN and IND at the 5<sup>th</sup> quantile returns ( $k_2$  and HCA based quantile returns  $(k_3)$ . However, we extreme  $1^{st}$ the joint on conduct a test,  $k_1 = k_2 = k_3 = 0$ , The F-statistics (last column in Table 3) reveal that gold is a strong safe haven for HCA, IND and MAT (ENG) sectors since F-statistic is significant at 1% (5%). For the rest of the seven sectors (CDI, CSI, FIN, RES, TEC, TEL and UTL), gold is a weak safe haven against decline in sector returns during major market downturns.

Eq. (11) coefficient estimates are based on conditional mean. Empirically, it is unknown how gold's hedging, diversification and safe haven features vary across ADCC distribution or cycles. From Table 3, the mean, maximum and minimum ADCC remarkedly differ across the sectors. All sectors' ADCC with gold exhibit excess kurtosis (fat-tailed distributions) although they differ in skewness. Further, apart from CDI-gold and HCA-gold ADCCs, ADCCs for the rest of sectors are, on average, non-normally distributed (Jarque-Berra test rejects normal ADCC distribution at 1%).

Table 5. Descriptive statistics of monting ADCC										
	Mean	Maximum	Minimum	Std. Dev.	Skewness	Ex- Kurtosis	Jarque-Bera	probability		
CDI	0.041	0.523	-0.502	0.161	-0.013	2.904	3.075	0.215		
CSI	0.067	0.511	-0.432	0.146	-0.088	2.928	11.115***	0.004		
ENG	0.144	0.659	-0.360	0.192	0.043	2.424	104.678***	0.000		
FIN	0.050	0.596	-0.600	0.191	-0.097	2.811	22.485***	0.000		
HCA	0.019	0.449	-0.487	0.141	0.029	2.920	2.984	0.225		
IND	0.067	0.547	-0.473	0.169	0.033	2.647	39.827***	0.000		

 Table 3: Descriptive statistics of monthly ADCC<sup>4</sup>

<sup>4</sup> The descriptive statistics of ADCC and FADCC are qualitatively similar due to one-to-one mapping of the two series.

MAT	0.239	0.714	-0.355	0.193	-0.206	2.560	111.754***	0.000
RES	0.133	0.445	-0.381	0.115	-0.318	3.147	131.427***	0.000
TEC	0.009	0.393	-0.560	0.155	-0.065	2.813	15.886***	0.000
TEL	0.065	0.487	-0.420	0.147	-0.018	2.526	69.645***	0.000
UTL	0.124	0.513	-0.244	0.142	0.049	2.562	62.000***	0.000

Notes: \*\*\*, \*\* and \* signals rejection of null at 1%, 5% and 10% significance level, respectively.

These features suggest that linear modeling based on Eq. (11) will yield biased results. Moreover, past studies have provided ample evidence of increased correlations in global financial market returns during bear markets (See for example, Campell, Koedijk and Kofman, 2002, among others), thereby depriving investors diversification benefit when they need it most. This suggests consideration of extreme market conditions and tail-adjusted mean-variance covariance matrix in econometric modeling. Therefore, it is critical to use a model that considers which portion of the ADCC distribution gold is a hedge, diversifier, and safe heaven. At what point along ADCC distribution does, for example, gold switch from being a hedge to a diversifier? That is, at what point does  $k_0$  change from strongly negative, weakly negative, weakly positive and strongly positive?

These questions have not been explored in past studies across multiple global sectors. This is an important question given that different quantiles of ADCC distributions represent diverse market conditions. This makes it interesting to study how golds hedging, safe haven and diversification benefits change at the upper and lower tails of the conditional ADCC distributions relative to conditional mean. To this end, Eq. (11) is estimated using quantile regression (QR) to capture different market conditions, asymmetries, and nonlinearities. Specifically,

$$FADCC_t(\tau|X_{t-i}) = k(\tau)X_{t-i}$$
(12)

where  $i \in (0,1)$  and  $X_{t-i}$  is  $n \times m$  vectors of regressors specified in Eq. (11).  $k(\tau)$  is the parameter estimate at quantile  $\tau \in (0,1)$  with  $\tau = 0.1, 0.10, \dots, 0.90$ , obtained by minimizing the weighted absolute deviation of the dependent variable from independent variable (Koenker,

2005; Koenker & Basset, 1978). We conduct 2000 bootstraps to obtain asymptotically valid QR

standard errors and avoid awkward variance-covariance matrix estimates.

Following Baur et al. (2012), Ngene (2021) and Kamal, Wohar and Kamal (2022), we divide the

quantiles into three distinct market conditions namely low, moderate, and high DCC cycles.

		Low ADCC c	ycle		Moderate ADCC cycle			High ADCC cycle		
Sector	$\tau \rightarrow$	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
CDI	$k_0$	-0.089***	-0.053***	-0.038***	-0.014**	0.011**	0.031***	0.050***	0.079***	0.117***
CSI	$k_0$	-0.075***	-0.042***	-0.019***	-0.007*	0.014*	0.038***	0.065***	0.087***	0.112***
ENG	$k_0$	-0.088***	-0.063***	-0.028***	-0.002	0.020***	0.048***	0.074***	0.105***	0.140***
FIN	$k_0$	-0.117***	-0.074***	-0.040***	-0.015**	0.006	0.029***	0.060***	0.100***	0.150***
HCA	$k_0$	-0.086***	-0.057***	-0.035***	-0.013**	0.007	0.031***	0.052***	0.074***	0.108***
IND	$k_0$	-0.103***	-0.058***	-0.032***	-0.012*	0.017**	0.042***	0.065***	0.089***	0.133***
MAT	$k_0$	-0.073***	-0.031***	-0.008	0.013	0.038***	0.062***	0.086***	0.123***	0.192***
RES	$k_0$	-0.062***	-0.018**	-0.002	0.024***	0.055***	0.069***	0.090***	0.118***	0.166***
TEC	$k_0$	-0.102***	-0.059***	-0.032***	-0.014***	0.002	0.020***	0.043***	0.070***	0.115***
TEL	$k_0$	-0.086***	-0.052***	-0.031***	-0.013***	0.007	0.029***	0.052***	0.085***	0.127***
UTL	$k_0$	-0.075***	-0.029***	-0.015***	0.002	0.014***	0.033***	0.045***	0.069***	0.103***

 Table 4a: Testing for hedging using quantile regression.

Notes: The results in Table 4a are based on Eq. (12).  $ADCC_t(\tau|X_{t-i}) = k(\tau)X_{t-i}$  but focuses on the intercept of the quantile regression,  $k_0(\tau)$ . \*\*\*, \*\* and \* signals rejection of null at 1%, 5% and 10% significance level, respectively.

Results in Table 4a show that gold is a strong hedge against unfavorable global sector returns in the lower quantiles (low ADCC cycles). Indeed, apart from basic materials (MAT) and real estate (RES) sectors, gold is consistently a strong hedge in 10th to 30th quantiles for the rest of the sectors. At 30<sup>th</sup> (40<sup>th</sup>) quantile, gold is a weak hedge for MAT and RES (CSI, ENG, and IND) since  $k_0(\tau)$ is statistically weak (10% significant) or insignificant. At 50<sup>th</sup> (40<sup>th</sup>) quantile, gold is a diversifier for CSI, FIN, HCA, TEC, and TEL (MAT and UTL) since the coefficient estimates are weakly positive or insignificant correlation. For 60<sup>th</sup> to 90<sup>th</sup> quantiles, the coefficient estimates are statistically significant and increasing in quantiles, suggesting decreasing diversification benefits. This evidence contradicts the results in Table 3 based on OLS showing gold is not a hedge and is a weak diversifier for only three sectors. The overall evidence suggests that accounting for asymmetry and nonlinearities in distribution of ADCC provides insightful details about gold's hedge and diversification properties as a function of correlation cycles.

We then test the gold's safe haven features across ADCC distribution or quantiles. The results are presented in Table 4b. We outline three major observations. First, the persistence of ADCC varies across the quantiles and sectors. For example, the ADCC autocorrelation coefficient estimate,  $k_{\rho}$ , ranges between 0.820 and 0.916 (0.524 and 0.635) for ENG (RES). That compares to 0.742 to 0.813 (0.838 to 0.910) range for CSI (UTL) sector. This evidence suggests heterogeneity in the speed of decay of dynamic correlation across the sectors and quantiles. Second, From Table 2,  $k_1$ ,  $k_2$  and  $k_3$  are individually and jointly insignificant for RES, TEC, TEL and UTL. In Table 4b,  $k_1$ is significantly negative at 10<sup>th</sup> and 20<sup>th</sup> quantiles for RES. For UTL,  $k_2$  (-0.108) is significantly (insignificantly) negative at 10<sup>th</sup> (20<sup>th</sup> to 60<sup>th</sup>) quantiles while  $k_3$  estimates (-0.094 and -0.116) are significantly (insignificantly) negative at 50<sup>th</sup> and 60<sup>th</sup> (20<sup>th</sup> to 40<sup>th</sup>) quantiles, respectively. For TEL,  $k_1$  (-0.072) is significantly negative at 10<sup>th</sup> quantile while  $k_2$  is insignificantly negative at 30<sup>th</sup> to 70<sup>th</sup> quantiles.

Table 4b: Gold as a safe haven across different ADCC quantiles or cycles

		0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
CDI	$k_{ ho}$	0.870***	0.825***	0.800***	0.825***	0.812***	0.798***	0.812***	0.839***	0.770***
	$k_1$	-0.123***	-0.136***	-0.018	-0.026	-0.042*	-0.043*	-0.056**	-0.079**	-0.020
	$k_2$	0.118**	0.100**	0.024	0.007	0.017	0.013	0.060	0.077*	0.076
	$k_3$	-0.003	-0.011	-0.070	0.046	0.024	0.006	0.058	0.042	-0.073
CSI	$k_{ ho}$	0.768***	0.743***	0.809***	0.812***	0.813***	0.805***	0.772***	0.742***	0.764***
	$k_1$	-0.048	-0.009	-0.022	-0.016	-0.032	-0.050*	-0.048*	-0.026	0.044
	$k_2$	-0.058	-0.122***	-0.062*	-0.078**	-0.053*	-0.011	0.005	0.031	-0.033
	$k_3$	0.064	0.055	-0.012	0.097	0.069	0.018	0.006	-0.060	-0.094
ENG	$k_{ ho}$	0.891***	0.916***	0.903***	0.890***	0.884***	0.854***	0.848***	0.820***	0.867***
	$k_1$	-0.111***	-0.020	0.022	-0.002	-0.002	0.007	-0.016	0.022	0.047
	$k_2$	-0.118**	-0.178***	-0.101**	-0.097**	-0.077**	-0.048	-0.045	-0.089**	-0.102*
	$k_3$	0.153	0.090	-0.059	0.117*	0.076	0.019	0.076	0.045	0.007
FIN	$k_{ ho}$	0.837***	0.824***	0.821***	0.853***	0.859***	0.874***	0.844***	0.813***	0.761***
	$k_1$	-0.038	0.013	0.036	0.017	0.030	0.053*	0.039	0.022	0.006
	$k_2$	-0.091	-0.172***	-0.152***	-0.115**	-0.122***	-0.100**	-0.077	-0.078	-0.109*
	$k_3$	0.232**	0.218**	0.140	0.122	0.094	0.026	0.208**	0.174**	0.152*
HCA	$k_{ ho}$	0.808***	0.807***	0.770***	0.790***	0.783***	0.767***	0.807***	0.805***	0.763***
	$k_1$	-0.155***	0.008	-0.012	-0.031	0.000	-0.016	-0.030	-0.034	-0.003
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	$k_2$	0.105**	-0.084**	-0.062*	-0.041	-0.027	-0.014	-0.008	0.019	-0.001
	$k_3$	-0.026	-0.029	-0.048	-0.022	-0.087	-0.111*	-0.077	-0.121*	-0.175**
IND	$k_{ ho}$	0.809***	0.782***	0.805***	0.852***	0.817***	0.816***	0.834***	0.812***	0.769***
	$k_1$	0.045	0.021	0.024	0.014	-0.007	-0.020	-0.039	-0.023	-0.020
	$k_2$	-0.194***	-0.202***	-0.154***	-0.100**	-0.098**	-0.066	-0.067	-0.085*	-0.037
	$k_3$	0.226**	0.211**	0.136	0.231***	0.212***	0.167**	0.213***	0.187**	0.081
MAT	$k_{ ho}$	0.891***	0.857***	0.850***	0.863***	0.865***	0.839***	0.852***	0.816***	0.750***
	$k_1$	-0.173***	-0.011	0.003	-0.003	-0.002	0.004	-0.004	-0.019	-0.025
	$k_2$	0.018	-0.155***	-0.106***	-0.119***	-0.122***	-0.096**	-0.105**	-0.023	0.051
	$k_3$	0.121	0.100	0.016	0.102	0.080	0.021	0.062	-0.031	-0.148*
RES	$k_{ ho}$	0.735***	0.674***	0.665***	0.658***	0.612***	0.618***	0.631***	0.592***	0.524***
	$k_1$	-0.081**	-0.075***	0.017	-0.006	0.044*	0.039*	0.022	0.017	0.011
	$k_2$	0.105*	0.074*	0.006	0.005	-0.047	-0.029	-0.008	0.010	-0.015
	$k_3$	0.023	-0.002	-0.043	0.131**	0.102*	0.076	0.061	0.020	0.001
TEC	$k_{ ho}$	0.821***	0.849***	0.848***	0.864***	0.859***	0.839***	0.811***	0.797***	0.783***
	$k_1$	-0.052	-0.032	-0.027	-0.045**	-0.051**	-0.035	-0.023	-0.010	-0.018
	$k_2$	0.066	0.006	-0.010	0.001	0.002	-0.007	-0.018	-0.057	-0.061
	$k_3$	0.014	0.017	0.002	0.095*	0.084	0.058	0.042	0.023	0.011
TEL	$k_{ ho}$	0.819***	0.843***	0.859***	0.857***	0.815***	0.836***	0.808***	0.773***	0.737***
	$k_1$	-0.072**	-0.018	0.006	0.002	0.001	-0.008	-0.016	-0.030	-0.032
	$k_2$	0.069	0.009	-0.016	-0.007	-0.015	-0.024	-0.037	0.003	-0.025
	$k_3$	0.054	0.030	0.011	0.030	0.012	0.011	0.137	0.074	0.057
UTL	$k_{ ho}$	0.910***	0.853***	0.881***	0.900***	0.895***	0.878***	0.883***	0.874***	0.838***
	$k_1$	0.031	0.021	0.013	-0.002	0.010	0.020	0.029	0.010	-0.007
	$k_2$	-0.108**	-0.060	-0.023	-0.016	-0.020	-0.025	0.034	0.051	0.051
	$k_3$	0.031	-0.040	-0.089	-0.074	-0.094**	-0.116**	-0.054	-0.075	-0.090*

Notes: The results in Table 4b are based on Eq. (12).  $ADCC_t(\tau|X_{t-i}) = k(\tau)X_{t-i}$  but focuses on the safe haven coefficient estimates,  $k_1(\tau)$ ,  $k_2(\tau)$ . and  $k_3(\tau)$  of the quantile regression. \*\*\*, \*\* and \* signals rejection of null at 1%, 5% and 10% significance level, respectively.

For TEC,  $k_1$  is significantly negative at 40<sup>th</sup> and 50<sup>th</sup> quantiles but insignificantly negative in the rest of  $k_1$  quantiles. Third, the strength of gold's safe haven feature is dependent on the strength of dynamic correlation even during extreme market downturn. For example, while there is undiscernible pattern of  $k_2$  estimate across quantiles for ENG and MAT sectors, gold remains a strong safe haven in six out of nine quantiles ( $k_2$  is significantly negative) but not at the upper quantiles. One of the potential reasons why extreme market conditions may not affect correlation between sectors and gold is the volatilities of the two assets. While time-varying correlation is a primary driver of changes in portfolio diversification benefits (and hence investor's investment opportunity set), low assets' volatilities during market downturn (due to huge cash outflow from the market) cause inter-asset correlation to insignificantly impact investor's investment opportunity set. Overall, the strong and weak safe haven features of gold widely vary across quantiles and sectors. Using linear models ignores the distributional characteristics of ADCC, resulting in biased results and inference on the strength of gold's safe haven attributes.

#### **Optimal Hedge ratios**

Figure 3 presents the time-varying conditional optimal hedge ratios ( $\mathcal{B}_t$ ), calculated from Eq. (4), for each of the eleven gold-sector combinations during the sample period. The conditional  $\mathcal{B}_t$  are clearly changing, with infrequent swings from positive to negative values and vice versa, as new information arrives at the market. This suggests that investors ought to continuously adjust their portfolios to effectively minimize risk exposure over time. We carried out unit root tests (results available on request) for each series of  $\mathcal{B}_t$  and confirmed that all the  $\mathcal{B}_t$  series are stationary. This implies that hedge ratios are mean reverting, so that the impact of a shock to the hedge ratios ultimately becomes insignificant.

During the sample period, the hedge ratios are largely positive, suggesting a short position in gold is required to offset a long position in stock. However, there are instances of negative hedge ratios. For example, around October 2002, the hedge ratio was -0.14, -0.25, -0.75 and -1.06 for RES, UTL, IND and TEC sectors, respectively. During the GFC, the hedge ratios plunged to as low as -0.34, -0.47 and -0.10 for CDI, FIN, and ENG, respectively. During COVID-19, the hedge ratio for RES and TEC were -0.06 and -0.60, respectively. The negative hedge ratios reflect the negative performance of the sector indices. During those market downturns when hedge ratios were negative, investors temporarily needed long positions in gold market to reduce the risk of the global sector equities.

The negative hedge ratios during crisis periods are not anomalous and are indeed consistent with literature (Akhtaruzzaman et al., 2021, 2024). The negative  $\mathcal{B}_t$  during GFC and COVID-19 followed by a rise to a positive  $\mathcal{B}_t$  could be attributed to economic stimulus packages during the GFC and in the first quarter of 2020 (after declaration of COVID-19 as a global pandemic) to step economic fallout (Batten et al., 2021). The significant rise in optimal hedge ratios at the inception of or during the COVID-19 pandemic signifies a spike in the cost of hedging.



There is a noticeable increase in hedge ratios around September 2022. This was after the global (US) inflation rate hit a record 7.5% (8.2%), increasing the cost of hedging the effects of

diminishing real returns and potential stock market decline from increased discounting rate. As Barsky et al. (2021) explain, an upswing in inflation or inflationary expectations sparks investors' interest in acquiring gold, triggering gold's price increase. Conversely, disinflation (decline in inflationary expectations) reduces demand for gold and its price.

Table 5 reports the descriptive statistics of the  $\mathcal{B}_t$  for all sector-gold pairs during the sample period. The average  $\mathcal{B}_t$  widely vary across the global sectors. For the positive average hedge ratios, the two lowest (highest) positive hedge values are 0.006 and 0.029 (0.180 and 0.270) for HCA and CDI (ENG and MAT), suggesting that a \$1000 long position in HCA and CDI (ENG and MAT) is hedged with \$6 and \$29 (\$18 and \$27) short position, respectively, in the gold market. The average hedge ratio for TEC (and all minimum hedge ratios) is negative. This negative hedge ratio arises from the negative correlation between gold and TEC sector and suggests that the hedge is established by taking either long or short positions for both gold and TEC sector. For example, a negative average hedge ratio of -0.012 for TEC implies that a \$1000 long position in TEC sector stocks is hedged by taking another long position for \$12 in the gold market. The low (high) OHR suggests that the hedging effectiveness involving gold and some sector stocks such as HCA, CDI and CSI (RES, MAT and ENG) is quite good (low). Our results are generally consistent with the observation that inclusion of gold into a diversified portfolio of stocks improves the risk-adjusted performance of the resulting stock-gold sector-based portfolio.

Table 5: Descriptive statistics of the optimal hedge ratios ( $\mathcal{B}_t$ )

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
CDI	0.029	0.769	-0.659	0.168	0.033	5.206	341
CSI	0.045	0.414	-0.285	0.105	-0.198	3.355	341
ENG	0.180	1.044	-0.645	0.257	0.111	3.519	341
FIN	0.050	0.669	-0.805	0.210	-0.150	3.716	341
HCA	0.006	0.375	-0.450	0.131	-0.508	3.708	341
IND	0.055	0.703	-0.754	0.167	-0.236	4.822	341
MAT	0.270	1.076	-0.586	0.227	0.085	3.502	341
RES	0.136	0.606	-0.229	0.121	0.480	4.171	341
TEC	-0.012	0.776	-1.064	0.238	-0.525	4.698	341
TEL	0.054	0.629	-0.638	0.167	-0.211	4.070	341
UTL	0.104	0.742	-0.247	0.126	0.717	5.627	341

For MAT and ENG, the maximum  $\mathcal{B}_t$  slightly higher than 1 hence at that point, the volatility of the MAT and ENG sector returns was significantly higher than the volatility of the gold returns, resulting in the  $\mathcal{B}_t$  being greater than 1. For these two sectors, investors might need additional gold to minimize the high volatility of MAT and ENG sector variance.

#### **Time-varying hedge effectiveness**

Unlike optimal hedge ratios which provide generic insight on hedging properties, hedging effectiveness (HE) index provides a time-varying measure of how effective hedging with gold over time. HE indicates the proportion of variance eliminated by the hedge. Specifically,

$$HE_t = \mathcal{B}_t^2 \frac{var(R_{G,t}|\mathcal{F}_{t-1})}{var(R_{S,t}|\mathcal{F}_{t-1})} = \left[1 - \frac{var(R_{hp,t})}{var(R_{up,t})}\right]$$

 $R_{hp,t}$  ( $R_{up,t}$ ) is the return of the hedged (unhedged) portfolio.  $R_{G,t}(R_{S,t})$  is the gold (global sector) stock return while  $\mathcal{F}_{t-1}$  is the information set at period t - 1. A hedged portfolio which includes gold has lower risk than an unhedged portfolio or a portfolio without gold. When the inclusion of gold in a sector equity portfolio diminishes total portfolio risk (variance), a 100% hedging effectiveness is achieved. Therefore, the higher the HE measures, the higher the risk reduction. A HE of one (zero) signifies a perfect (no) hedge.

Fig. 4a presents the time-varying HE during the sample period and across sector-gold combinations. The HE variation reflects changes in optimal hedge ratios and the variance of hedged and unhedged portfolios. For example, for CDI, CSI, FIN and TEC, HE seems to drastically plunge to zero (zero risk reduction) at the start the GFC, rise during the GFC crisis and peaks on September 2008 when of Lehman Brothers collapsed and when the US Federal government announced nationalization of Freddie Mac and Fannie Mae, plunge again thereafter and eventually rise after the GFC, heralding an increased risk reduction by including gold in a sector equity portfolio.

Fig. 4b reveals variation in maximum and average HE values across the global sectors during the sample period. The minimum HE was zero for all the sectors.



Figure 4a: Time-varying hedge effectiveness



ENG

2010

IND

2015

2020

2005

.5

.4

.3

.2

.1

.0 1995

2000

2000

2005

2010

2015





On average, the HCA-gold, TEC-gold, TEL-gold, and CSI-gold portfolios witnessed a 2.0%, 2.4%, 2.6% and 2.6% reduction in risk, respectively, albeit a maximum 16.2%, 23.2%, 15.7% and 19.8% risk reduction was achieved during the sample period. This unfavorably compares to 5.8% (40%) and 9.5% (47%) average (maximum) variance reduction for ENG-gold and MAT-gold portfolios, respectively. The vast variation in average and maximum HE across the sector-gold portfolio further reinforces the need to investigate the hedging effectiveness of gold at the more disaggregated sector level as opposed to the aggregate national stock market indices.

#### Is the hedging strategy economically significant?

Following Kroner and Sultan (1993), Narayan and Sharma (2016), and Batten et al. (2021), we investigate whether the hedge portfolio affords utility gains for investors. The formulation of change in expected utility,  $\Delta E(u)$ , is premised on the assumption that investors optimize their utility with a mean-variance utility function. Conditionally on information set at period t-1, that is,  $\mathcal{F}_{t-1}$ , the average incremental expected utility,  $\Delta E(u)$  is the difference between the expected utility derived from the returns of a hedged portfolio,  $[E(u(R_{up,t}|\mathcal{F}_{t-1}))]$  and the expected utility from the returns of unhedged portfolio,  $[E(u(R_{up,t}|\mathcal{F}_{t-1}))]$ . Formally,

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$$\Delta E(u) = \left[ E\left( u\left( \mathsf{R}_{hp,t} \middle| \mathcal{F}_{t-1} \right) \right) \right] - \left[ E\left( u\left( \mathsf{R}_{up,t} \middle| \mathcal{F}_{t-1} \right) \right) \right]$$

Where

$$E(u(\text{HP}|\mathcal{F}_{t-1})) = E(R_{hp,t}|\mathcal{F}_{t-1}) - \delta var(R_{hp,t}|\mathcal{F}_{t-1}) - TC \text{ and}$$
$$E(u(\text{UP}|\mathcal{F}_{t-1})) = E(R_{up,t}|\mathcal{F}_{t-1}) - \delta var(R_{up,t}|\mathcal{F}_{t-1}) - TC$$

The return of the hedged portfolio,  $R_{hp,t}$ , is from Eq. (1).  $\delta \gg 0$  captures the different degrees of risk aversion. Specifically, and following prior literature, we estimate expected utility by setting  $\delta = 3$ ,  $\delta = 6$  and  $\delta = 12$  to capture low risk aversion, moderate risk aversion and high-risk aversion, respectively.  $TC \ge 0$  represents transaction costs and assesses whether the hedging strategy is still economically feasible and profitable after accounting for transaction costs. Table 6 gathers the estimated average monthly percentage utility gain for each global sector portfolio using the sector-gold hedge described in Eq. (1). Panel A (Panel B) of Table 6 shows the incremental utility without (with) transaction costs of 0.5%. We make three main observations from Table 6.

Panel A:	No transa	action costs		Panel B:	With transact	ion costs
Risk aversion	$\delta = 3$	$\delta = 6$	$\delta = 12$	$\delta = 3$	$\delta = 6$	$\delta = 12$
CDI	0.375	0.755	1.515	-0.125	0.255	1.015
CSI	-1.320	-2.638	-5.275	-1.820	-3.138	-5.775
ENG	3.885	7.780	15.571	3.385	7.280	15.071
FIN	1.957	3.916	7.836	1.457	3.416	7.336
HCA	-0.492	-0.984	-1.967	-0.992	-1.484	-2.467
IND	0.222	0.448	0.900	-0.278	-0.052	0.400
MAT	1.721	3.450	6.908	1.221	2.950	6.408
RES	0.108	0.216	0.432	-0.392	-0.284	-0.068
TEC	3.788	7.580	15.164	3.288	7.080	14.664
TEL	0.733	1.466	2.934	0.233	0.966	2.434
UTL	-0.724	-1.446	-2.890	-1.224	-1.946	-3.390

 Table 6: Assessment of economic significance of the hedging strategy

Note:  $\delta = 3$ ,  $\delta = 6$  and  $\delta = 12$  signify low risk aversion, moderate risk aversion and high-risk aversion, respectively.

First, in presence and absence of transaction costs, utility gain is increasing in risk aversion, suggesting higher diminished variance in the hedged position than in the unhedged position. Second, utility gains markedly vary across global equity sectors and hedging is not always profitable. The two best (worst) hedge performance is identified for ENG and TEC (UTL and CSI).

For example, ignoring transaction cost, a highly risk averse investor obtains an average monthly percentage utility gain (loss) of 15.57% and 15.16% (5.28% and 2.89%) for ENG and TEC (CSI and UTL), respectively if they use a stock-gold hedge. We document hedging utility loss for CSI, HCA and UTL. These sectors are the classical value sectors which are largely stable and insensitive to business cycles. Utility gains are highest (lowest) for cyclical (non-cyclical or defensive sectors) such as ENG, TECH, FIN and MAT (CSI, UTL and HCA). A potential explanation for the high economic gains for cyclical sectors is the higher dynamic correlation between each sector's returns and gold returns. Third, turning to the results in Panel B of Table 6, we note that while the 0.5% transaction costs reduce utility gain or hedging profitability, the reduction is dependent on the level of risk aversion. For example, the utility gain for IND in Panel A (ignoring transaction) become utility losses at all levels of risk aversion.

#### ADCC and global risk aversion

Bekaert, Engstrom and Xu (2022), using US-based data, derives a time-varying measure of risk aversion (RA) and find that RA accounts for 96%, 72.5% and 96.8% of the equity risk premium, corporate bond risk premium and variance of equity's variance risk premium. The RA measure, derived from hyperbolic absolute risk aversion (HARA) utility function, is based on six market-based financial variables namely detrended dividend or earning yield, term spread, credit spread, realized equity return variance, risk-neutral equity return variance and realized corporate bond return variance. The seminal study ensures unbiased representation of RA by uniquely distinguishing between the quantity of risk (time-varying economic uncertainty) and the price of risk (time variation in risk aversion).

Extending Bekaert et al. (2022) study, Xu (2023) finds that among multiple global macroeconomic uncertainties and risk aversion of a typical global investor, global risk aversion (GRA) explains 90% (40%) of correlation dynamics of global equity (bond). By quantifying the impact of correlation risk on asset prices and controlling volatility of asset return and major risk factors, Krishnan, Petkova and Ritchken (2009) and Mueller, Stathopoulos and Vedolin (2017) demonstrate that correlation represents a significantly negative price of risk. Therefore, the knowledge about drivers of co-movements of assets' returns and volatility plays a pivotal role in effective portfolio diversification strategies and asset pricing. Anaya et al., (2017) shows that the global risk aversion is a conduit of transmitting US monetary policy (which drives credit growth in the US) to emerging economies and cross-border credit flows and the evidence of a significant U.S. monetary policy effect on emerging economies. We investigate the role of global risk aversion in explaining the dynamic co-movements of eleven sector-gold pairs using the global risk aversion measure recently developed by Xu (2019). We formally investigate the potential relationship between the global risk aversion (GRA) and time varying asymmetric DCC (ADCC) between each global sector, *i*, and gold. We estimate the following model.

$$ADCC_{i,t} = \alpha_{10} + \alpha_{11}GRA_t + \mu_{i,t} \tag{13}$$

where  $\mu_{i,t}$  is a series of residuals.  $\alpha_{1i}$  are the parameter estimates. We expect that as the global risk aversion increases, investors engage in flight-to-safety hence they will dump the risky stocks (stock prices will plunge) and seek safety in gold (gold prices will rise). Therefore, we expect  $\alpha_{11} < 0$  (increase in GRA triggers negative but heterogeneous correlation between gold and each sector equity. Our sample period, January 1995 through May 2023, is characterized by numerous extraordinary crisis periods and events. We therefore modify Eq. (12) by interacting notable crisis periods with GRA. Specifically,

$$FADCC_{i,t} = \alpha_{10} + \alpha_{11}GRA_t + \alpha_{12}GRA_t * D_{Asia,t} + \alpha_{13}GRA_t * D_{COVID,t} + \alpha_{14}GRA_t * D_{GFC,t} + \alpha_{15}GRA_t * D_{ESDC,t} + \mu_{i,t}$$
(14)

In Eq. (14),  $FADCC_{i,t}$  is the Fisher-transformed dynamic correlation.  $D_{Asia,t}$ ,  $D_{COVID,t}$ ,  $D_{GFC,t}$  and  $D_{ESDC,t}$  are, respectively, dummy variables equal to 1 during the Asian crisis period (July 1997– December 1998<sup>5</sup>), COVID-19 pandemic period (March 11 2020 to May 11 2023<sup>6</sup>), the Global Financial Crisis (GFC) period (Dec 2007–July 2009 as defined by the National Bureau of Economic Research, NBER) and the European sovereign debt crisis (ESDC) period (Oct 5<sup>th</sup> 2009-March 2013<sup>7</sup>) and zero otherwise.  $\alpha_{1i}$  are the coefficients to be estimated. Since the dependent variable, FADCC, is non-normally distributed (See Table 3), asymmetric and exhibits excess kurtosis, we adopt the quantile regression model for Eq. (14) to account for these FADCC features.

sector	$\tau \rightarrow$	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
CDI	$\alpha_{10}$	0.170	0.181***	0.259***	0.253***	0.346***	0.354***	0.388***	0.346***	0.371***
	$\alpha_{11}$	-0.107***	-0.099***	-0.111***	-0.100***	-0.119***	-0.110***	-0.106***	-0.078***	-0.068**
	$\alpha_{12}$	0.021	0.035***	0.033***	0.030**	0.024*	0.028**	0.027*	0.031**	0.028
	$\alpha_{13}$	0.032***	0.042***	0.041***	0.035***	0.039***	0.037***	0.035***	0.036***	0.064***
	$\alpha_{14}$	0.005	0.029**	0.037***	0.039***	0.049***	0.051***	0.044***	0.036***	0.035**
	$\alpha_{15}$	0.041***	0.046***	0.050***	0.053***	0.051***	0.061***	0.071***	0.072***	0.065***
CSI	$\alpha_{10}$	0.083	0.191***	0.240***	0.268***	0.314***	0.348***	0.386***	0.343***	0.334***
	$\alpha_{11}$	-0.064***	-0.085***	-0.092***	-0.090***	-0.097***	-0.101***	-0.103***	-0.074***	-0.047*
	$\alpha_{12}$	-0.029	-0.002	0.002	0.000	-0.006	0.001	0.000	0.002	-0.007
	$\alpha_{13}$	0.046***	0.051***	0.052***	0.045***	0.052***	0.051***	0.051***	0.047***	0.050***
	$\alpha_{14}$	-0.011	0.032***	0.034***	0.028***	0.037***	0.049***	0.048***	0.044***	0.023
	$\alpha_{15}$	0.023**	0.034***	0.046***	0.060***	0.056***	0.053***	0.057***	0.057***	0.056***
ENG	$\alpha_{10}$	0.274***	0.262***	0.332***	0.416***	0.422***	0.502***	0.542***	0.625***	0.607***
	$\alpha_{11}$	-0.123***	-0.102***	-0.110***	-0.128***	-0.118***	-0.122***	-0.121***	-0.122***	-0.071**
	$\alpha_{12}$	-0.034*	-0.012	0.026*	0.018	0.031*	0.014	0.008	0.005	-0.017
	$\alpha_{13}$	0.019	0.022*	0.028***	0.024**	0.024**	0.014	0.027*	0.029	0.013
	$\alpha_{14}$	0.068***	0.078***	0.078***	0.085***	0.087***	0.082***	0.076***	0.065***	0.029
	$\alpha_{15}$	0.044***	0.046***	0.068***	0.072***	0.075***	0.076***	0.080***	0.064***	0.039**
FIN	$\alpha_{10}$	-0.054	-0.065	-0.006	0.002	0.068	0.125*	0.230***	0.265***	0.407***
	$\alpha_{11}$	-0.058	-0.020	-0.019	-0.004	-0.011	-0.016	-0.033	-0.030	-0.058**
	$\alpha_{12}$	0.077***	0.046**	0.029	0.020	0.013	0.012	0.004	-0.001	-0.003
	$\alpha_{13}$	0.027	0.016	0.000	-0.011	0.006	-0.003	-0.006	0.010	0.050***
	$\alpha_{14}$	0.028	0.006	-0.003	-0.017	-0.011	0.005	0.011	0.008	0.021
	$\alpha_{1F}$	0.050***	0.039***	0.030***	0.050***	0.046***	0.047***	0.070***	0.065***	0.056***

Table 7: Fisher-Transformed ADCC, global risk aversion and crisis events

<sup>5</sup> Following Demirer et al. (2018) definition of the Asian crisis period.

<sup>6</sup> The World Health Organization (WHO) officially declared COVID-19 as a global pandemic on March 11<sup>th</sup> 2020. The U.S. Department of Health and Human Services (HHS) and WHO formally declared the end of COVID-19 pandemic on May 11<sup>th</sup>, 2023.

<sup>7</sup> We follow the definition adopted by Niţoi and Pochea (2019)

HCA	$\alpha_{10}$	0.031	0.096*	0.178***	0.218***	0.260***	0.251***	0.242***	0.202***	0.268***
	$\alpha_{11}$	-0.061***	-0.071***	-0.086***	-0.089***	-0.098***	-0.087***	-0.071***	-0.047***	-0.048**
	$\alpha_{12}$	-0.026	0.004	0.002	0.011	0.019**	0.024**	0.016	0.021	0.008
	$\alpha_{13}$	0.052***	0.049***	0.050***	0.047***	0.051***	0.052***	0.045***	0.049***	0.054***
	$\alpha_{14}$	0.008	0.032***	0.037***	0.035***	0.046***	0.044***	0.037***	0.031***	0.026*
	$\alpha_{15}$	0.032***	0.048***	0.046***	0.058***	0.060***	0.061***	0.060***	0.071***	0.070***
IND	$\alpha_{10}$	0.189**	0.221***	0.258***	0.328***	0.339***	0.386***	0.435***	0.374***	0.471***
	$\alpha_{11}$	-0.114***	-0.104***	-0.105***	-0.118***	-0.103***	-0.110***	-0.118***	-0.075***	-0.087***
	$\alpha_{12}$	-0.009	0.003	0.018	0.019	0.014	0.010	0.031**	0.013	0.021
	$\alpha_{13}$	0.034***	0.038***	0.038***	0.040***	0.032***	0.038***	0.042***	0.034***	0.076***
	$\alpha_{14}$	0.045***	0.044***	0.045***	0.053***	0.046***	0.051***	0.055***	0.044***	0.046**
	$\alpha_{15}$	0.044***	0.046***	0.050***	0.062***	0.061***	0.062***	0.076***	0.065***	0.061***
MAT	$\alpha_{10}$	0.441***	0.608***	0.657***	0.656***	0.687***	0.739***	0.735***	0.671***	0.641***
	$\alpha_{11}$	-0.155***	-0.190***	-0.190***	-0.176***	-0.174***	-0.174***	-0.149***	-0.101***	-0.053
	$\alpha_{12}$	0.015	0.010	0.019	0.008	0.004	0.003	0.007	0.006	-0.016
	$\alpha_{13}$	0.058***	0.071***	0.071***	0.065***	0.060***	0.054***	0.034**	0.037**	0.042**
	$\alpha_{14}$	0.086***	0.095***	0.101***	0.098***	0.093***	0.089***	0.077***	0.050***	0.011
	$\alpha_{15}$	0.056***	0.068***	0.065***	0.074***	0.077***	0.086***	0.074***	0.057***	0.043***
RES	$\alpha_{10}$	0.126**	0.170***	0.187***	0.178***	0.203***	0.246***	0.279***	0.277***	0.346***
	$\alpha_{11}$	-0.044**	-0.041**	-0.035**	-0.025**	-0.026**	-0.034***	-0.036**	-0.021	-0.035**
	$\alpha_{12}$	0.001	-0.003	0.001	0.009	0.008	0.004	0.002	0.000	0.003
	$\alpha_{13}$	0.000	0.014	0.016***	0.018***	0.017***	0.020***	0.021***	0.020**	0.029***
	$\alpha_{14}$	-0.002	-0.001	-0.003	-0.008	-0.009	-0.007	-0.007	0.000	0.009
	$\alpha_{15}$	0.007	0.002	0.011	0.012**	0.023***	0.025***	0.023***	0.018**	0.022***
TEC	$\alpha_{10}$	0.146**	0.208***	0.267***	0.299***	0.317***	0.275***	0.261***	0.269***	0.299***
	$\alpha_{11}$	-0.110***	-0.116***	-0.124***	-0.125***	-0.121***	-0.097***	-0.084***	-0.068***	-0.054**
	$\alpha_{12}$	-0.022	0.021	0.039***	0.037***	0.030***	0.029**	0.031**	0.028*	0.012
	$\alpha_{13}$	0.039***	0.050***	0.053***	0.050***	0.046***	0.047***	0.061***	0.056***	0.057***
	$\alpha_{14}$	0.004	0.038***	0.047***	0.056***	0.050***	0.042***	0.039***	0.031**	0.027*
	$\alpha_{15}$	0.045***	0.047***	0.050***	0.059***	0.068***	0.070***	0.075***	0.075***	0.057***
TEL	$\alpha_{10}$	0.206***	0.198***	0.250***	0.267***	0.332***	0.386***	0.446***	0.404***	0.438***
	$\alpha_{11}$	-0.112***	-0.093***	-0.101***	-0.097***	-0.109***	-0.113***	-0.115***	-0.087***	-0.074***
	$\alpha_{12}$	0.023	0.014	0.013	0.025**	0.016	0.010	-0.001	0.017	0.017
	$\alpha_{13}$	0.029***	0.043***	0.042***	0.035***	0.037***	0.033***	0.025**	0.022**	0.038***
	$\alpha_{14}$	0.044***	0.038***	0.053***	0.051***	0.055***	0.061***	0.055***	0.047***	0.033**
	$\alpha_{15}$	0.046***	0.045***	0.046***	0.063***	0.061***	0.054***	0.051***	0.051***	0.037***
UTL	$\alpha_{10}$	0.200***	0.336***	0.323***	0.319***	0.302***	0.338***	0.368***	0.430***	0.387***
	$\alpha_{11}$	-0.090***	-0.121***	-0.105***	-0.093***	-0.073***	-0.077***	-0.069***	-0.071***	-0.037
	$\alpha_{12}$	-0.007	0.000	0.003	0.004	0.005	0.003	-0.006	0.004	0.000
	$\alpha_{13}$	0.041***	0.046***	0.047***	0.043***	0.038***	0.038***	0.032***	0.040***	0.044***
	$\alpha_{14}$	0.054***	0.062***	0.060***	0.051***	0.037***	0.042***	0.033**	0.029*	0.012
	$\alpha_{15}$	0.027***	0.033***	0.037***	0.040***	0.031***	0.039***	0.030**	0.032***	0.040***

**Notes:** Across all the quantiles, the average estimate for  $\alpha_{13}$  ( $\alpha_{14}$ ) are 0.040 (0.036), 0.050 (0.032), 0.022 (0.072), 0.010 (0.005), 0.050(0.033), 0.041(0.048), 0.055 (0.078), 0.017 (-0.002), 0.051 (0.037), 0.034 (0.049) and 0.041 (0.042) for CDI, CSI, ENG, FIN, HCA, IND, MAT, RES, TEC, TEL and UTL sectors, respectively. \*\*\*, \*\* and \* signifies statistical significance at 1%, 5% and 10% level.

Formally,

$$FADCC_t(\tau|X_{t-i}) = \alpha(\tau)X_t$$

(15)

where  $\tau = \in (0,1)$  and  $X_t \in (GRA_t; GRA_t * D_{Asia,t}; GRA_t * D_{COVID,t}; GRA_t * D_{GFC,t}; GRA_t * D_{ESDC,t})$ 

 $\alpha(\tau)$  is the parameter estimate at quantile with  $\tau = 0.10, \dots, 0.90$ 

The results are presented in Table 7. We find that apart from the financial sector-gold FADCC, GRA is consistently a significant driver of the sector equity-gold dynamic correlations across correlation quantiles. While the effect of GRA on ADCC is expectedly negative, which is consistent with flight-to-quality effects, results presented in Table 7 also indicate that global sector equities do not homogeneously react to global risk aversion shocks, even after controlling for major global crisis periods. For example, the top three largest GRA effects or  $\alpha_{11}$  coefficient estimates, averaged across the quantiles, on descending order, are observed on MAT-gold (-0.151), ENG-gold (-0.113) and IND-gold (-0.104). The least impact of GRA is observed for FIN-gold (0.000), RES-gold (-0.033) and HCA-gold (-0.073) correlations.

Further analysis shows the apart from CDI and TEC sectors where  $\alpha_{12}$  is significant across some FADCC quantiles, the Asian crisis had distinctively insignificant or very weak impact on how GRA affected FADCC across FADCC distributions. This implies that the Asia crisis was largely an emerging market crisis without a global scale. When we interact GRA with different crisis periods, the coefficient estimates are largely positively significant except FIN during COVID-19 and GFC periods and RES during the GFC period, where the interaction estimates are largely insignificant across the quantiles. These results on FIN and RES are plausible. During the GFC and COVID-19 pandemic periods, FIN sector received significant government bailout and liquidity (through quantitative easing, QE) support from governments across the world. There were multiple real estate (RES) policy interventions such as the Home Affordable Modification Program (HAMP) and the Home Affordable Refinance Program (HARP) programs in the US to stem home foreclosures and defaults. These initiatives mean the for FIN and RES sectors, GFC and COVID-19 crises had insignificant impact on the effect of GRA on FADCC. For the remaining nine sectors, the risk aversion effect on FADCC is driven primarily by COVID-19, GFC and Euro sovereign debt crises periods. However, we observe the effects of these crises periods on how GRA affect the time varying FADCC is heterogeneous across sectors and the FADCC quantiles. For example, the GFC period (based on the average coefficient estimate across the quantiles) increased the impact of GRA on FADCC by 0.077 and 0.072 for MAT and ENG, respectively. This compares to -0.003 and 0.005 increase for RES and FIN sectors. Similarly, the COVID-19 amplified, on average, the impact of GRA on FADCC by 0.010, 0.017 and 0.022 (0.050, 0.051 and 0.055) for FIN, RES, and ENG (CSI, TEC, and MAT), respectively.

Although the analyzed increases in GRA effect are based on the average coefficient estimates across the quantiles, they highlight the heterogeneous response of different sectors to crisis shocks and the indirect impact on FADCC. A potential explanation why crises events amplify correlation between sector equity and gold is increased uncertainty during the crisis periods and the investor behavior. According to Pástor and Veronesi (2013) and Bloom (2009), high level of uncertainty in economic policies (especially during crisis periods) can (i) negatively impact investments and cash flows while also triggering a rise in discount rates and (ii) curtail the demand by the private (corporate and household) sectors due to reduced or delayed capital spending. These two forces jointly affect both stock and commodity markets in similar directions, generally resulting in increased correlations between sector stock and commodities, including gold. Our results have implications on diversification and asset allocation decisions. For example, high risk aversion, which is linked to high uncertainty, affects investment and diversification decisions. Further, uncertainty affects correlations and therefore, optimal portfolio weights, hedge effectiveness and marginal utility of adding gold to a portfolio of sector equities.

#### V) Conclusion

We investigate whether gold's hedging feature varies across correlation and business cycles. Using eleven global sector returns spanning from January 1995 to May 2023, we find that gold is a strong hedge in the low dynamic conditional correlation (DCC) cycle but strongly effective diversifier at high DCC cycles. Gold hedging and diversification features are functions of correlation cycles. Linear models provide biased and unreliable results. Economically, hedging value stock sectors such as healthcare, consumer staples and utility with gold yield marginal utility loss unlike cyclical global sectors.

The overall findings on the role risk aversion driving dynamic correlation underscore the importance of non-cash flow related shocks (risk aversion and herding behavior by investors) on sector equity and commodity markets' co-movements. The effects of GRA is heterogeneous not just across the global sector equities but also across correlation cycles. Further, crisis periods heterogeneously impact the effect risk aversion across sector-gold dynamic correlations and across correlation cycles. This evidence matters for global investors as they assess contagion between gold and each of the eleven global sectors and in identifying which sectors are les subject to systematic risk during crisis periods.

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## WHEN TO TAKE YOUR SOCIAL SECURITY RETIREMENT BENEFITS: A DIFFERENT TAKE ON THE DECISION

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## ABSTRACT

While the Social Security full retirement age is currently 67, workers that are eligible for benefits may begin to receive payments as early as 62, but the payments are reduced. Conversely, if they defer receiving payments until age 70, the payments are increase by 24% above those paid at 67. The analysis of when to elect to receive benefits often focuses on the crossover age," the age at which the sum of the early, but lower payments, equals the sum of the deferred, but higher payments. The thinking is that if you expect to live beyond the crossover age, you should elect to defer your retirement benefits. There are numerous weaknesses in this approach. This analysis assumes the decision is made in a vacuum, instead of within a household. Spousal benefits can play a significant factor in this decision.

When to take your Social Security Retirement Benefits: A Different take on the decision

#### Abstract

While the Social Security full retirement age is currently 67, workers that are eligible for benefits may begin to receive payments as early as 62, but the payments are reduced. Conversely, if they defer receiving payments until age 70, the payments are increase by 24% above those paid at 67. The analysis of when to elect to receive benefits often focuses on the crossover age," the age at which the sum of the early, but lower payments, equals the sum of the deferred, but higher payments. The thinking is that if you expect to live beyond the crossover age, you should elect to defer your retirement benefits. There are numerous weaknesses in this approach. This analysis assumes the decision is made in a vacuum, instead of within a household. Spousal benefits can play a significant factor in this decision.

## Introduction

Most people look forward to their retirement years. The idea of being free to pursue your interests on your own schedule is appealing after years of working on projects often chosen by someone else with timelines imposed by them. The prudent individual has a plan as to how they will fund their retirement years. Social Security is often viewed as one leg of the three-legged retirement stool, with the other two legs being employer-provided retirement benefits, and your own retirement savings.

The question as to when to retire is often a difficult one. You don't want to retire too early and outlive your retirement funds. In addition, tax laws impose a penalty if you withdraw from tax-deferred retirement savings before you are 59 ½. Healthcare may also be an issue in retirement. If your health insurance is provided by your employer, you may need to wait until you qualify for Medicare at 65 to retire.

## Social Security Retirement Benefits

You must work a minimum of 40 quarters to qualify for Social Security retirement benefits. The amount of your benefit is a function of what you contributed to the Social Security taxes during your work life, the number of years that you worked, and your age when you claim your benefits. While the full retirement age for Social Security is now 67 (for those born after 1954), you may begin receiving benefits as early as 62. However, your benefit at 62 is only 70% of what you would receive at 67. If you defer benefits to age 70, you will receive 124% of your full retirement benefit.

Your benefit also impacts what your spouse may receive from Social Security through spousal benefits. If you are receiving Social Security benefits and your spouse is of full retirement age (currently 67), then they are eligible for 50% of your full retirement benefit if that amount exceeds what they would have received themselves. For instance, if your benefit is \$30,000 per year and your spouse is eligible for \$12,000 per year (based on their contributions), your spouse would receive \$15,000 per year, an additional \$3000 per year. Spousal benefits may be received as early as 62, but at a rate of less than 50% of your benefit.

Should you predecease your spouse, their survivor benefit would be your benefit of \$30,000 per year, a significant increase over the \$12,000 they had earned by themselves as well as the \$15,000 they would have been receiving as spousal benefits. The increase in the payment resulting from the survivor

benefit can be viewed as a lifetime annuity for the surviving spouse. Deferring your Social Security benefit until 70 maximizes that survivor benefit.

#### **Crossover Analysis**

Many studies focus on the crossover age in determining when to take your Social Security benefit. The goal is to maximize lifetime benefits received. Using the \$30,000 full retirement benefit above at 67, you would receive 21,000 at 62 or \$37,200 at 70. The crossover age between \$21,000 at 62 and \$30,000 at 67 can be calculated as follows:

## \$21,000 (X + 5) = \$31,000 (X).

The solution for X is 11.667 years, so the crossover age is 11.67 years beyond full retirement age, or 78.667. At age 78.667, either retirement age has produced \$350,000 in benefits. If you expect to live beyond 78.667, crossover analysis suggests that you defer receiving your retirement benefits until you are 67. The crossover age between the \$21,000 benefit at 62 and the \$37,200 at 70 is 80.37 years (X = 10.37). At 80.37, either retirement age would have generated \$385,778 in benefits.

Crossover analysis has many acknowledged flaws, not the least of which is it completely ignores the time value of money. Since money in the present is worth more than money in the future, then there is a premium on receiving your retirement sooner rather than later. The higher the rate of return, the more the difference between present value and future value becomes.

In addition, crossover analysis focuses on the individual, but retirement decisions are made at the household level. For instance, if your retirement dream is to travel with your spouse, but your spouse is not ready or eligible to retire, then you may choose to continue to work. The additional work time only enhances your own retirement. If you are older than your spouse and carry the health insurance from your employer, then you need to wait until your younger spouse is 65 and qualifies for Medicare before you retire, even if you are eligible for retirement benefits now.

## A Holistic/Household View of Retirement

The retirement benefits to the household will be the sum of the benefits to each member. Using the earlier example of \$30,000 and \$12,000 respectively at their full retirement age, it is possible to evaluate different scenarios. Assume the couple are the same age and each retires at 62. Individually, they would each receive 70% of their benefit, \$21,000 and \$8400, or \$29,400 total. However, the spousal benefit will increase the benefit of the lower income earner to 50% of the higher benefit, or \$10,500, making their total Social Security benefit at 62 sum to \$31,500.

However, if they defer collecting these benefits until 67, the household would receive \$30,000 plus \$15,000 in the spousal benefit (since this amount exceeds the \$12,000 the individual had earned), or \$45,000 total. This joint income analysis yields a crossover of 11.67 years (31500(X+5)=45000(X)). Comparing a joint retirement at 62 to 70 yields a slightly lower crossover of 10.37 years (31500(X+8)=55800(X)).

As stated before, crossover analysis depends on your expectation of your own mortality. If you think you will die before the crossover date, then you opt for he earlier retirement. Alternatively, if you think you will live beyond the crossover date, then you retire later. But this ignores the survivor benefit you

leave your spouse. If the lower income earner dies first, then the surviving spouse keeps their higher retirement benefit. However, if the higher income spouse dies first, then the lower income earner's benefit rises to their spouse's higher benefit. In our example above, if the couple retire at 62 and higher income earner passes away, the lower income earner's benefit rises from \$10,500 to \$22,000. Had they retired at 67, the lower income earner's benefit rises from \$15,000 to \$30,000. Retiring at 70 sees their benefit rise from \$18,600 to \$37,200.

Assume the couple retires at 62 (with \$31,500 in annual Social Security benefits) and the higher earner passes away at 75. In the 13 years they were retired, they would have received \$409,500 in payments. Had they retired at 67 on \$45,000 in retirement benefits, they would have received \$360,000 in payments over the 8-year period. However, the survivor that retired at 62 will now have an income of \$22,000 while the retiree at 67 will receive \$30000 until the die. In 6.1875 years, the two survivors will have received the same amount. This shows that the high-income earner needs to be concerned not only with their mortality but also the expected lifespan of their partner.

#### Another option: Retire but defer

We generally use retirement and receiving Social Security benefits interchangeably but that need not be the case. If you have accrued retirement funds, you may stop working but defer your Social Security payments, as they will increase from age 62 to 70. Assume your have accumulated \$500,000 in a retirement fund that you intend to use to augment your Social Security benefits. This fund is diversified and earns 6%. You have formed your retirement plan based on not living beyond 95. If you both retire at 62, you will receive \$26,250 (\$8500+\$17,000) per year from Social Security. Your \$500,000 retirement fund will pay out \$35,136 annually at 6% for 33 years (to get you to 95), making your total retirement income \$61,386 annually until 95. (See Table 1.)

If you retire at 62 but defer your Social Security benefits until 67, you will need to withdraw \$61,386 annually for 5 years to have an income equivalent to taking your Social Security benefits at 62. At the end of the 5 years (when you turn 67), the retirement fund will have decreased to \$320,538. At 67, your Social Security benefit will be \$37,500. The retirement fund will pay out \$23,910 per year, making your retirement income from age 67 to 95 to be \$61,410. This is slightly less (0.7%) than the earlier calculation. However, the survivor's benefit has increased from \$17,500 to \$25,000 per year. (See Table 2.)

Waiting until 70 to begin Social Security benefits requires a \$61,386 withdrawal from the retirement fund for 5 years (62 to 67). This reduces the retirement fund to \$320,538. They are both now 67 years old. The low income earner's spousal benefit does not increase beyond their full retirement age. Even though the high income earner has not yet begun to receive their Social Security benefit, the low income earner should begin to receive their full retirement age benefit of \$12,000. The retirement fund will need to pay out \$49,836 for three years. This amount plus the \$12,000 in Social Security benefits from the low income earner, yields the original \$61,836. After 3 years with such withdrawals, the fund's value falls to \$223,107. At age 70, there is no benefit from further deferral of benefits, so the high income earner begins to receive their benefit or \$31,000 annually. The spouse begins to receive the spousal benefit of \$15,500, so the couple's total Social Security benefit is \$46,500. The retirement fund will pay out \$17,452 annually for 25 years (to the target age of 95), making the total retirement income \$63,9523 per year from 70 to 95. At 6%, it appears that deferring benefits from 62 to 67 slightly decreases the total retirement benefit, but does increase the survivor benefit for the low income spouse. Deferring

receiving benefits until 67 for the low income earner and 70 for the high income earner raises both the total retirement income and the survivor benefit. (See Table 3.)

#### Conclusion

The decision on when to draw Social Security retirement benefits is influenced by many factors. The decision an individual would make can be vastly different from the decision that same person might make if they are part of a couple. The decision is also influenced by any additional assets an individual or couple might possess. If they have access to a retirement fund, then they may retire but defer taking Social Security benefits, which enables those benefits to increase to age 70. There is no "one size fits all" when it comes to retirement planning. Different scenarios should be examined to find the one that is most appropriate.

Table 1		
J and K have \$500K in savings	at 6%. Expect to live to 95	
J's Ret	Ret	

Ret age	Benefit	Benefit			
62	8400	17500			
67	12000	25000			
70	14880	31000			
Ret age	J Soc Sec	K Soc Sec	Savings	Total	500000
62	8750	17500	35136	61386	494864
63	8750	17500	35136	61386	489420
64	8750	17500	35136	61386	483649
65	8750	17500	35136	61386	477532
66	8750	17500	35136	61386	471048
67	8750	17500	35136	61386	464175
68	8750	17500	35136	61386	456889
69	8750	17500	35136	61386	449167
70	8750	17500	35136	61386	440981
71	8750	17500	35136	61386	432303
72	8750	17500	35136	61386	423106
	<b>•</b> • • •				

Continues to 95

Table 2

Ret age	J Soc Sec	K Soc Sec	Savings	Total	500000
62	0	0	61836	61836	468164
63	0	0	61836	61836	434418
64	0	0	61836	61836	398647
65	0	0	61836	61836	360730
66	0	0	61836	61836	320538
67	12500	25000	23910	61410	315860
68	12500	25000	23910	61410	310901
69	12500	25000	23910	61410	305645
70	12500	25000	23910	61410	300074
71	12500	25000	23910	61410	294169
72	12500	25000	23910	61410	287909

Continues to 95

Table 3

Tuble 5					
Ret age	J Soc Sec	K Soc Sec	Savings	Total	500000
62	0	0	61836	61836	468164
63	0	0	61836	61836	434418
64	0	0	61836	61836	398647
65	0	0	61836	61836	360730
66	0	0	61836	61836	320538
67	12000	0	49836	61836	289934
68	12000	0	49836	61836	257494

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69	12000	0	49836	61836	223107
70	15500	31000	17452	63952	219042
71	15500	31000	17452	63952	214732
72	15500	31000	17452	63952	210164
	Continues to				

## THE PROSPECT OF A SOFT LANDING: EVIDENCE FROM THE BEVERIDGE CURVE

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#### ABSTRACT

We document several effects of economic events in the United States on the position of the *Beveridge Curve* (the relationship between the job vacancy rate and the unemployment rate) from the year 2000 through the most recent monthly data. First, we present three distinct Beveridge curves (in a single figure)—(1) representing the period prior to the Great Recession, (2) the shift of the curve associated with the Great Recession, and (3) the shift related to the Covid Pandemic. Second, we show the effects of the recovery from the Great Recession and the "full banana" as the Curve returns to its previous position. Next, we document the shift of the Beveridge Curve associated with the Covid Pandemic and the movement along the curve as employment recovers. We also review recent analyses of the likelihood of a "soft landing," based on the Beveridge Curve, as the Federal Reserve follows a restrictive monetary policy in an attempt to lower inflation in the post-pandemic period.

A paper by Blanchard, Domash, and Summers (BDS, 2022) titled "Bad News for the Fed from the Beveridge Space," argues that FED policies that lower the rate of inflation will raise the unemployment rate substantially. First, these authors suggest that the natural rate of unemployment has increased in the environment in which they write (July 2022). Assuming equilibrium in the labor market at the end of 2019, the natural rate would have been 3.6 percent. BDS suggest that the natural rate has increased by at least 1.3 percentage points to 4.9 percent, primarily due to matching inefficiencies and reallocation in the labor market. Federal Reserve actions to combat inflation will slow the economy, causing the job vacancy rate to fall and produce a movement along the *Beveridge Curve* indicating a still higher unemployment rate. The authors do not give a point estimate of such a higher rate (perhaps since future monetary policy is not known with certainty). Suffice it to say BDS believe a soft landing is very inlikely.

Two Federal Reserve economists, Chris Waller and Andrew Figura (2022) make the case that the *Beveridge Curve* may be very steep at its current position. If that's the case, the FED might achieve a significant reduction in inflation without a large increase in the unemployment rate. The BDS paper and the analysis by Waller and Figura depend on slightly different versions of the Beveridge Curve framework. Unlike BDS, Waller and Figura begin their version of the *Curve* with the separation rate (the rate at which workers are separated from employment and flow into unemployment) as a starting point in their model of the *Beveridge Curve*. Based on their analysis these authors show, under reasonable assumptions, that a decline in the vacancy rate from 7 percent to 4.6 percent would raise the unemployment rate by 1 percent or less. That would leave the unemployment rate at less than 5 percent and consistent with, they argue, a soft landing. We also document a paper by Cheremukhin, and Restrepo-Echavarria (2023) in which the authors propose a dual vacancy model of the labor market that may explain the current movement toward the softlanding.

The soft-landing hypothesis appears to be supported by the most recent data. The vacancy rate and the inflation rate have both fallen significantly while the unemployment rate has remained relatively constant and in line with full employment estimates, implying a nearly vertical movement of the data comprising the *Beveridge Curve* space.

## ENHANCING THE PROFITABILITY OF SOYBEAN CRUSH MARGIN

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## ABSTRACT

We utilize the Minimum Variance Portfolio (MVP) method on relative proportions of soymeal and soyoil to estimate portfolio weights that enhance the soy crush spread. The purpose of the strategy is to augment the soy complex spread with higher long position in soybean and short position in its products by a certain calculated percentage derived by the MVP method. The MVP is applied on the daily value deviations of soymeal and soyoil from their respective U.S Department of Agriculture (USDA) reports. We find that this method of constructing soy complex spread has better performance and is associated with higher growth rate of the spread. We show evidence that this association has a significant link to upside risk especially within the high frequency of daily instead of lower frequency of monthly or yearly trading.

## WEALTH INEQUALITY AND CEO COMPENSATION

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# ABSTRACT

Over the past twenty years there has been a dramatic increase in both CEO pay and the wealth of the richest Americans. We examine three hypotheses regarding the relationship between wealth inequality and CEO compensation: first, that the increase in CEO income inequality helped cause increased wealth inequality; second, that increases in wealth inequality helped cause increased CEO income inequality; and third, that both types of inequality are caused by a third factor. We test these hypotheses by using ExecuComp and Forbes 400 data to estimate power law distributions and compare the behavior of these distributions over time. We find no support for any of the three hypotheses.

Keywords: Inequality, CEO compensation, Power law distribution, Pareto distribution JEL Codes: D31, J30

# **1 INTRODUCTION**

In 2008, according to Forbes magazine, the wealthiest American was Bill Gates with an estimated worth of \$57 billion. In that same year, the highest compensated CEO was Eugene Isenberg of Nabors Industries, who earned \$128 million. Their counterparts in 1993 (Pierre DuPont and Sanford Weill of Citigroup) were worth \$9 billion and earned \$35 million respectively, a 530 percent increase in the case of wealth and a 260 percent increase in the case of earnings. By comparison, the average American worker earned only 62% more in 2008 than in 1993. These examples illustrate the increases in wealth and income inequality that many researchers have observed in the United States in the late 20th and early 21st centuries (see for example, Piketty [24], Alvaredo et al. [1] and Atkinson et al. [3]; Pryor [25] provides a good review of recent inequality trends in wealth, income, education and wealth). Unsurprisingly, given these recent trends, CEO compensation in the context of rising wealth and income inequality has become a significant societal concern in the United States.

This paper investigates three hypotheses regarding the relationship between CEO compensation and wealth inequality. The first hypothesis is that increasing compensation for "supermanagers" (as Piketty [24] labels them) has led to increasing wealth inequality. This hypothesis is based on the idea that much wealth is derived from income, and so trends in income will be reflected in wealth. The second hypothesis reverses the causality, and suggests that growing wealth inequality in the US has helped to cause increasingly higher and unequal CEO pay. The third hypothesis, that wealth and income inequality are contemporaneously correlated, suggests that changes in CEO compensation and wealth are symptoms of more deeply seated processes in the US economy that are leading to inequality in both wealth and income. We address these hypotheses by examining the distribution of CEO compensation (as measured by ExecuComp data) and the distribution of wealth (as measured by the Forbes 400). Building on a long line of research indicating that the tails of both income and wealth distributions tend to follow a power law distribution, we estimate  $\zeta$ , a key parameter for that distribution, for each data set and then observe how the two parameters correlate over time. Using this novel approach, we find no evidence for any of the hypotheses.

This paper addresses a number of issues in the wealth and income inequality literature. First, it examines the dynamic relationship between income and wealth inequality, a relatively understudied area. Second, it addresses this topic with a novel data set (CEO compensation) that allows for micro level data to shed light on a macro level phenomenon. Third, this paper introduces a new way (Clauset et al. [7]) to estimate Pareto/Power law exponents to the wealth and income inequality literature. Finally, this research addresses the current debate over the possible return to prominence of the rentier class of the late 19th and early 20th centuries by examining the income/wealth dynamic.

# **2 POWER LAW DISTRIBUTIONS**

To compare distributions, we must first choose a distributional form. There is substantial evidence that both income and wealth distributions follow a Pareto/Power Law distribution, and so we will employ that distribution. The Pareto distribution has a long history of application in income and wealth studies, going back to work Pareto (1964) did in the late nineteenth century showing that income and wealth were distributed as Pareto distributions. A Pareto distribution's density function is of the form:

$$f(x) = \begin{cases} \frac{\zeta x_{\min}^{2}}{x^{\zeta+1}}, & x > x_{\min} \\ 0, & x \le x_{\min} \end{cases}$$
(1)

where greater exponent  $\zeta$  values imply a distribution with a fatter tail and  $x_{min}$  is some lower bound for the power law distribution.

It turns out to be relatively simple to relate the parameters of the power law distribution to traditional measures of inequality, e.g., the Lorenz curve. The Lorenz curve is useful for understanding the amount of inequality in a given distribution. The equation for the Lorenz curve for a power law distribution is:

$$L(u) = 1 - (1 - u)^{1 - \frac{1}{\zeta}}, \ 0 < u < 1$$
<sup>(2)</sup>

where u is the percentile in the income distribution. The Gini coefficient, an index of inequality, is the measure between a line of perfect equality and the observed Lorenz curve. The equation for the Gini coefficient of a power law distribution follows:

$$G = 1/(2\zeta - 1)$$
(3)

The power law exponent,  $\zeta$ , can then be interpreted as a measure of inequality (Kleiber and Kotz [19]). As can be seen from (3), the larger  $\zeta$ , the smaller is *G*, indicating less inequality.

Pareto/power law distributions have been found to fit income and wealth data well. Income levels across a country typically follow a power law distribution. Many individuals are earning a relatively low income; they are concentrated in the large area in the left of the distribution. However, there are always a few extremely high earners who fall in the long tail of the distribution. Recent work arguing that income and wealth follow the Pareto distribution includes Levy and Solomon [22], Dragulescu and Yakovenko [8], Fujiwara et al. [11], Kleiber and Kotz [19], Silva and Yakovenko [27], Castaldi and Milakovic [6], and Jones [16].

The power law exponents for income and wealth vary over time and across nations. Typically, the exponent for income is between 1.5 and 3 (Gabaix [13]), with recent estimates ranging from a low of 1.7 in the US (Dragulescu and Yakovenko [8], Silva and Yakovenko [27] and Atkinson and Piketty [2]) to a range of 1.8 to 2.1 in Japan (Fujiwara et al. [11]) to a range of 2.0 to 2.3 in the UK (Dragulescu and Yakovenko [8]). Almost all estimates of the power law exponent on wealth are based off of the Forbes 400; estimated values of the power law exponent range from a low of 1.2 (Klass et al. [18]) to 1.26 (Castaldi and Milakovic [6]) to 1.36 (Levy and Solomon [22]), with high values of 1.6 from Klass et al. [18] and 1.57 from Castaldi and Milakovic [6]. The one paper that uses data from the UK (Castaldi and Milakovic [6]), found the power law exponent ranged from 1.03 to 1.19. There appears to be only one paper examining the distribution of CEO compensation as a power law: Gabaix and Landier [12]. They argue that CEO compensation in relation to firm size forms a power law distribution and estimate that CEO compensation is proportional to the firm's size raised to the 1/3 power.

# **3 HYPOTHESES**

As mentioned in the introduction, we have three hypotheses regarding the relationship between CEO compensation and wealth. The first hypothesis can be summarized as increasing CEO compensation inequality causes increasing inequality in wealth. The second hypothesis reverses the causality and therefore can be stated as increasing inequality in wealth causes increasing CEO compensation inequality. The third hypothesis is that CEO compensation inequality and wealth inequality are jointly determined by a third, deeper factor, which results in the two measures being contemporaneously correlated.

A number of theories have been posited to explain the dramatic increase in CEO compensation, but no consensus explanation has emerged. The relevant literature contains four major theories: 1) compensation structure has changed, primarily due to the increased usage of bonuses and stock options (discussed in Gabaix and Landier [12]); 2) opportunities for profit skimming by the CEO have increased (Frydman and Saks [10]); 3) managerial skill has improved (discussed in both Gabaix and Landier and Frydman and Saks); and 4) Firm size has increased, and as the size of the firm grows, so does the CEO's compensation (Roberts [26]); Gabaix and Landier [12]).

According to Piketty [24], in the United States, the general pattern of wealth inequality since the late 1970's has been upward, with a plateau in wealth inequality in the 1990's. Using a variety of measures, Kopczuk [21] finds a similar pattern. Piketty regards this phenomenon as a continuation of long term trends of increasing capital accumulation by the most wealthy. Although the trend is toward more wealth inequality, the size of the trend appears to be smaller than the trend towards more income inequality. Piketty views the fundamental driver towards

rising wealth inequality as the fact that the return on capital (r) has generally been greater than the real growth rate of the economy (g) (memorably shown as r > g). Piketty acknowledges that a huge number of other factors also impact wealth inequality (for example, tax structure and historical shocks like World Wars or the Great Depression.)

# 3.1 Hypothesis 1

Hypothesis one is suggested from work by Piketty [24] and Bakija et al. [4]. Piketty argues that in the US, increasing income inequality is mainly due to the rise of incomes of a group he labels "supermanagers." Bakija et al. show that about 70% of the increase in income going to the top 0.1 percent of income earners comes from executives, managers, supervisors and finance professionals. We propose that if this group is primarily responsible for the increase in income inequality, that because large incomes eventually become large fortunes, this group is also responsible for the increases in wealth inequality. Two examples may help explain how this process works. Steve Ballmer was hired by Microsoft at a starting salary of approximately \$50,000 in 1980. He rose through the company to eventually become CEO. Because of his salary and stock options at Microsoft, by 2013 Ballmer was ranked #22 on the Forbes 400 list of the wealthiest Americans, with a fortune estimated to be \$22 billion. Ballmer made most of his fortune from saving his compensation at Microsoft. John Paulson is an even more dramatic example of how extreme income can become extreme wealth. In 2007, it is estimated Paulson earned almost \$4 billion; unsurprisingly, he debuted on the Fortune 400 list in 2008 at #165, with an estimated fortune of \$2.5 billion. In sum, because high income individuals are able to convert a greater proportion of their income into wealth, wealth and income inequality should be related (and indeed, Alvaredo et al. [1] provide evidence of this effect). Given the previous empirical work, and the proposed possible mechanisms, we suggest that changes in CEO compensation inequality will cause changes wealth inequality.

# 3.2 Hypothesis 2

An alternative hypothesis is based on CEO compensation theories one and four. If wealth inequality has increased because of differential increases in the return on stocks versus other assets in the economy, then CEO compensation (which often includes generous quantities of stock options) inequality could be impacted by wealth inequality. Kopczuk and Saez [20] show that, since 1990, stocks have become a larger proportion of wealth for both the wealthy and the middle class. The returns from these stocks then could be the mechanism that transmits wealth inequality to income inequality.

# 3.3 Hypothesis 3

The third hypothesis is that CEO pay has increased for the same reasons that the income and wealth distributions have changed in the US in general, and in the top income/wealth classes in particular. The precise mechanism is unknown, but we hypothesize that whatever general cause is fueling income and wealth inequality in the US is affecting the market for CEO compensation as it has affected other labor markets at the higher income levels. For example, Frank and Cook [9] have argued that labor markets in the US are generating greater inequality because of technological advances that allow the most talented to reap more and more of the available gains.

Supporting Frank and Cook's argument and our hypothesis is previous work by Blackwell et al. [5] showing that between 1995 and 2008, increases in the inequality in CEO compensation were positively correlated with increases in income inequality.

## 3.4 Theoretical Framework

In terms of formal theory, given the breadth of the phenomenon we are trying to model, we are going to have to use a high level of abstraction. We start with the assumption that both income and wealth follow power law distributions. (Jones (2015) discusses models that generate power law distributions for both wealth and income. See Kinsella et al. (2011) for a more complex model that generates power law distributions of wealth from labor market interactions.) If we designate  $y_{i, t}$  as the income of individual *i* in period *t* and  $w_{i, t}$  as that individual's wealth in the same time period, and designate *n* as the number of time periods into the past that previous income/wealth levels impact the future, then hypotheses one, two and three become:  $H1: w_{i, t} = \chi(y_{i, t-1}, y_{i, t-2}, ..., y_{i, t-n})$  (4)

$$H2: y_{i,t} = \psi(w_{i,t-1}, w_{i,t-2}, ..., w_{i,t-n})$$
(5)

$$H3: y_{i,t} = \omega(w_{i,t}) \tag{6}$$

where  $\chi, \psi$ , and  $\omega$  and are functions that translate wealth into income or income into wealth. A simple example of  $\chi$  might be accrued wealth from saving a constant proportion of income:  $w_t = \sum_{\tau=1}^{\tau=t} (sy_{\tau})(1+r)^{(t-\tau)}$  where *s* is the marginal propensity to save and r is the market rate of interest. If we assume  $\chi, \psi$ , and  $\omega$  have a relatively limited number of impacts (for example, they involve linear transformations, or the max or min function, or an exponential function), then Jessen and Mikosch [15] have shown that if the independent variable is power law distributed, the dependent variable will also be power law distributed.

## 4 DATA

To measure executive compensation, we use Standard & Poor's ExecuComp database, which provides information on executive compensation for firms in the S&P 500, the Midcap 400, and the Smallcap 600, between 1993 and 2013. The ExecuComp data comes directly from publicly traded companies' annual reports and includes CEOs' salary and total compensation including restricted stock, payouts from long-term plans, benefits, and stock options valued at the grant-date using ExecuComp's modified Black-Scholes methodology. To measure the overall distribution of wealth in the US, we will use data from the Forbes 400. Each year since 1982, Forbes magazine has compiled a list of the 400 richest people in America. Using a variety of sources, Forbes estimates the net worth of each person on the list.

## **5 METHODOLOGY**

We estimate the yearly power law exponents for both the Forbes 400 and the CEO compensation data sets and then observe how those exponents move together. The first question then is how to estimate  $\zeta$  and  $x_{min}$ . The most intuitive way to recognize a power law distribution is to plot the counter-cumulative density function on a log-log scale. On such a graph, the points will form,

roughly, a straight line. In Figure 1, we show a sample plot for CEO compensation for the year 2006. Notice that the right tail of the distribution follows a straight line, indicating power law type behavior.



Figure 1 Counter-cumulative distribution of CEO compensation in log-log scale (Year = 2006)

Previous studies on power law distributions have estimated the exponents of distributions by graphing the data on log-log scales and roughly estimating the slope of the line of best fit. However, this method is flawed; it fails to incorporate the restriction that the counter-cumulative density function must equal 1 at  $x_{min}$ . We will use the methodology outlined by Clauset et al. [7]) (henceforth, CSN) to fit the data to a power law distribution.

CSN suggest using the estimator developed by Hill [14] for  $\zeta$ :

$$\hat{\zeta} = \left[\sum_{i=1}^{n} \ln\left(\frac{x_i}{x_{min}}\right)\right]^{-1} \tag{7}$$

If  $x_{min}$  is not given, we need to estimate the parameter;  $x_{min}$  gives the location where power law behavior begins and must be estimated accurately. If  $x_{min}$  is estimated to be too low, the distribution will appear to be incorrect as we would be attempting to fit non-power law distributed data to a power law distribution. If  $x_{min}$  is estimated too high, important data will be omitted from the distribution. CSN suggest using for  $x_{min}$  the value that minimizes the vertical distance between the cumulative density function (c.d.f.) of the distribution of the data and the c.d.f. of the estimated power law distribution. CSN suggest using the Kolmogorov-Smirnov (*KS*) statistic, which is the maximum distance between the c.d.f.'s of the data and the fitted model:

$$KS = \max_{x \ge xmin} |G(x) - P(x)| \tag{8}$$

where G(x) is the c.d.f. of the data for observations above  $x_{min}$  and P(x) is the c.d.f. for the power law that best fits the data for the same region. CSN then suggest using the value for  $x_{min}$  that generates the lowest *KS*.

After obtaining an exponent value,  $\zeta$ , for each year of CEO compensation and wealth using the algorithm above, we estimate the following regression models for each hypothesis. Referring back to Figure 1, we see the results of this algorithm in the fitted line laid on top of the distribution. The fitted line indicates the extent of the power law behavior in this distribution.

$$H1: \zeta^{Wealth}{}_{t} = \varphi_{0} + \varphi_{1}\zeta^{CEO}{}_{t-1} + \varphi_{2}\zeta^{CEO}{}_{t-2} + \dots + \varphi_{n}\zeta^{CEO}{}_{t-n} + \varepsilon_{t}$$

$$H2: \zeta^{CEO}{}_{t} = \varphi_{0} + \varphi_{1}\zeta^{Wealth}{}_{t-1} + \varphi_{2}\zeta^{Wealth}{}_{t-2} + \dots + \varphi_{n}\zeta^{Wealth}{}_{t-n} + \epsilon_{t}$$

$$(10)$$

where  $\varepsilon_t$  and  $\epsilon_t$  are normally distributed random error terms. This approach will quantify the strength of the relationship between the distribution of CEO compensation and the distribution of income.

#### **6 RESULTS**

We estimate  $x_{min}$  and  $\zeta$  for every year for both data sets. We present the estimated  $\zeta$  in Table 1. Note that the exponent on the Forbes 400 distribution changes little over time, but that the exponent on the CEO compensation data varies considerably. This variation, and the relationship between the two exponents, is shown in Figure 2. Interestingly, the graph seems to show an upward trend for  $\zeta^{CEO}$  and a downward trend for  $\zeta^{Wealth}$ . These trends imply that CEO compensation inequality has fallen over time, while wealth inequality has risen over the same time period.


Figure 2 Estimated Zeta Coefficients for Forbes 400 and CEO Compensation Distributions by Year, 1993-2013

Year	$\zeta^{CEO}$	$\zeta^{Wealth}$
1993	1.7285	1.6088
1994	1.6967	1.502
1995	1.9718	1.4238
1996	1.8005	1.4172
1997	1.4042	1.4653
1998	1.7359	1.3675
1999	1.2476	1.4553
2000	1.0837	1.2614
2001	1.5284	1.2989
2002	2.1189	1.2762
2003	1.6684	1.3387
2004	1.9821	1.3472
2005	4.2349	1.4901
2006	2.5759	1.4564
2007	2.7885	1.4832
2008	1.9172	1.4151
2009	3.3529	1.3707
2010	2.1364	1.380
2011	2.6726	1.3739
2012	2.4548	1.305
2013	2.9246	1.3267

Table 1Estimated  $\zeta$  for CEO Compensation and Forbes 400 Distributions

#### 6.1 Regression Results

Tables 2 and 3 show the results of our estimates of the models given by equations 9 and 10. We estimated a distributed lag model as hypothesized in H1 and H2 up to four lags. In addition we estimated the contemporaneous relationship. In each case none of the lags are statistically significant indicating the absence of a relation between past income and wealth and vice versa. The contemporaneous correlation as measured by the Pearson correlation coefficient between  $\zeta^{CEO}$  and  $\zeta^{Wealth}$  is 0.1158 and is not statistically significant, providing no evidence in support of hypothesis three.

Variable	1 Lag	2 Lags	3 Lags	4 Lags
Constant	1.3270***	1.2859***	1.2815***	1.2910***
	(0.0494)	(0.0564)	(0.0639)	(0.0701)
$\zeta^{CEO}_{t-1}$	0.0288	0.0276	0.0322	0.0335
	(0.0222)	(0.0223)	(0.0247)	(0.0254)
$\zeta^{CEO}_{t-2}$		0.0178	0.0209	0.0297
		(0.0223)	(0.0238)	(0.0259)
$\zeta^{CEO}_{t-3}$			-0.0075	0.0019
			(0.0255)	(0.0256)
$\zeta^{CEO}_{t-4}$				-0.0222
				(0.0256)
$R^2$	0.0860	0.1659	0.1983	0.2617

Table 2Estimation Results for Equation 9

Notes: Dependent variable is  $\zeta^{Wealth}$ . Standard errors are in parentheses. \*, \*\*, and \*\*\* denotes significance at, respectively, the 10%, 5% and 1% levels of significance.

Variable	1 Lag	2 Lags	3 Lags	4 Lags
Constant	3.7282	3.5712	4.8064	7.2427
	(2.8818)	(3.8973)	(4.5391)	(5.4476)
$\zeta^{Wealth}_{t-1}$	1.1153	0.0537	1.1372	0.0278
	(2.0519)	(3.0834)	(3.1246)	(3.5800)
$\zeta^{Wealth}_{t-2}$		1.0352	1.2687	2.2101
		(2.6474)	(3.2924)	(3.6598)
$\zeta^{Wealth}_{t-3}$			-4.2238	-3.0384
			(2.6798)	(3.7606)
$\zeta^{Wealth}_{t-4}$				-2.7525
				(3.0379)
$R^2$	0.0161	0.0126	0.1576	0.2088

Table 3Estimation Results for Equation 10

Notes: Dependent variable is  $\zeta^{CEO}$ . Standard errors are in parentheses. \*, \*\*, and \*\*\* denotes significance at, respectively, the 10%, 5% and 1% levels of significance.

#### 7 DISCUSSION

We find no evidence in support of any of our hypotheses. Little evidence for hypothesis two is unremarkable, but the result that there is no relationship between past income and current wealth or between current wealth and income inequality is surprising. These results shock for two reasons: 1) there is a large literature showing that both wealth and income inequality have been rising in the United States, and it seems likely there would be a correlation between the two measures, and 2) previous work by Blackwell et al. [5] using this same CEO compensation data set found that CEO compensation and overall income inequality were correlated.

There are many potential reasons for our null finding. First, we are using a relatively small data set (for a time series), which includes only 21 yearly observations. We may lack the statistical power to detect whatever relationships exist. It may also be the case that the transmission of income inequality to wealth inequality simply takes a long time, and so our limited data set is unable to detect this relationship. Second, our methodology may have a flaw. Although the

methods presented by CSN have been used in hundreds of papers, we are not aware of this method being used on wealth or income data in any paper but CSN's original work. Our estimates of  $\zeta^{Wealth}$  are consistent with what other researchers have found; however, our estimates of  $\zeta^{CEO}$  are larger than estimates for the US labor force as a whole. These larger estimates imply that there is less income inequality among CEO's than among the general population. In addition, our  $\zeta^{CEO}$  estimates are much more variable than other estimates for the US labor force, and so may be symptomatic of a yet undiscovered flaw in Clauset et al.'s methodology. Third, our data may be less than ideal for addressing this question. Although the trend in wealth inequality we see using our methodology roughly matches that of Kopczuk and Saez [20] for the Forbes 400, Kopczuk [21] points out that there are at least two other measures of US wealth inequality - data from the estate tax and data from the Survey of Consumer Finances. Although analyses based on all three of these datasets show a general trend towards increasing wealth inequality, they do exhibit substantial variation from each other. We suggest that applying our methodology to these other data sets would be an excellent extension of our research.

Our research addresses only indirectly the question of the role of inheritance in wealth inequality. Instead, we are primarily examining the inverse question - to what extent does earned income impact wealth inequality? The fact that we cannot find evidence that earned income inequality generates wealth inequality suggests that perhaps inheritance is playing a larger role than has been previously hypothesized by Kopczuk [21] and Piketty [24].

Despite our inability to find statistical evidence for any of our three hypotheses, we believe this paper makes some useful contributions to the literature. We have introduced the methodology of CSN to the wealth and income inequality literature. We have examined the dynamic nature of income and wealth. We hope that future studies will look at this phenomenon further, as the wealth generating process is an incredibly important phenomenon for society to understand if appropriate policy for dealing with inequality is to be designed.

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## ASSOCIATIONS BETWEEN CULTURE AND PROFESSIONALISM PERSPECTIVES: A COMPARATIVE STUDY OF THE U.S. AND INDIA

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#### ABSTRACT

Hofstede (1984) defines culture as "the interactive aggregate of common characteristics that influence a human group's response to its environment" (p 21). Culture usually differs across countries and even among individuals within a country. Previous research has shown that culture (both national and individual) influences a variety of behaviors. And it has become more common for companies to offshore their business functions, including accounting and legal services, to lower-cost countries such as India and China. Therefore, examining the influence of culture on work practices and characteristics in different countries is important. One related consideration is the association between culture and professionalism perspectives, as one type of "soft skill" important in the accounting profession. In this study, we examine two closely related relationships. Initially, we compare the professionalism perspectives of survey respondents in two culturally different countries, the U.S. and India. Then we expand our analysis to measure the impact of participants' individual culture (i.e., espoused culture) on their professionalism perspectives. The data for this study is collected from 864 graduate business students in the U.S. (n = 422) and India (n = 442). Our U.S. respondents rate professionalism overall, and each of the seven elements of professionalism individually, as significantly more important than do our India respondents. Additionally, based on regression analysis, we show that espoused power distance and espoused masculinity are both *negatively* associated with professionalism perspectives, whereas espoused uncertainty avoidance is positively associated with professionalism perspectives; espoused collectivism is not shown to have a significant association. Our findings have practical implications for global firms including public accounting firms that routinely offshore their business functions to India.

## VALUATION OF NATURAL RESOURCE PROJECTS UNDER CONSTRAINT INPUTS

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## ABSTRACT

Proper solution for optimal investment decisions is a crucial part of the decision-making process. Compared to the classical net present value rule, the real options approach captures the value of the flexibility embedded in the investment opportunity. In this paper we study relevant PDE models interpreting the project as well as flexibility value as the option premium. Specifically, the problem we face is described by systems of governing equations of the Black-Scholes type in terms of time and output price, equipped with the terminal condition enforced at time instants resulting from the specific timing and type of the flexibility that such an investment provides. As a result, comprehensive methodological concept is proposed to improve the numerical valuation process. The resulting numerical procedure is sufficiently robust to cope with an early exercise constraint as well as a wide range of model parameters. A specific attention is paid to constrained inputs to the model. These inputs can either be specified by the project proper or can come from external market or environmental conditions. Namely, we analyze two distinct types of investment projects, a mining industry one, and forest stand one. The scheme we propose is based on the DG framework and is designed for a sufficiently robust valuation that enables to clarify the possible investment decision that takes into account input fluctuations, different expansion/contraction factors as well as choice of timing.

# ENHANCING ACCOUNTING EDUCATION THROUGH STEM INTEGRATION

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# ABSTRACT

In the modern educational paradigm, combining Science, Technology, Engineering, and Mathematics (STEM) with accounting is innovative and essential for cultivating a competitive workforce. This study explores integrating STEM principles into accounting curricula as a strategic approach to attracting and retaining accounting majors. The research demonstrates how incorporating data analytics, information systems, and computational strategies can enrich accounting education by analyzing the curricular synergies between accounting and STEM fields. This interdisciplinary fusion aligns with the digitization trends in the financial sector and amplifies students' analytical and problem solving skills, making the area more appealing to prospects. Previous research has shown that "STEM parents" who work in a STEM field affect their children's career choices. This study contributes to educational discourse by offering a curriculum development framework and highlighting the benefits of a STEM-oriented mindset in accounting education, which could reshape the landscape of business education and meet the evolving demands of the global economy.

# RETHINKING WHAT MATTERS MOST: UNDERSTANDING THE SKILLS THAT EMPLOYERS DEMAND FROM RECENT ECONOMICS UNDERGRADUATES

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# ABSTRACT

For students, the choice of a major is one of the most important decisions they will make. Among the factors students consider are their career aspirations and future job opportunities. Put simply, *what can they do with this degree*? For students interested in economics, that question becomes difficult to answer if they do not know where to look. Entry level job postings generally do not have the word "economist" in their title, and graduates often find themselves in a wide variety of positions.

When teaching, we tend to emphasize the critical thinking and analytical skills students are developing, and while we may produce some of the best problem solvers in undergraduate education, our students acquire skills and knowledge that are not specifically listed on job postings and difficult to prove to potential employers during the hiring phase.

With the rapid increase of skills-based hiring, it is important for economics faculty to understand the most sought after skills to improve our students' career readiness and job prospects, particularly for students that are not bound for graduate school. So we ask, what are the skills most likely to appear on job postings that are appropriate for our entry-level undergraduate economics students?

To answer this question, we use a unique dataset obtained through Lightcast, a labor market analytics firm, that contains data on millions of job postings from major sources like Indeed.com and LinkedIn. Our first step was reducing our sample to relevant postings for economics students. Because "economist" was unlikely to yield a large result, we use lists of possible careers for economics majors published by the Bureau of Labor Statistics and Indeed.com. We restrict our sample to these postings and then examine the frequency with which specific skills are listed.

Many of the careers valued knowledge in other related business fields such as accounting, finance, or marketing. Proficiency with Microsoft products is imperative, with several of the higher paying jobs emphasizing knowledge of SQL, Python, and other programming languages. And the soft skills – particularly those related to communication – remain important. Problem solving, analytical thinking, and similar skills, while listed on some job postings, appear much less frequently than the skills listed above.

Economics, to those of us that teach it, offers an opportunity to teach a perspective and skills that serve students well in life and leadership positions. But in today's labor market, those skills may need to be supplemented to help our entry level students get their foot in the door.

After presenting our findings regarding the most frequently listed common and technical skills, we hope to engage in discussion with our colleagues on ways that we might all increase our programs' responsiveness to current hiring trends.

#### THE VALUE OF LEGITIMACY: WHAT DOES COMPARABILITY COST?

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#### ABSTRACT

We provide insight into effect of IFRS adoption in a transitional economy. Russia provides a unique setting to explore this issue because publicly traded firms with consolidated financial statements must produce two sets of financial statements, one set in RAS (Russian Accounting Standards) and the other in IFRS (International Financial Reporting standards). RAS are tax oriented domestic GAAP. IFRS are used in Russia to stimulate foreign direct investment by satisfying the demands of foreign investors and lenders for financial statements produced using a widely accepted system of international accounting standards (legitimacy). This dichotomy represents the conflict between those who view financial statements as providing statistical data for tax purposes and those who see financial statements as providing information to external users/investors/creditors. Using hand-collected data from 2010-2013 (pre- and post-adoption period), we find income measures (operating, ordinary, and net income) under RAS are converging to income measures under IFRS (which are greater than those reported using RAS). The quality of earnings, measured by discretionary accruals, exhibits no change under IFRS while earnings are being managed upward for firms that adopted IFRS. Russian firms that did not adopt IFRS are managing earnings downward. The relative variation in market and book values differ more widely under IFRS when compared to RAS, implying more volatility and risk under IFRS. We attribute our findings to a monitoring effect from IFRS; publicly traded firms are constrained from reporting RAS numbers that differ significantly from IFRS, even when this results in higher income taxes.

# AI Tools

## TECHNOLOGY ADOPTION AND LEARNING ENGAGEMENT WITH CHATGPT: EXPLORING TRANSFERENCE TO NEW CONTEXTS

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## ABSTRACT

The rapid development of transformative Large Language Models (LLMs) in machine learning has paved the way for innovative digitalization applications in various domains, particularly in education. These applications include document creation, grammar checking, document paraphrasing, rewriting, and code completion. Among these, ChatGPT, an advanced LLM tool, has witnessed widespread adoption, emerging as one of the fastest technologies to engage over 100 million users. Notably, students have been at the forefront of embracing ChatGPT, employing it for a myriad of purposes, sparking debates on its ethical use within academic contexts.

In the Information Systems (IS) literature, user adoption of technology is often attributed to its perceived ease of use and reported usefulness. However, as ChatGPT continues to evolve, an intriguing question arises: will it sustain its user base, and will users expand its application beyond initial usage? Specifically, will students persist in using ChatGPT throughout their academic journeys? Existing IS research suggests that technologies deemed highly useful are more likely to endure. This study delves deeper into the concept of continuance, distinguishing between single-use tools like Word Processors and Spreadsheet applications and multi-purpose applications like ChatGPT. It aims to investigate the factors that motivate users initially employing ChatGPT for writing purposes, such as composing reports, to extend its application into analytical tasks, like statistical analysis.

The theoretical underpinning of this study is grounded in the knowledge transference literature, particularly the distinction between high-road and low-road transference. High-road transference is akin to applying knowledge acquired in one context to another, which requires substantial cognitive effort, conscious mental processing, and mindful abstraction. In contrast, low-road transference is characterized by seamless and instinctive application with minimal cognitive load.

Our methodology entails surveying ChatGPT users to gauge their intentions regarding its application in new contexts. To analyze the transference process, we will employ established instruments used in technology adoption and continuance research. Additionally, we will assess users' perceptions of whether the transition to new contexts

involves high-road or low-road transference. This comprehensive investigation seeks to shed light on the evolving role of ChatGPT and its enduring appeal as a multifunctional tool for students and other users in diverse domains.

## FACULTY PERSPECTIVES AND APPLICATIONS OF GENERATIVE AI IN BUSINESS EDUCATION AND RESEARCH

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#### ABSTRACT

The evolution of artificial intelligence (AI) technologies, particularly the recent emergence of generative AI programs like ChatGPT, has become a crucial point for discussions around teaching, learning, and scholarship in higher education. Generative AI uses machine learning and natural language processing models to develop human-like responses to prompts based on a statistical analysis of underlying data and the application of predefined algorithms [1] [3]. The public introduction of generative AI, like ChatGPT, caused an outcry from higher education leaders about its potential effects on student learning and the role of the instructor in supporting student learning [7] [8]. Some universities even banned the use of ChatGPT by students and faculty [2] [6]. However, recent attitudes toward the detrimental effects of ChatGPT have diminished, leaving educators to wonder how they can incorporate generative AI into their academic practices [5] Despite the transformative potential of AI technologies and their increasing use in business schools, there is a lack of studies on integrating generative AI programs in business teaching and research [11]. This research explores the attitudes of university business faculty toward incorporating generative AI into their teaching, learning, and scholarship activities. The literature relating to technology adoption and acceptance [12] [4] informs the development of interview questions used in semi-structured interviews with educators from the business college of a public university in the United States. The results of the interviews will be analyzed for sentiment and themes to identify potential limitations, hindrances, and challenges of using generative AI in academia. Our study sheds light on the contemporary applications of generative AI in business education and scholarship. Tangible examples will be shared from multiple subjects, drawing on insights and practical suggestions from the participating instructors who have integrated ChatGPT into their teaching over the past year. Concerns that arise from the interviews will also be investigated, such as the potential for hallucinations, information biases, or limited contextual understanding [9]. Additionally, we explore concerns and recommendations regarding AI-induced plagiarism [3] and the potential for fostering passive learning in students [10]. The study will benefit academics in all disciplines, as the results will include recommendations for safely and appropriately incorporating generative AI into teaching, learning, and scholarship practices safely and appropriately.

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### EMPLOYEE ATTITUDE TOWARD ARTIFICIAL INTELLIGENCE IN HIRING

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#### ABSTRACT

The popularity of Artificial Intelligence (AI) has transformed human resources and recruitment practices. However, the perceptions of candidates and employees with AI-based hiring are relatively unknown. This article explores their perspectives, focusing on AI knowledge, frequency of AI interaction, and attitudes toward AI, influencing how they perceive trustworthiness, ethics, and satisfaction in AI-based assessment in hiring. The findings fro2m 99 working adults in Vietnam and the US indicate that belief in AI predicts perceptions of trust, justice, and satisfaction in AI-enabled recruitment. Contrary to expectations, AI knowledge and interaction frequency did not impact candidate perceptions. Furthermore, age, considered a control variable, affected perceptions. Younger workers perceived AI-based hiring as more trustworthy, ethical, and satisfying than older workers. Discussion and implications for businesses and future research were addressed.

#### **INTRODUCTION**

Although Artificial Intelligence (AI) has been used to assist human resource professionals in making hiring decisions, the question of its ethicality remains hotly contested. Those who view AI as a job replacement were found to dislike AI-based hiring due to their fear of job loss to automation [1]. These reactions stem from distrust and anxiety toward AI-based tools and processes [2], [3]. In contrast, those who view AI as augmenting their jobs [1], were found to have a positive attitude toward AI-based tools and processes. Job applicants were found to exhibit more positive attitudes when interacting directly with human recruiters as they believed that such interactions were more personal and effective in terms of demonstrating their job performance ability [4].

However, AI and its applications have been shown to be beneficial, enabling expedient and costeffective personnel recruitment while promoting exceptional performance [5]. For example, Hilton has increased the speed of screening job applicants ranging from 75% to 90% faster than humans by using AI [6]. This suggests that more AI-based tools will be implemented in decisionmaking. Recognizing the importance of job applicants' attitudes towards AI-based hiring affects organizations' competitive advantage because of the positive linkage between attitude and behavior. Specifically, job applicant satisfaction with AI-based hiring procedures was found to be inversely related to the intention to file a lawsuit against the hiring organization [4].

The purpose of this study is to extend current research on applicant reactions toward AI-based hiring in Viet Nam, a country that has been under-researched. Specifically, I will replicate previous research in documenting a positive association between the level of AI familiarity or AI knowledge and trust in AI-based hiring systems [7] as well as the positive relations among attitudes toward AI-based hiring systems, perceived ethical procedure of the hiring system [8],

and satisfaction with the AI-based hiring system. In the next sections, I will present a review of extant literature. Next, I will introduce the conceptual model and its hypotheses. Then, I will describe the methodology and discuss the results. In closing, I will deliberate on the theoretical and practical implications of this study to foster additional avenues for future research.

For this research, I hope to make several contributions to extant literature. First, the conceptual model research will provide a broader understanding of how AI affects the behavior of job applicants. Second, it offers valuable perspectives on the practical implementation of AI in hiring for future research in related topics from the perspective of job seekers in Vietnam, a developing country. Finally, many businesses in Vietnam have been using AI in hiring, but there is no research related to the reaction or attitude of employees in Vietnam to this new technology. Therefore, this study was intended to fill this gap.

#### LITERATURE REVIEW

Depending on the business capacity, industry, and its implication, the level of AI intervention in hiring varies. Technological influence has transformed talent attraction, transitioning from the Digital Recruitment 1.0 to 3.0 era [9]. The 1.0 Recruiting era shifted from paper-based recruitment methods to digital platforms where job descriptions were posted on the website and accessible to everyone [9]. While the current 3.0 Recruiting Era emerges AI to screen out applicants and gather and analyze data for employers in hiring decisions [9]. However, budget constraints, lack of preparedness for restructuring [9], and concerns regarding ethics among employees and recruiters have prevented some companies from seizing this opportunity [4], [10]. From 2018 to 2022, AI or automation adoption in recruiting increased from 38% [45] to 79% [11]. While many studies focused on the employee perspective on AI-driven recruitment in developed countries such as the U.S.A., Germany, England, or France [4], [12], [13], similar research in developing countries such as Vietnam is non-existent. Therefore, this gap indicates that more studies are required to gain an understanding of employee attitudes from diverse backgrounds and nations, for several reasons.

Due to budget problems and a lack of skilled professionals in developing countries, many workers have limited exposure to advanced technologies. However, it does not mean their behavior is not important to the research. Their diverse cultural background may provide differentiating factors influencing the perception of AI in hiring. Additionally, data availability is the primary element for AI efficacy. With their large potential talent pools, developing countries present potential markets for AI recruitment. According to the World Bank (2023) [14], out of the five million working-age individuals globally, 84% reside in developing countries, engaged in both formal and informal employment. This vast workforce brings a large amount of data that can be used by AI. This knowledge is valuable for companies operating in developing nations considering the adoption of AI in recruiting. Therefore, to get a better understanding of employee attitudes from different backgrounds, I will first review the existing literature about job applicants' behaviors.

Applicant reaction to AI in the selection process over the past few years has concentrated on individual differences such as age, gender, and education level, to understand job applicant perspectives. Some studies reported a significant relationship between those variables and

technology acceptance and trust toward those technologies and organizations [3], [15]. Many studies have shown that older workers and females tend to have a negative attitude toward new technology [16], [17]. This can be explained because of the difference in physical and psychological characteristics of these groups. [18] found that older workers have physical limitations and aging-related factors such as cognitive impairments, which may make them uncomfortable with acquiring new technologies, changing mindsets, and maintaining skills to match today's technological developments. Females feel more anxious and risk-averse when adopting new technology. Therefore, they exhibited lower levels of trust in AI [19], less enthusiasm towards algorithms used in recruitment [3], less willingness to work with robots, and frequently displayed negative attitudes when interacting with AI applications [20] in comparison to males. More educated individuals also demonstrated higher levels of trust in AI [17], [21], [22]. This correlation can be explained by the fact that higher education levels provide a greater understanding of risk management [22], and enhance perceived ease of use (PEOU), leading to reduced anxiety and an improved overall attitude toward technology's usefulness [18]. Whereas other studies reported no significant differences or no relationship between the above demographic variables and technology-based tools in recruitment as well as in general [13], [23], [24]. Therefore, I will treat demographic variables including age, gender, and education level as control variables in this study.

There are many research studies on job applicants' and recruiters' attitudes toward the use of AI in recruiting. However, very few of them examine AI interaction frequency and AI knowledge of employees as antecedents. Several studies showed that interaction frequency with AI is associated with employee behaviors [25]-[27]. This is because some employees consider AI as a "social agent" and interact with AI as their coworkers [27]. AI systems are also designed to mimic peer interactions, which means communicating with employees and maintaining relational dynamics [27]. Therefore, it affects the behavior and attitude of employees similarly when they interact with humans. Moreover, interaction frequency with AI was found to engage in both positive reactions, such as helping behaviors toward fellow employees, and negative reactions, such as loneliness and insomnia [27]. Besides, the extent to which employees trust AI also depends on the frequency of interaction with AI [25], [26]. However, a recent study found no significant relationship between the average trust ratings or changes in trust ratings of individuals over time and the frequency of interactions in automation, whether they were high or low [28].

Familiarity with or knowledge of AI is another variable that can affect employees' behavior; thus, it needs to be considered when analyzing employees' perspectives. For example, a study found that job applicants might view AI/ML-based (Artificial Intelligence/Machine Learning) decisions as unreliable, and their systems as less transparent and less fair due to unfamiliarity with how AI/ML works [29]. [21] also found that the more familiarity with AI applicants, the more trust consumers will gain. He explained that familiarity reduces uncertainty and limits anxiety based on past experiences, which contributes to the development of trust. Greater familiarity results in more accumulated knowledge from previous interactions, leading to higher levels of trust. Familiarity with AI served as a moderating factor that had a significant impact on the likelihood of accepting a job offer [30]. Higher levels of familiarity were correlated with stronger perceptions of procedural justice during the selection process, which involved augmented, human-based, and AI/ML-based methods [30].

Attitude refers to the feelings, beliefs, and reactions – which can be positive or negative – of an individual towards an object, person, event, or phenomenon [31]. Attitude consists of cognitive, affective, and behavioral components. Cognitive components refer to knowledge, thought, and belief about attitude objects [31]. For example, AI as a replacement belief argues that 47% of U.S. employment could be at risk due to the number of tasks and jobs that have been replaced and its recent development [1]. The opposite view believes AI will augment humans by increasing efficiency, and productivity, and creating new jobs [1]. For example, AI has been employed as a diagnostic assistant for doctors, reaching a level of proficiency comparable to, or in some cases surpassing, human experts in pattern recognition and judgment [1]. Affective components refer to emotions or feelings about attitude objects [31], fear, distrust, and anxiety have been seen in women toward AI [2], [3]. Behavioral components refer to actions and behaviors resulting from other components, such as adopting or resisting the use of AI tools in hiring [31].

While there have been numerous studies on employee or job applicants' attitudes towards AI in hiring, only a limited number of studies have explored these attitudes based on human interaction frequency with AI and knowledge of AI, especially in Vietnam. Vietnam is currently in the early phase of engaging with Industry 4.0, which adopting and promoting of digital technologies (e.g., AI and big data), physical technology (e.g., 3D printing, robots, communication devices), biotechnology (e.g., protein microarrays, biochips, and stem cells) and energy technology (e.g., solar photovoltaic systems, hydrogen, or Biomass energy) [32]. However, Vietnamese people's understanding of AI is limited compared to other developed countries. Even IT students in Vietnam were also discovered to have limited AI knowledge and skills, potentially because of the inadequate availability of essential and compulsory AI and relevant courses" [32]. Therefore, our studies were designed to address the gap in the extant literature on employee attitudes in Vietnam to see if AI-based hiring is acceptable.

# HYPOTHESES DEVELOPMENT

The theory of interpersonal trust states that trust comprises affective and cognitive foundations [26]. Cognition-based trust refers to our belief in another's knowledge and competence that the other person has in a particular subject or area upon whom we place our trust (e.g., a college professor of HR is trusted to have a vast amount of knowledge about HR matters). Familiarity with AI was an important determinant of initial trust and trust over time with AI algorithms [33]. Therefore, our following hypothesis is:

H1a: The level of familiarity with or knowledge of AI will be positively associated with the perceived trustworthiness of the hiring system.

Affect-based trust refers to the emotional connection and feelings of comfort through showing reciprocated genuine concern and care between individuals based on their social interaction (e.g., a college professor of HR has gained her student's liking after interacting with her). In empirical research during the period 1987–2004, [34] found that companies that invest in relationships with their customers and engage in frequent interactions with them experience an increase in customer trust. Social interaction was also found to enhance trust recovery after a trust violation in customer–business relationships, as proven in the three experimental designs of [35]. Although

artificial intelligence (AI) is not sentient, which means AI interaction does not replace or substitute interacting with human co-workers, some individuals perceive AI as a "social agent" as discussed in the literature review, attributing social expectations to these systems as they would to other individuals [27]. In contrast to conventional technologies like phones and websites, AI systems are created to mimic the way employees would interact with their human colleagues [27]. Therefore, it is not far-fetched to assume the effect is built based on AI interaction frequency.

H1b: The frequency of AI interaction will be positively associated with the perceived trustworthiness of the hiring system.

Trust also refers to the attitude or belief that "an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability" [36]. In this definition, an agent can be an Artificial Intelligence that interacts with the environment on behalf of the person. In this case, if a person believes that Artificial Intelligence will help them to complete work efficiently, they will place more trust in AI.

H1c: The belief in AI will be positively associated with the perceived trustworthiness of the hiring system.

Rawls's theory of justice defined that a decision is considered fairest when those involved in the decision-making process can envision themselves behind a "veil of ignorance", which requires them to be blind to their personal status and position, and those of others [37]. In the hiring process, the decision-maker must disregard the applicant's personal characteristics and demographics (e.g., age, gender, religion, race, physical disability) that are irrelevant to the hiring goal. Instead, they should focus on the applicant's qualifications, talent, and merit. By doing so, the decision would be ethical and fair.

AI can be used in the recruitment process by screening out job applicants in a large pool of candidates, quantifying work experience during resume screening, conducting interviews with applicants through asynchronous video interviews (AVIs), and making the process faster, more efficient, and especially reducing human bias, resulting in a fairer assessment compared to human involvement [4]. This is because AI is not sentient and does not possess emotions like humans. Unlike human decision-makers who may have unconscious biases or be influenced by emotions, AI operates based on algorithms and data, making it less susceptible to emotional biases. They do not have personal feelings, preferences, or discriminatory tendencies that could influence their decision-making process unless they were designed by humans to do so. As a result, AI is more likely to make impartial and unbiased decisions, focusing solely on the qualifications, skills, and experience of job applicants, which is considered fair under Rawls's theory of justice. Therefore, if job seekers have previously had positive experiences with AI and see the hiring organization implementing AI-based tools as fair and just to its reputation, they will likely perceive the hiring system as justice. Then, our flowing hypotheses are:

H2a: The level of familiarity with or knowledge of AI will be positively associated with the perceived justice of the hiring system.

H2b: The frequency of AI interaction will be positively associated with the perceived justice of the hiring system.

H2c: The belief in AI will be positively associated with the perceived justice of the hiring system.

Job applicants' satisfaction with AI in hiring refers to positive experiences when they engage with AI technology during various stages. This includes ease of use, accuracy assessment, fairness, outcomes of AI decisions, and positive attitudes toward the use of AI in the future. Social exchange theory suggests that people engage in specific relationships due to the satisfactory level of outcomes they provide, which means the more favorable the outcomes, the higher the level of satisfaction [38]. The perceived level of outcomes is influenced by how individuals perceive their partner's attributes (such as physical attractiveness, intelligence, shared interests, etc.) and the quality of interaction between them [38]. Therefore, if a person frequently interacts with AI, the quality of interaction will improve, leading to higher levels of outcomes and satisfaction. Additionally, these outcomes are assessed based on a person's expectations. When someone comprehends how an AI functions, its features, and its intended use, they are more likely to have realistic expectations. Consequently, this understanding can significantly impact their level of satisfaction. Therefore, I expect our hypotheses are:

H3a: The level of familiarity with or knowledge of AI will be positively associated with AI-based assessment satisfaction.

H3b: The frequency of AI interaction will be positively associated with AI-based assessment satisfaction.

According to Davis's Technology Acceptance Model (1986) [39], perceived usefulness and perceived ease of use are the two main factors that shape users' attitudes and intentions to use new technology (e.g., Artificial Intelligence), which ultimately affects their actual usage behavior. Previous studies showed that usefulness and ease of use are also important factors in predicting user satisfaction [40]. Therefore, I predict that there is a relationship between employees' attitudes and their satisfaction with the use of AI in hiring. To support this prediction, Social Cognitive Theory states that self-efficacy and outcome expectations are also significant factors that influence cognitive processes, and how individuals acquire and develop their behaviors and attitudes u. Since self-efficacy has shown a significant contribution to satisfaction and outcome expectations can influence the satisfaction level [38], our following hypothesis is:

H3c: The belief in AI interaction will be positively associated with AI-based assessment satisfaction.

Figure 1 presents a conceptual model of proposed hypothesized relationships. Demographics consist of age, gender, and education act as control variables while AI knowledge, interaction frequency with AI, and belief toward AI (replacement vs. augmentation) function as predictor variables. The hiring system's trust perception, the hiring system's justice perception, and the hiring system's AI satisfaction serve as the dependent variables within this framework.



**METHOD** 

# Participant and procedure

Data was collected from an anonymous online survey through the Qualtrics platform during the last two weeks of July 2023 after securing approval from the Institutional Review Board. Participants who conducted the survey voluntarily, without monetary compensation, came from Vietnam and the United States. They joined through invitations from email and other social networks including Facebook, Instagram, and Zalo (Vietnamese social media platform) in which a link to the survey on Qualtrics was inserted. Informed consent was presented to them before answering any questions for this study. Due to incomplete data, the final sample size consists of 99 participants, including 68.7% female, and 28.3% male (3 participants preferred not to answer), and the mean age was 32.49 (SD=13.709). Participants reported a high level of education with 49.5% having at least a bachelor's degree and 13.1% possessing a master's degree, while the remaining sample had a high school diploma or higher education. Regarding employment status, most respondents are working, with 70.7% being paid employees, 12.1% being self-employed, and 7.1% looking for another job (both currently employed and unemployed participants). However, most of those who are currently employed lack experience in recruiting with only 7.2% interacting with hiring tasks daily.

## Measure

For interaction frequency, I adopted and adjusted the measure developed by Wilson [26] which consists of 3 items, "How frequently do you initiate work-related interaction with Artificial Intelligence?", "How frequently do you interact with Artificial Intelligence at work?", and "How frequently do you interact with Artificial Intelligence informally or socially outside of work?". Participants were asked to respond on a 5-point scale (1 = never; 5 = always). This variable showed Cronbach's alpha of 0.84, indicating that high scores correspond to a high frequency of interactions with AI.

For belief toward AI, four items were written to measure the attitude toward Artificial Intelligence. They consist of replacement attitudes such as "Artificial Intelligence will replace most if not all jobs in the future.", "Artificial Intelligence will replace low-skilled jobs (e.g., entry-level jobs) in the future.", and "Artificial Intelligence will replace high-skilled jobs (e.g., managerial and professional jobs) in the future."; and augmentation attitude such as "Artificial Intelligence will assist workers with their jobs in the future.". 5- point scale items were coded from 1 "strongly disagree" to 5 "strongly agree". In this study, replacement attitudes will be measured instead of both replacement and augmentation attitudes, due to the variable's Cronbach's alpha being 0.72. High scores for this variable reflect a higher belief that AI would likely replace most jobs in the future.

Trust perception was measured using ten items from the trust placed in the preselection made by colleagues/the algorithm [7]. I modified these items to fit the purpose of our study, which included statements such as "I think AI-based assessment of job applicants is appropriate in hiring decisions.", "I think job applicant information is used correctly by Artificial Intelligence in making hiring decisions.", and "I would believe in AI-based assessment even when I don't know for certain that it is correct." Anchors ranged from 1 "strongly disagree" to 5 "strongly agree". Cronbach's alpha for this variable was 0.94. High scores for this variable reflect a higher level of trust that participants perceive AI recruiting.

For justice/ethical perception, I used 10 items developed by [8] to measure the extent to which employees perceived the use of AI to be ethical in the hiring process. Sample items for traditional hiring procedure consist of "Screening applicants to determine whether they meet the minimum job qualifications", "Assessing applicants' characteristics and traits such as intelligence, honesty, and personality", "Conduct applicant interviews", "Select which applicants will be hired", and "Analyze submitted documents from applicants"; for AI-based hiring procedure contain "Analyze social media information for traits and characteristics", "Analyze interview text (transcribed) for answer quality", "Analyze video of applicants for nonverbal behaviors", "Analyze still images of applicants for facial features", and "Analyze audio of applicants for voice cues". Participants were asked to rate how ethical each statement was on a 5point scale from 1 being "very unethical" to 5 being "very ethical". A high score for this variable indicates a high level of ethical perception in AI-based hiring. The internal consistency of this variable was estimated to be 0.82 and 0.87 for traditional and innovative hiring procedures, respectively.

### **Result and Analysis**

Table 1

Descriptive statistics and zero-order correlations among variables in the study

	1	2	2	18 1411401	-	<i>x</i> cy <i>(</i>	-	0	0
Variable	1	2	3	4	5	6	1	8	9
1. Age	-								
2. Gender	18	-							
3. Education level	.40**	.04	-						
4. AI knowledge	.02	.07	03	-					
5. Frequency of AI	19	.04	02	.22*	.84				
interaction									
6. Belief in AI	25*	06	05	.1	.33**	.74			
7. Trust perception	36**	11	13		.22*	.52**	.94		
in AI-based									
assessment in hiring									
8. Ethical perception	29**	17	15	.1	.09	.39**	.59**	.87	
of AI-based hiring									
procedure									
9. AI-based	40**		18	.08	.21*	.47**	.65**	.48**	-
assessment									
satisfaction									
Mean	32.49	1.78	4.8	1.76	2.98	2.90	2.81	3.03	2.41
Std	13.71	.60	1.56	.43	.88	.83	.98	.91	1.17

Note: N=99 for all study variables except for AI knowledge and frequency of AI interaction. Gender: 1 = Male, 2 = Female. \*p < .05; \*\*p< .01 (two-tailed). Cronbach Alpha estimates are shown along the diagonal.

IBM SPSS version 25.0 is used to analyze the data collected. Table 1 shows the descriptive statistics and zero-order correlations of variables in the study. As shown in Table 1, significant negative relations were found between age and three outcome variables – trust perception in AI–based hiring, ethical perception of AI-based hiring procedure, and AI-based assessment satisfaction. Specifically, older workers reported perceiving lower trust (r = -0.36, p < 0.01), lower ethics (r = -0.29, p < 0.01), and less satisfaction (r = -0.40, p < 0.01) with AI being used in the hiring process. This finding was consistent with prior research [41]. While the negative relation of gender and education level with three outcome variables was not statistically significant.

Hypothesis 1 states that (a) AI knowledge, (b) frequency of AI interaction, and (c) belief in AI will be positively associated with the perceived trustworthiness of the hiring system. As indicated in Table 1, interaction frequency with AI and belief in AI were found to be significant and positively related to the hiring system's trust perception, respectively (r = 0.22, p < 0.05, and r = 0.52, p < 0.01), whereas the correlation between AI knowledge and hiring system's trust perception was negligible. Hence, hypothesis 1a was preliminarily rejected, while hypotheses 1b and 1c received preliminary support.

Hypothesis 2 asserts that (a) AI knowledge, (b) frequency of AI interaction, and (c) belief in AI will be positively associated with the perceived justice of the hiring procedure. An investigation of Table 1 shows that belief in AI was positively associated with the justice perception of AI-based hiring with a correlation coefficient of 0.39 statistically significant at p < 0.01 level. For AI knowledge and frequency of AI interaction, the correlations were positive but failed to reach statistically significant. Therefore, these findings preliminarily reject hypotheses 2a and 2b but preliminary support hypothesis 2c.

Hypothesis 3 proposes that (a) AI knowledge, (b) frequency of AI interaction, and (c) attitude toward AI will be positively associated with the hiring system's AI satisfaction. According to Table 1, significant positive validity correlations were found between the frequency of AI interaction and AI-based assessment satisfaction (r = 0.21, p < 0.05), and between belief in AI and AI-based assessment satisfaction (r = 0.47, p < 0.01). However, the relationship between AI knowledge and AI-based assessment satisfaction was not positively significant. Thus, hypothesis 3a was tentatively rejected, with hypotheses 3b and 3c obtaining preliminary support.

I further conducted a hierarchical regression analysis to continue testing our hypotheses. Demographic variables – age, gender, and education will be used as control variables. Table 2 presents the hierarchical regression results.

#### Table 2

	0	2		U I				,				
	Outcome variables											
	Mod	Model 1 (Trust in AI-based Model 2 (Ethical perception of				ption of	Model 3 (AI-based					
	assessment in hiring)				AI-based hiring procedure)				assessment satisfaction)			
Predictor Variables	β	t	р	R <sup>2</sup>	β	t	р	R <sup>2</sup>	β	t	р	R <sup>2</sup>
Age	27	-2.75	.01		25	-2.38	.02		28	-2.77	.01	
Gender	13	-1.50	.14		20	-2.13	.04		03	28	.78	
Education	.00	.01	1.00		02	20	.84		05	51	.61	
level				.14				.11				.14
AI knowledge	04	42	.68		.10	1.05	.30		.04	.45	.66	
Frequency of AI Interaction	.04	.46	.65		08	80	.43		.03	.28	.78	
Belief in AI	.43	4.66	<.001		.33	3.30	.00		.39	4.07	<.001	
				.30				.19				.27

Hierarchical Regression Analysis Results of AI predictors on outcome variables (N = 99)

Note: All values are standardized coefficients in the last step of the regression equation. R<sup>2</sup> values are adjusted for measurement errors.

As shown in Model 1 of Table 2, 30% of the variance in the perceived trust in AI-based hiring assessment data was explained by the predictor and control variables. The predictor of interaction frequency with AI contradicted our expectations after controlling demographic variables. The standardized regression coefficient associated with trust perception in AI hiring was not statistically significant, albeit in the right direction ( $\beta = 0.04$ , t= 0.46, p = 0.65). However, AI knowledge and belief in AI yielded similar results. The belief in AI associated with trust perception in AI hiring was a positively significant predictor of AI hiring trust perception ( $\beta = 0.43$ , t = 4.66, p < 0.001), whereas AI knowledge was negatively non-significant ( $\beta = -0.04$ , t= 0.42, p = 0.68). Therefore, hypothesis 1c was supported. For every unit (in standard deviation metrics) increase in belief in AI, the perceived trust in AI-based assessment in the hiring procedure went up by 0.43 or 43% after controlling for age, gender, and education level.

Besides that, I found that age in Model 1 has a significant relationship with trust perception in AI-based assessment in hiring. Specifically, younger workers were more trusting of AI ( $\beta$  = -

0.27, t = -2.75, p = 0.01) than older workers. This finding was consistent with prior research [16];[18], [17].

As presented in Model 2 of Table 2, the  $R^2 = 0.19$  depicts that the predictor and control variables explained 19% of the variance in the justice of the AI hiring procedure. Hypothesis 2 evaluates whether (a) AI knowledge, (b) interaction frequency with AI, and (c) belief in AI are positively associated with ethical/justice perception in AI-driven hiring. The result revealed that belief in AI has a significant and positive coefficient with justice perception ( $\beta = 0.33$ , t= 3.30, p = 0.00). This suggests that a one-unit rise in AI belief (in standard deviation units) led to a 0.33 or 33% increase in ethical perception of AI-based hiring assessment. Hence, hypothesis 2c was supported. Nevertheless, hypotheses 2a and 2b were rejected due to the statistical non-significant of the standardized regression coefficient of AI knowledge ( $\beta = 0.10$ , t =1.05, p = 0.30) and interaction frequency with AI ( $\beta = -0.08$ , t = -0.80, p = 0.43) after controlling for age, gender, and education level. Age and gender were found to have a significant relationship with justice perception in AI-based assessment in hiring, respectively ( $\beta = -0.25$  t = -2.38, p = 0.02; and  $\beta = -$ 0.20, t = -2.13, p = 0.04), as younger working adults and males perceived AI in hiring as more just.

Finally, Model 3 of Table 2 shows that belief in AI was a significant positive predictor of AIbased assessment satisfaction after controlling age, gender, and education level ( $\beta = 0.39$ , t = 4.07, p < 0.001). This provides support for hypothesis 3c. With each standard deviation unit rise in AI belief, AI-based hiring assessment satisfaction increased by 0.39 or 39%. In contrast, the regression coefficient was positive, but not significant for both Al knowledge ( $\beta = 0.04$ , t = 0.45, p = 0.66), and interaction frequency with AI ( $\beta = 0.03$ , t = 0.28, p = 0.78) after controlling for demographic variables. These findings rejected hypotheses 3a and 3b. Altogether, 27% of the variance in the perceived trust in AI-based hiring assessment data was explained by the predictor and control variables. Moreover, age also has a negative and significant relationship with job seekers' satisfaction in AI hiring. Particularly, younger workers were more satisfied with the use of AI in hiring assessment ( $\beta = -0.40$ , t = -3.81, p < 0 .001) compared to older workers. Education level was found to not significantly affect the outcome variables in the three models.

#### DISCUSSION

In this study, I examined employees' and job applicants' perspectives on the use of Artificial Intelligence in the hiring procedure. Attitude towards AI or belief in AI was a significant positive predictor of three outcome variables. Specifically, when people believe that AI would likely replace most jobs in the future, they were found to be more likely to trust AI-based assessment. This is reasonable because numbers do not lie while humans make errors and bias, such as the asynchronous mode can decrease the impression primacy effect and bias when evaluating a candidate's competencies via video interview [42].

Moreover, when one believed that AI would likely replace most jobs in the future, they were found to perceive AI-based assessment in hiring to be more ethical in terms of procedural justice. This is logical since they probably knew from interacting with AI that numeric values uphold intrinsic veracity, so they might believe the same rules will apply to everyone during the procedure. I can only speculate as I did not measure these aspects/variables. More research on this aspect is required to get a further understanding of employees' perspectives. However, the same result is not true when it comes to perceiving human-based assessment and human plus AI-based assessment in hiring as ethical when one believed that AI would likely replace most jobs in the future. Their correlation coefficients were positive but not statistically significant.

Additionally, individuals who held the belief that AI would potentially replace a significant number of jobs were found to be more likely satisfied with AI-based assessment in hiring. However, this does not mean that their satisfaction would be the highest. In fact, their satisfaction was the lowest with an average value of 2.41, compared to human-based assessment in hiring and a combination of AI and human-based assessment with mean scores of 3.32 and 3.99, respectively. This is consistent with the findings of [4] where people prefer interacting with human recruiters than machines which is more personal and effective.

Surprisingly, AI knowledge and frequency of interaction with AI were found not significantly to affect employees' perceptions. Two main factors can affect this result. First, although AI has become popular and widely used recently, except for experts in the field, the average person might have a limited understanding of AI applications. AI in the recruitment process operates based on complex algorithms that can be challenging for participants to comprehend. Secondly, only 7.2% of the 99 participants engaged with hiring tasks daily; therefore, understanding the use of AI in hiring might be difficult for them.

I also found that younger workers placed more trust in AI, believed AI was more ethical, and were more satisfied with AI tools in hiring. This is because they are more willing to take risks compared to older workers and females. This is consistent with the findings of [16], [17], [41] as older have some physical and psychological characteristics that might prevent them from accepting the changes. Male workers were found to perceive AI-based assessment in hiring to be more ethical than females. This might be because women easily feel anxiety and fear instead of pleasure when interacting with AI [2], [3]. However, the above reasons are speculative, future research may take risk and anxiety variables into account to identify their perception.

# **Contributions and Future Research**

Our study was the first to document the Vietnamese employee's attitudes towards AI in hiring. Given the increase of AI technology used in recruitment, our findings might help businesses in Vietnam and foreign better understand workers' behavior. Since attitude towards AI was found to be the most influential, our findings offer a valuable resource for shaping informed strategies that align with the evolving landscape of workforce and technological integration, such as focusing on AI features such as transparency, fairness, and effectiveness so that users can trust AI and avoid litigation when they are not satisfied with the process.

Since belief in AI has a relationship with people's judgment of trustworthiness, justice, and level of satisfaction, future research should examine the interrelationship between those three outcome variables. Previous studies showed that procedural justice is positively associated with the desirable work attitudes of employees, leading to increased job satisfaction [43]. Moreover, procedural justice and managerial trustworthiness are the moderating factors between the

satisfaction and work attitudes of employees [43]. Trust is closely tied to perceptions of fairness and justice. When there is a strong foundation of trust, individuals are more likely to believe that their needs will be considered justly, leading to increased satisfaction. Therefore, the interrelation between trust, justice, and satisfaction is a worthy area for future research.

Although AI knowledge and interaction frequency with AI are not significant factors in predicting outcome variables, future research needs to investigate what contributes to those variables. Since knowledge is a complex term, we cannot judge someone's knowledge solely based on the definition of AI. Their understanding of AI can be affected by social factors such as news which can give false information, leading to negative attitudes. Hence, more factors are needed to determine the AI knowledge of participants.

#### Limitations

As with any study, several limitations need to be addressed. First, the sample size was small and predominantly female. This may increase the margin of error and instability when comparing males to females. men are more likely to take risks, thus, their perception might be more positive than women's. A greater number of men will the result more skewed in one direction. Balancing this variable is necessary to yield more equitable results. I used a survey based on hypothetical situations and personal self-assessment, suggesting that the results may deviate from reality. The findings of this study need to be supplemented by other studies involving people's actual experiences. Interacting with AI in the recruitment process will be completely different from humans. As Acikgoz et al mentioned [4], machine-human interaction is one-way communication, and less preferable as it does not allow the candidate to demonstrate their job performance ability. Besides, outcome favorable can also affect a candidate's attitude after interacting with AI, such as receiving positive feedback or getting hired will make them feel more satisfied with AI. For example, A practical experience conducted in a laboratory to determine the difference between AI versus human decisions shows that algorithmic decisions are perceived to be less fair than human decisions [44]. Real-world settings for this research are needed to confirm my findings.

#### CONCLUSION

Job applicants' and employees' attitudes toward AI used in the recruitment process can impact companies' resources and reputations by rejecting job offers or acting on litigation [4]. Our research has shown that attitudes toward AI potentially replacing human jobs significantly influence how individuals perceive the trustworthiness, fairness, and satisfaction of AI used in the hiring process. We hope this research will assist businesses worldwide in developing better strategies for recruiting talents based on an understanding of their attitudes. Additionally, it will provide future researchers with more information to study as AI continues to gain popularity.

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## EXPLORING AUTONOMOUS VEHICLE DISENGAGEMENTS VIA LATENT DIRICHLET ALLOCATION ANALYSIS: A NATURAL LANGUAGE PROCESSING APPROACH

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#### ABSTRACT

Autonomous vehicles (AVs) have been making significant advancements, yet the challenge of disengagements, where the vehicle's system reverts to manual control, or the driver instinctively assumes control, remains persistent. This study delves into patterns and nuances of these disengagements, drawing data from the California Department of Motor Vehicles (CA DMV) disengagement reports. Through topic modeling, the study identifies ten core themes linked to disengagements relating to discrepancies, trajectory breakdowns, poor perception, and software glitches. These insights are pivotal for various stakeholders, from academics to industry experts and policymakers, aiming to advance AV technology. The results are a foundation for further investigative studies, potentially enhancing AV safety and efficiency.
#### **INTRODUCTION**

The emergence of AVs has promised a transformative shift in the transportation paradigm, promoting efficiency and heightened safety. However, the journey toward full autonomy is riddled with challenges, and one of the most pressing among them is the phenomenon of disengagement. These moments, when an AV submits control back to a human driver or when the onboard systems encounter a glitch, threaten the principles of safety and reliability that autonomous driving seeks to establish. Understanding and addressing these disengagements is not just a technical challenge but also a pivotal step in gaining public trust and ensuring the seamless integration of AVs into our transportation networks. This study delves into the intricacies of disengagements, seeking patterns, causes, and potential solutions to this persistent hurdle in the AV landscape. After Sweden introduced groundbreaking road safety initiatives in 1997, targeting zero road deaths, many nations, including the United States, have been motivated to pursue this vision [1]. In partnership with prominent national safety organizations, Key American transportation agencies are at the forefront of this significant road safety mission.

The collective goal is to formulate a cohesive plan for no fatalities on the roads within three decades [2]. The primary federal agency overseeing the country's infrastructure plays a crucial role in making enhancements that accentuate the safety merits of autonomous vehicles [3]. Their endeavors range from liaising with key players in the automotive industry and evaluating existing policies to delving into innovative research areas like synchronized vehicle movement (technically known as platooning) and environmentally conscious driving [4]. One of the primary benefits of self-driving cars is their potential to improve road safety greatly. Data from NHTSA indicates that 2017 traffic accidents led to approximately 37,000 fatalities [5]. Autonomous vehicles could significantly reduce these numbers by eliminating human mistakes, which are often the root cause of many accidents [6].

Additionally, these vehicles are poised to alleviate traffic jams and contribute to cleaner air by utilizing advanced technologies. From an economic standpoint, while the initial investment in an autonomous vehicle might be steep, the long-term costs are expected to be lower. This is due to their longer durability and reduced maintenance requirements [5]. The autonomous vehicle sector is experiencing significant advancements, heralding a new era in transportation [7], [8]. To streamline this progress, the US Department of Transportation has established specific guidelines through its various sub-agencies, outlining the best practices for the testing and assimilation of autonomous systems [4]. In detailing the spectrum of automation, the Society of Automotive Engineers (SAE) has laid out a classification ranging from no automation to complete autonomy [2]. A representation of the autonomy levels, as outlined by the SAE, can be found in **Figure 1** [9].



#### Figure 1 AV automation levels

Manufacturers have their sights set on achieving Level 5 autonomy for AVs, but currently, most self-driving cars on our roads are at SAE Levels 2 to 4. This encompasses cars with partial automation (Level 2) where human drivers must remain alert; conditional automation (Level 3), where drivers must be ready to assume control when needed; and high automation limited to specific areas (Level 4). In Levels 2 and 3, drivers delegate certain driving tasks to the vehicle but might need to regain control when the vehicle's system faces situations it can't handle [10]. A primary concern arises when these disengagements occur unexpectedly, which can compromise the vehicle's reliability. The shift from automated to manual control needs to be smooth and without risk [11]. While there's extensive research on advanced driver support systems (ADAS) and human-machine interactions (HMIs), real-world scenarios of these disengagement events remain less explored [10].

This study aims to bridge the gap between AV technology and road safety aspirations set forth by groundbreaking initiatives. By examining disengagements in-depth, the study seeks to uncover patterns and causes and devise potential solutions to this critical hurdle. The research questions guiding this inquiry focus on understanding the frequency, contexts, and responses to disengagement events to inform AV design and policy enhancements. The study's objectives are two-fold: to provide a comprehensive analysis of disengagement incidents to support the development of more reliable AV systems and to contribute to the broader goal of achieving zero traffic-related fatalities. The study's outcomes are intended to assist key transportation agencies, partnered with safety bodies, in formulating a cohesive safety strategy. This underscores the pivotal role of policy and innovation in advancing AV technology. Through the findings from this study, the aim is to address a technical challenge and instill public trust and facilitate the seamless integration of AVs into the existing transportation networks.

#### LITERATURE REVIEW

Transportation is on the cusp of a monumental change with the rise of AVs. These vehicles, supported by cutting-edge technology, aim to redefine how we view and use transportation modes. The trajectory from envisioning AVs to actual implementation has been astounding. Innovation has been swift and impactful, from early automation tools, such as adaptive cruise systems, to vehicles that can completely self-navigate [12]. A primary anticipated advantage of AVs is enhanced safety. Conventional vehicle accidents, often resulting from human lapses like intoxication, distractions, or fatigue, could see a significant reduction as AVs are designed to bypass these human frailties. The potential is so vast that research suggests AVs might cut fatal accident rates by nearly 40% [13]. Beyond safety, AVs are also seen as a solution to reduce road traffic and environmental pollution. Their built-in technology promises smoother traffic patterns, leading to fuel efficiency and increased average speeds during peak traffic. Integrating vehicle-tovehicle (V2V) and vehicle-to-infrastructure (V2I) communication could enhance these effects, maximizing road space and potentially boosting lane capacities [14]. However, even with such advantages in sight, the U.S. Department of Transportation (USDOT) and the National Highway Traffic Safety Administration (NHTSA) emphasize the paramount importance of safety in automated driving systems (ADS) [15]. Research delving into the progression of AVs has underscored safety considerations, focusing on elements like risk assessment, software upgrades, design choices, and user engagement through the Human-Machine Interface [16]. Continuous data collection and evaluation of AV-related incidents have made such advancements feasible.

To gauge the efficiency and trends of AVs, disengagements serve as an insightful metric. Numerous studies have evaluated disengagements using statistical and machine-learning methodologies. Research by [17] combined a nested logit model with an endogenous switching mechanism to examine system malfunctions, software errors, and interactions with other vehicles. They found that while software-related disengagements didn't typically lead to crashes, interventions by test drivers often prevented potential accidents. Another study sought to understand drivers' responses during disengagements and identified key influencing factors [18]. They found that trust in technology increased over time, suggesting growing familiarity and comfort. A different angle of research classified disengagement caused into broader categories and noted that addressing internal challenges can significantly reduce disengagement occurrences [19]. Another study examined disengagement reports and introduced a metric called miles per disengagement (MPD) to evaluate the growth of autonomous technology [10].

Using Machine Learning, other research efforts have unearthed insights into AV disengagements. [21] used a classifier machine learning model to analyze a five-year disengagement dataset, finding that fewer automatic disengagements didn't necessarily indicate technological improvement. Another study, by [22], used classification and regression tree models (CART) to pinpoint the leading causes of disengagements and the time human drivers took to regain control.

The rapid advancements in NLP techniques have provided deep insights across various research fields. For AVs, NLP has been pivotal in analyzing disengagement reports. Through processing and evaluating these textual descriptions, patterns have emerged, classifying disengagement types and predicting potential causes. [23] used an end-to-end deep learning NLP model to analyze causes, revealing that most disengagements were driver-initiated, particularly during spring and

winter. Another study used probabilistic topic modeling (PTM) to analyze AV crash narratives, highlighting the effectiveness of NLP techniques in revealing safety concerns [24]. Further research combined unsupervised machine learning with NLP to comprehensively understand AVs.

# **RESEARCH APPROACH**

Navigating the intricate landscape of autonomous vehicle functionality requires an in-depth understanding of the challenges and interruptions they face during real-world testing. A critical component of this understanding stems from examining disengagements, moments when the vehicle's autonomous system ceases to operate, and control is handed back to a human driver or the system itself. Investigating these instances not only reveals the technological limitations but also paves the way for refining and optimizing the autonomy of these vehicles. With this premise in mind, we dive into the research approach adopted for this study.

Under the guidance of the CA DMV, firms enrolled in the Autonomous Vehicle Tester (AVT) Program and the AVT Driverless Initiative are mandated to submit annual summaries. These summaries should document the instances when their autonomous vehicles shifted out of autonomous mode during trials. The main aim is to capture events arising from tech hitches or when a human tester/operator must step in to maintain the vehicle's safe maneuvering. Essential elements in these disengagement summaries encompass Manufacturer, Permit ID, Date, VIN Number, Vehicle Type, Presence of Driver, who initiated the disengagement, Disengagement Site, and a detailed account of what led to the disengagement. The study scopes through disengagement events for over three years. **Figure 2** below summarizes a flow chart of the research framework for the study.



# **Figure 2 Research Framework**

# **Probabilistic Topic Modeling Analysis**

Given the varied nature of disengagement reports as submitted by various manufacturers, manually sifting through them becomes a tedious and erroneous task. Latent Dirichlet Allocation (LDA) presents a sophisticated approach to automatically categorize these disengagements into distinct topics, aiding stakeholders in pinpointing specific areas of concern. LDA is a particularly efficient probabilistic analysis for fitting a topic model. It treats each corpus as a mixture of topics, and each topic as a mixture of words. This allows documents to unveil information via the topics to highlight commonalities among semantically similar documents regarding AV disengagement reports, even if they do not share specific keywords. In the explicit analysis of AV disengagements, LDA was the optimal and best-suited model to uncover textual structures from the reports.

Mathematically, the LDA model is rooted in the generative process wherein, for each topic k, a multinomial distribution  $\phi_k$  over words are sampled from a Dirichlet distribution parameterized by  $\beta$ . Similarly, for each document d, a multinomial distribution  $\theta_d$  over topics is sampled from a Dirichlet distribution with parameter  $\alpha$  (**Equation 1**).  $\alpha$  and  $\beta$  are hyperparameters that influence the distribution of topics in documents and the distributions of words in topics, respectively. Each word w in document d then sees a topic z sampled from  $\theta_d$  and a word w from  $\phi_z$  (**Equation 2**). The methodology progresses with data preprocessing after the mathematical delineation, transforming disengagement descriptions into a structured format. The optimal number of topics is determined via coherence scores. Subsequent training of the LDA model iteratively assigns

words to topics, and the resulting topics provide thematic interpretations of the disengagements. Each report is then mapped to topic probabilities, offering a quantitative breakdown of its thematic resonance within the realm of AV disengagements.

$$\phi_k \sim Dirichlet(\beta)$$
 (1a)  $z \sim Multinomial(\theta_d)$  (2a)

$$\theta_d \sim Dirichlet(\alpha)$$
 (1b)  $w \sim Multinomial(\phi_z)$  (2b)

In the study of AV disengagements, revealing the underlying topics from vast textual data unveils crucial insights into the causes and contexts of these disengagements. The LDA presents a probabilistic framework that uncovers topics through a posterior distribution. The posterior distribution  $p(\theta, z \mid w, \alpha, \beta)$  delineates the distribution of the latent variables  $\theta$  (topic distributions for AV disengagement narratives) and z (topic assignments for individual disengagement events) given a document w (description of an AV disengagement) and hyperparameters  $\alpha$  and  $\beta$ . This is summarized by **Equation 3** below:

$$p(\theta, z \mid w, \alpha, \beta) = \frac{p(\theta, z, w \mid \alpha, \beta)}{p(w \mid \alpha, \beta)}$$
(3)

However, this distribution is computationally intractable due to the complex interdependencies among the latent variables and the observed data, given the multifaceted and dynamic nature of the disengagement descriptions. To address this, the Variational Bayes (VB) was used. VB approximates the true posterior by defining a simpler, factorized distribution over the latent variables and then optimizes the parameters of this distribution to make it as close as possible to the true posterior. This is achieved by minimizing the Kullback-Leibler divergence between the true and approximate distributions (**Equation 4**). The VB approach allows for a structured understanding of the latent topics in AV disengagements, potentially segregating disengagements based on causes like sensor failures, software glitches, external environmental factors, and human interventions. Employing VB in analyzing AV disengagement narratives ensures a balance between computational feasibility and model accuracy.

$$KL(q(\theta, z \mid \gamma, \phi) \mid\mid p(\theta, z \mid w, \alpha, \beta)) = E_q[logq(\theta, z \mid \gamma, \phi)] - E_q[logp(\theta, z, w \mid \alpha, \beta)]$$
(4)

For computational convenience, VB transforms the problem into maximizing a lower bound on the log marginal likelihood as summarized by **Equation 5** below:

$$\mathcal{L}(\gamma,\phi;\alpha,\beta) = E_q[logp(\theta,z,w\mid\alpha,\beta)] - E_q[logq(\theta,z\mid\gamma,\phi)]$$
(5)

In the context of AV disengagements:

- $\theta$  represents topic distributions for each AV disengagement narrative.
- *z* symbolizes the topic assignment for each word in the disengagement description.
- *w* stands for the observed words in the disengagement narrative.

The optimization involves updating the variational parameters  $\gamma$  and  $\phi$  to maximize the lower bound until convergence.

#### **Data Cleaning and Preprocessing**

In the initial stages of the analysis, considerable emphasis was placed on preparing raw textual data. Recognizing the direct correlation between data quality and the effectiveness of the LDA model, a series of preprocessing steps were methodically executed. Using the *NLTK* library, common English words such as "and", and "the" were systematically purged from the dataset. Though these words are prevalent in English, their contribution to meaningful topic differentiation is minimal. Additionally, while punctuation serves to clarify textual meaning, for topic modeling, it was deemed extraneous and subsequently removed to mitigate potential noise. Lemmatization was employed to refine the linguistic quality of the data further. This process streamlined various forms of a word, such as "driving" and "driven", converging them to a singular base form like drive. After these rigorous cleaning steps, the data was tokenized. This step fragmented the cleaned documents into individual words, facilitating the creation of a bag-of-words model, wherein texts are conceptualized as unordered collections of terms.

To summarize all the variables and parameters used in the LDA model for the given AV disengagement corpus, **Table 1** below summarizes each variable or parameter along with a brief description and their role in the analysis.

Variable/ Parameter	Description	Role in Analysis
α	Dirichlet hyperparameter for topic distributions	Influences the mixture oof topics in documents
β	Dirichlet hyperparameter for word distribution within topics	Influences the mixture of words in topics
θ	Topic distribution for documents	Represents the topics each document is composed of

Table 1 Parameters and	l their rol	e in the	analysis
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$\phi_k$	Word distribution for topics	Represents the probability of each word in a topic
Z	Topic assignment for words	Indicates the topic to which each word is assigned
W	Observed words	Actual words from the disengagement reports
γ	Variational parameter for topic distributions	used in optimizing the Variational Bayes Inference
φ	Variational parameter for word distributions in topics	used in optimizing the Variational Bayes Inference

# Model Training and Analysis

The LDA model was trained using the refined data after completing the preprocessing steps. A dictionary, crucial for mapping words to unique IDs was formulated using the gensim's library corpora module. This dictionary facilitated the conversion of tokenized documents into a document-term matrix, representing each document's word frequency. The LDA model was trained on this matrix with 30 iterations to ensure optimal convergence. This resulted in extracting 10 topics, each signifying a distinct set of keywords indicative of the themes and scenarios related to AV disengagements. The rationale behind selecting 10 topics was multifaceted. It aimed to balance granularity and clarity, was tailored to capture a spectrum of disengagement causes inherent to the dataset, and prioritized interpretability, efficiency, and flexibility for future refinements. A blend of domain understanding and coherence-based evaluation metrics also underpinned the choice. **Figure 3** below visualizes the distribution of words across the ten topics.



Figure 3: Distribution of words across the 10 extracted topics

## **RESULTS AND DISCUSSION**

After analyzing the dataset on AV disengagements, this chapter aims to uncover and explain the patterns, insights, and overarching themes that emerged from the topic modeling. These findings not only clarify the nuanced reasons behind the disengagements but also set the stage for constructive discussions about the future of autonomous driving.

The application of LDA to the AV disengagement dataset revealed ten distinct topics, each representing a facet of the latent structure within the disengagement narratives. Direct connections have been drawn between these topics and specific disengagement incidents, enhancing the comprehension of the intricate dynamics that prompt manual intervention. This is often due to unpredictable traffic conditions or when the AV fails to adjust its velocity according to traffic flow, leading to disengagements for safety and comfort reasons. Notably, topics 1, 7, and 8 highlight the instances where human operators had to intervene, reflecting the real-world challenges that AVs face and the current limitations of autonomous systems. These topics include words like '*planner*, '*perception*', '*operator*',' *manually*', '*driver*', and '*proactive*'. This revelation underscores the need for an improved AV-human interface to ensure safe navigation when the technology meets complex scenarios that exceed its capabilities.

Keywords such as 'weather,' 'condition,' and 'collision' highlight incidents where environmental factors, such as weather conditions, contribute to safety-critical scenarios, prompting

disengagements. This reinforces the importance of AVs operating safely in diverse environmental conditions. With keywords such as 'planning',' testing', and 'proposal', topic 4 offers insights into the AV testing phase, emphasizing the controlled conditions under which AVs are fine-tuned. By contrasting these controlled conditions with the unpredictability of real-world operation, light is shed on the discrepancies in AV performance, drawing attention to the need for rigorous testing protocols that more closely mimic the challenges outside the testing environment. Topic 5, With 'vehicle,' 'trajectory,' and 'control' as key terms, this topic points to disengagements during complex road interactions, such as navigating traffic signals or executing lane changes, especially in urban settings with numerous traffic elements. Topic 6 highlighted the proactive safety measures and driver intervention. This topic, with keywords like 'road,' 'stop,' and 'test driver,' indicates proactive safety measures where the test driver preemptively takes control. It discusses the critical role of human oversight during testing phases and the need for fail-safe measures. Featuring 'disengagement,' 'driver,' and 'safety,' this topic indicates disengagements initiated for integrity checks and safety verifications. This points to the proactive strategies where the system or the operator ensures the vehicle's positioning and localization are accurate for safe travel. Topic 9 is characterized by 'discrepancy,' 'vehicle,' and 'maneuver.' It suggests that disengagements often result from unplanned maneuvers or discrepancies in the vehicle's planned path versus its actual path, leading to safety concerns.

To quantitatively evaluate the quality of the topics derived from our LDA model, we computed the coherence score, a widely accepted metric in topic modeling. A coherence score gauges the semantic similarity between high-scoring words within topics. For this model, the coherence score was found to be approximately 0.598. While this score suggests a moderate level of coherence, it is worth noting that topic interpretability is inherently subjective, and human validation remains paramount. In essence, the extracted topics, augmented by the coherence score, furnish a nuanced understanding of AV disengagements. They underscore the challenges and intricacies inherent in autonomous navigation, pointing towards areas for technological enhancement and reinforcing the pivotal role of human-AV interaction in ensuring road safety.

## CONCLUSION

The investigation into autonomous vehicle disengagements has provided a profound understanding, revealing intricate challenges and insights confronting the AV sector. By employing sophisticated NLP methodologies, notably topic modeling, patterns integral to comprehending the causative factors of disengagements have been discerned. These revelations emphasize the imperative of ongoing innovation and stringent testing protocols in affirming the safety and efficacy of autonomous travel. As the realm of AV technology undergoes rapid evolution, the insights derived from this study act as pivotal markers, steering subsequent technological advancements and legislative directives. While the odyssey of autonomous vehicles is interspersed with multifaceted challenges, it embodies unparalleled potential. Through rigorous research and enlightened discourse, the industry edges closer to a horizon where autonomous vehicles harmoniously blend into the societal fabric, championing safer, more efficient, and environmentally conscious transit.

This study relies on disengagement data obtained from CA DMV to analyze the disengagement description variable from the dataset critically. The contribution from this study is as follows:

- Utilize topic modeling, specifically Latent Dirichlet Allocation (LDA), to identify and categorize the major reasons behind disengagements.
- Provide valuable insights and actionable information to researchers, developers, and policymakers to enhance the understanding of autonomous vehicle disengagements and drive advancements in safety and performance for autonomous driving technology.

## LIMITATIONS AND RECOMMENDATIONS

The current research, while enlightening, has considerable limitations. Firstly, the study relies on data from the CA DMV, potentially missing out on diverse AV disengagement scenarios from other regions or under different regulatory frameworks. Moreover, the descriptions provided, though detailed, might not encompass the intricate technical reasons behind each disengagement. Furthermore, the dataset lacks contextual data such as geospatial data, traffic density, or specific software versions, which can be pivotal in understanding disengagements holistically.

Looking ahead, there's a realm of possibilities for enriching this research. Future studies can consider integrating data from various regions, offering a broader perspective on AV disengagement. A more in-depth exploration of each identified topic can further unravel the layers of challenges AVs face. The topics can be further analyzed with the other existing variables to understand trends better. As AV technology evolves, a temporal analysis can shed light on its trajectory and areas of rapid advancements. Employing alternative NLP techniques can further refine the findings, and integrating feedback from diverse stakeholders in the AV ecosystem can offer a blend of quantitative and qualitative perspectives, driving the future of autonomous vehicle research.

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# ANALYZING TWITTER DATA ON COVID-19 AND SCHOOL TRANSPORTATION: A TOPIC MODELING APPROACH

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# ABSTRACT

The global outbreak of the Coronavirus Disease 2019 (COVID-19) has affected various aspects of life, including education. School closures and lockdowns were adopted almost worldwide in the first wave to combat the pandemic. With schools resuming their operations amid ongoing concerns about the virus, ensuring safe and efficient student transportation has become a critical issue. School bus transportation plays a crucial role in school travel in the United States, carrying up to half of all students to and from school daily. It is, therefore, crucial to understand how the pandemic affected the operation of these bus services. This study analyzes Twitter (now X) data to identify trends and concerns regarding school bus transportation before, during, and after the COVID-19 pandemic. Three datasets from different periods (Fall 2019, Spring 2021, and Fall 2021) were collected and preprocessed. Employing a comparative approach, this study juxtaposes two topic modeling techniques, Latent Dirichlet Allocation (LDA) and Generalized Dirichlet Supervised Mixture Model (GDSMM), to assess their efficacy in capturing the dynamics of these temporal transitions. The results show a consistent interest in accidents and incidents involving school buses or students and daily commutes across the three timeframes. In Spring 2021, there is a shift from discussions on safety to school bus services, which remains in Fall 2021. The performance of the LDA and GDSMM models varies across the different study periods; GDSMM performs better than LDA in Fall 2019 and Fall 2021. The findings offer valuable information for developing policies to address public needs related to school transportation, particularly in the face of unanticipated situations such as the COVID-19 pandemic.

#### Leveraging Machine Learning in SAS Viya for Enhanced Predictive Analytics

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#### ABSTRACT

In today's data-driven world, organizations seek insights from processing data to make decisions and gain a competitive edge. Machine learning is pivotal in this process, enabling businesses to uncover hidden patterns, make accurate predictions, and automate complex tasks. This abstract provides an overview of how SAS Viya, a powerful analytics platform, empowers users to harness the full potential of machine learning. SAS Viya combines data wrangling, exploration, feature engineering, modern statistical, data mining, and machine learning techniques in a scalable, in-memory processing environment. [1] SAS Viya will be demonstrated to the audience to showcase the power of this analytical tool. Organizations choose SAS Viya as it offers several techniques in one platform. Organizations of all sizes with diverse analytic needs will find some capabilities of SAS Viya that fit their needs. SAS Viya will be demonstrated to the audience to showcase the power of this analytical tool. Artificial Intelligence (AI) and data analytics form an analytical life cycle. [1] Organizations can quickly move through this analytical life cycle in a dynamic competitive environment by automating as much of their processes, resulting in superior and high-quality information for faster decisionmaking. SAS Viya offers a comprehensive suite of tools and capabilities for building, deploying, and managing machine learning models. With its user-friendly interface and scalable architecture, organizations can seamlessly integrate machine learning into their analytics workflows. Some key highlights of machine learning in SAS Viya include; Diverse Algorithm Library, Automated Machine Learning (AutoML), Scalability & Parallel Processing, Model Deployment & Monitoring, Explainability & Interpretability, and Open Integration.

In conclusion, SAS Viya empowers organizations to embrace machine learning as an integral part of their analytics strategy. By providing a comprehensive platform for developing, deploying, and managing machine learning models, SAS Viya enables businesses to get new insight and unlock the potential hidden benefits within their data, driving better decision-making and competitive advantage.

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# THE IMPACT OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI) ON STUDENT LEARNING: A REVIEW OF BENEFITS AND CHALLENGES

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# ABSTRACT

Generative Artificial Intelligence (Gen AI) has emerged as a transformative force in education, revolutionizing how students learn and educators teach. Integrating Gen AI into educational settings has brought forth a paradigm shift in how students approach and engage with schoolwork [1, pp. 1-2]. However, using Gen AI in higher education has also raised concerns about student learning, such as loss of critical thinking skills, unethical use of AI, lack of Gen AI usage regulation and standards, etc. The advent of Gen AI is reshaping the landscape of student learning, offering numerous benefits while simultaneously presenting a set of challenges [2] [1, pp. 2-3].

Therefore, this paper explores the dual nature of Gen AI in higher education, examining students' diverse perspectives regarding the use of Gen AI for academic tasks, delving into their experiences, challenges, and overall perceptions, and the hurdles that educators and institutions must navigate. To summarize the empirical findings from the recent literature, this paper synthesizes existing research, exploring critical themes related to integrating Gen AI in higher education, encompassing its impact on teaching methodologies, learning outcomes, challenges, and potential future trajectories.

Gen AI is profoundly disrupting student learning, revolutionizing how education is delivered and experienced. Students' perceptions of using Gen AI for schoolwork are multifaceted, reflecting a blend of enthusiasm, concerns, and varied experiences. The positive impact of Gen AI on enhancing the learning experience is evident, but it is essential to address challenges. The literature on Gen AI in higher education reflects a dynamic landscape marked by transformative potential, challenges, and ethical considerations. As the field continues to evolve, future research should focus on longitudinal studies, further exploration of faculty perspectives, and the development of comprehensive frameworks to guide responsible Gen AI integration in higher education.

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# ADAPTING TO THE DISRUPTIVE INNOVATION OFAI BY UNDERSTANDING EDUCATOR CHALLENGES, ENHANCING CORE COMPETENCIES, AND REFRAMING STRATEGIES AND APPROACHES

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## ABSTRACT

Education is being impacted by disruptive technologies of the fourth industrial revolution, Industry 4.0. Educators are being asked to implement these disruptive technologies in deployment of Education 4.0 and prepare students for the Industry 4.0 workforce. In the rapidly evolving landscape of education 4.0 and the Industry 4.0 workforce, the integration of AI tools has emerged as both a pivotal but contentious issue. Disruptive Innovation can leave incumbent users/customers of technology in a lurch. One of the key areas identified for future research of Disruptive innovation is the performance trajectories [5]. The performance trajectories may reflect innovation rates that outpace the rate that customers can absorb [4]. Artificial Intelligence has been identified as one of "the most potent disruptive innovations" [15]. AI disruption in education is one of the top reviewed systems [22]. While AI presents unprecedented opportunities to enhance the educational experience and equip students with skills demanded by the future job market, it has encountered challenges within academic institutions and instructors. This paper explores the multifaceted nature of academic professional challenges to AI tools and proposes strategies for educators to reframe education, aligning it with the transformative potential of AI, thereby maximizing its value for students.

The study begins by dissecting the sources of academic professional challenges, shedding light on concerns related to AI user performance. Through a comprehensive literature review, it delves into the existing research and surveys the prevalent attitudes and perceptions of educators and administrators, regarding AI integration in education.

To address these concerns and obstacles, the paper advocates for a strategic shift in the education industry. It argues that educators must reframe educational deployment to harness the full potential of AI tools. This reframing includes a reassessment of curriculum design, instructional methodologies, and the development of digital literacy skills among students. Additionally, it explores the potential role of educators as AI facilitators, guiding and encouraging students to critically engage with AI-driven tools and fostering AI literacy. With this reframing, there remains an emphasis of ethical considerations and the need for robust policies and guidelines to protect student data and privacy in an AI-infused educational environment.

Ultimately, this paper aims to provide a roadmap for educators and institutions to reduce academic challenges, foster a symbiotic relationship between education and AI, and empower students with the skills and knowledge necessary for success in the 21st-century workforce. It encourages a proactive approach to leverage AI as a transformative force in education, ultimately redefining the educational landscape to the benefit of students and society at large.

## **INTRODUCTION**

In the fourth industrial revolution, rapid technological advancements such as big data, internet of things (IoT), quantum computing, robotics, block chain, and artificial intelligence (AI), present unprecedented opportunities to reshape industry [9]. In the education industry, AI stands to enhance educational experience and equip students with nuanced skills demanded by the future job market and the ever-evolving workforce. The incorporation of AI in education stands as a transformative force. However, this transition is not without its challenges. The prevailing challenges for academics and institutions has cast a shadow of uncertainty over the full realization of AI's potential in education. One of the top five challenges of adopting AI in education as identified by the Artificial Intelligence Board of America [1] is the need to prepare teachers for AI powered education. Luckin and Holmes[14] find one of the keys to educational implementation is understanding the impact of AI on skill development.

This paper aims to unravel the multifaceted nature of academic challenges with utilization of AI tools and offers a compelling case for the need to empower educators . It seeks to address the concerns surrounding AI integration, survey contentions attitudes, and propose strategies to mitigate this resistance. By exploring the pathways to AI's harmonious integration into education, this paper aims to underscore its potential to generate unprecedented value for students and, in doing so, enhance their readiness for the workforce of the future.

#### UNDERSTANDING ACADEMIC CHALLENGES WITH AI IN EDUCATION

Adapting to changing technology can be difficult for educators. According to an early study by Lidtke, the unwillingness to change may be due to lack of evidence of the effectiveness; teacher resistance to change; lack of training in the use of equipment: lack of adequate hardware, software, and courseware; the need to change teaching style to use the technology; and the extra time and preparation are required to use these technologies [13].

#### **Change Teaching Style to Use the Technology**

If the need to change teaching style to use the technology is perceived, it will be difficult to get instructors to switch. Instructors often take pride in their expertise and teaching methods, and they may fear that AI tools could disrupt their established teaching practices or limit their ability to make pedagogical decisions and maintain pedagogical autonomy [2].

#### Lack of Evidence of the Effectiveness and Teacher Resistance to Change

Instructors pride themselves in being able to make choices for the most effective methods of instruction. If it is perceived that the new way is less effective, it will be less likely used. Instructors may worry that the introduction of AI tools could lead to a more standardized or prescriptive approach to education, which may compromise their ability to tailor teaching methods, content, and assessments to the unique needs of their students. Instructors often value

the creativity and flexibility they have in designing and delivering lessons. They may fear that AI tools could limit these creative elements or alter structures within the teaching process

Along the line of effectiveness of technology, the use of AI tools might also change the role of instructors, with some fearing that they will be reduced to mere facilitators or overseers of technology, rather than the primary educators shaping the learning experience. There may also be a question of the effectiveness of less interaction with students. The potential for increased use of AI in education can raise concerns about reduced face-to-face interaction between instructors and students, which is a fundamental aspect of many teaching styles.

#### **Academic Integrity**

With the advances in AI technology, the algorithms of the technology may produce output with little to no human input and is becoming more concerning for educators [18][19]. Cheating concerns in the context of AI technology are a significant source of challenge for adoption. Some AI proponents see AI as akin to mathematics teachers denying students the use of calculators. Just as some math instructors have expressed concerns that calculators might enable students to bypass the fundamental understanding of mathematical concepts, educators may worry that AI tools could facilitate academic dishonesty and undermine the development of essential skills. The fear is that students might misuse AI, seeking shortcuts to completing assignments or assessments, which can lead to cheating and plagiarism. This apprehension can result in reluctance among educators and institutions to fully embrace AI-enhanced education, with the belief that it might compromise the integrity of the educational process. Addressing these concerns and distinguishing between responsible use of AI and cheating is crucial for fostering a more accepting and informed approach to integrating AI technology into education [12].

#### **Privacy and Data Security**

AI is considered a privacy risk because it has no privacy standardization for AI-based technologies, Consent gathering from the user is inefficient, and AI decision making needs to be monitored [21]. Academics resist incorporation of AI tools due to concerns and apprehensions related to the collection, storage, and use of personal and educational data within the context of AI-enhanced education [23]. It encompasses data collection, ethical use of data, as well as data ownership and control. Concerns may arise about the extent to which AI tools collect, monitor, analyze, and store student and instructor information. In regards to academic privacy regulations, such as FERPA, there is a significant fear of legal and financial consequences for educational institutions in integrating AI tools, should they compromise personal data.

# **REFRAMING EDUCATION WITH AI: STRATEGIES AND APPROACHES**

#### The Role of Educators as AI Facilitators

The role of educators as successful facilitators in a disruptive artificial intelligence learning environment is highly dependent on their core competencies. These core competencies include communication, organization, planning, facilitation, engagement, flexibility and adaptability.

Flexibility and adaptability are two of the most important competences which educators are now forced to exercise. Especially within the context of an environment where artificial intelligence has disrupted and will continue to play an integral role in the evolution of how the approach to pedagogy is practiced. The ability to practice based on new curriculum, technology and instructional strategies are paramount. The change can be uncomfortable, uncertain, and disruptive to the routine that existed. Educators steeped within changing conditions though exercise resilience and capitalize on the opportunities presented within the disrupted environment to invest in their personal and professional growth. The lesson that can be harnessed from the students of educators is that educators constantly will be required to immerse themselves within a state of learning. This includes flexibility by being open-minded and adaptable so they can learn and apply new skills and knowledge as they equip themselves with the tools provided by artificial intelligence.

The principles underlying strategic thinking within organizations that allows them to establish and maintain sustainable competitive advantages include understanding their internal resources that are valuable and which can be organized to create these competitive advantages. These resources provide opportunities for the development of dynamic capabilities which are then refined to produce core competencies for the organization. The principles are tantamount to the requirements of the process which needs to be embraced and applied by educators and provides a blueprint that can be seamlessly modeled. Reskilling and upskilling while being intentional about technology adoption. Investing time in learning technology through training and development. Embracing the benefits of technology and developing assignments that facilitate student learning, acknowledging that artificial intelligence will affect students as job seekers but their early interaction with its potential helps to provide and advance equitable outcomes in society [7]. While the prevailing sentiment is that students will be using AI to augment their assignments, there may not have been concentrated or deliberate efforts on the part of academic institutions to ensure their faculty equip themselves with AI tools considering the impact it will have on their pedagogical delivery [8]. Based on a report on a study by Best Colleges, "most college students (60%) say that neither their schools nor instructors have specified how to use AI tools ethically or responsibly" [25]. Importantly, AI literacy for educators may be lacking as they may not be prepared or lack the technological expertise to develop assignments driven by AI tools [24]. The necessity to guide students in developing their AI competencies [11][27] is an indication how imperative it is for educators to undergo training and development and be adequately educated on AI literacy [26].

## The Role of Institutions as AI Facilitators

In the face of disruptive innovation brought about by artificial intelligence (AI), institutions play a pivotal role as facilitators, guiding educators through the integration of AI tools into the educational landscape. As the educational paradigm shifts, institutions must proactively support and empower educators with the necessary resources, training, and infrastructure. Serving as catalysts for change, institutions can create environments conducive to the successful adoption of AI, fostering collaboration, and providing a framework for educators to enhance their core competencies in alignment with the demands of an AI-driven era.

## **Curriculum Redesign: AI-Integrated Courses**

Curriculum Redesign is being called for by researchers to facilitate AI [20]. In response to the disruptive force of AI, curriculum redesign becomes paramount for educators seeking to equip students with the necessary skills. Embedding AI-integrated courses within the curriculum offers a dynamic approach for both students and instructors [16]. These courses go beyond theoretical understanding, immersing students in real-world applications of AI. By merging traditional subject matter with AI concepts, students gain practical insights and develop competencies that prepare them for an AI-dominated future.

#### Instructional Methodologies: Intelligent Tutoring Systems

The integration of AI into instructional methodologies can help tailor educational experiences to individual student needs. Leveraging AI algorithms, educators can create personalized learning paths and adaptive learning environments that cater to diverse learning styles and paces. Personalized learning paths represent a strategic move towards a student-centric educational model, optimizing the benefits of AI in fostering individualized skill development.

Intelligent Tutoring Systems (ITS) represent a significant stride in instructional methodologies, acting as personalized mentors for students. By incorporating ITS into the educational toolkit, educators can enhance their capacity to address individual student needs comprehensively. This shift in instructional methodologies aligns with the imperative to cultivate core competencies by providing tailored, data-driven guidance and support.

Supporting this strategic move is the evidence from a systematic review [17], where Intelligent Tutoring Systems (ITS) were identified as effective AI tools in higher education. ITS, as revealed in the grounded coding [6], specialize in customizing educational activities and strategies based on students' unique characteristics and needs. For instance, Stat-Knowlab [3] and LabTutor [10] are ITS examples that demonstrate the potential of AI to provide personalized learning experiences. In higher education contexts with varying class sizes, the use of ITS becomes particularly valuable. The study showcases the effectiveness of AI in offering immediate and tailored instruction, guidance, feedback, and facilitating personalized learning paths [6].

# **CONCLUSIONS AND NEXT STEPS**

The evolving landscape of AI in education presents a disruptive innovation, with great potential to transform learning environments. Educators' cautious approach indicates the need for thoughtful integration, recognizing both the opportunities and challenges that AI brings. To facilitate the speed of adoption of AI in education, institutions play a crucial role in providing comprehensive training opportunities to develop AI specific core competencies of educators, as well as a refresh of curricula and instructional methodologies.

Articles cited in this paper use samples primarily in K-12 and technological fields such as engineering. The next steps in research should extend beyond the prevalent K-12 and technology sectors to explore the unique sectors of AI in higher education institutions and across various disciplines. Faculty should be surveyed along with institutional stakeholders, such as learning centers and academic units. Ethical considerations should remain at the forefront, ensuring the privacy and security of user data and promoting AI that is inclusive, flexible and adaptable.

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# WELCOME TO THE AI FUTURE: LLMS, BCHATGPT, BARD, COPILOT AND BEYOND

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# ABSTRACT

Never before in history have, we had true access to virtually all of human knowledge. The human mind has finite capacity. New large language models (LLMs) give us access to virtually all openly available human knowledge. These generative AI systems can provide us access to expert models in most knowledge domains.

The advent of the Internet increased the availability of human knowledge and thus created the possibility for greater expansion of that knowledge. We now stand on the edge of another such exponential change.

But what are these new LLM's? This paper will provide a brief introduction to the history, development, and state of LLM's. What are some of the available tools we can use to tap the power of these systems? What are the threats and opportunities these systems offer humanity?

## INTRODUCTION

The history of humankind is a technology story. Nothing else in the history of man has made any real difference in human population. Andrew McAfee demonstrated this in his Ted Talk (McAfee, 2012) 2012 with the following chart. Here he plotted human population over the last 4000 years.



What do we see? That nothing else has made any major impact on the human population. Not great empires, or religious philosophers, not the Renaissance or the discovery of the Americas. It was the discovery of power and the industrial revolution that made the first real change in the trajectory of the human population. Start in the 1800's we see a marked increase in population and social development.

Before the development of these technologies, you could not go faster than the speeding horse or communicate with anyone beyond the sound of your voice. But today, with cell phones, you can communicate instantly around the world. The modern airliner flies at more than five hundred mph. The Internet has placed all human learning at our fingertips.

The World Economic Forum in 2024 said, "First there was steam. Then there was electricity. Early automation followed." (Edmond, 2024) Then came the computer age. Followed by the Internet. And today we are entering a new phase in human history, The generative AI phase or GAI.

# HISTORY OF AI

Let's begin by reviewing the historical development of Artificial Intelligence. Artificial Intelligence, often abbreviated as AI, has a rich history that begins almost with the invention of the computer. The term "artificial intelligence" was coined in the mid-1950s, and this era is often referred to as the "Dartmouth Workshop" period. Researchers aimed to create computer programs that could mimic human intelligence. Early AI projects focused on symbolic reasoning and problem-solving.

Next came the Golden Age and AI Winter. During this period, AI research expanded rapidly. Some notable achievements included the development of the first chess-playing computer program and natural language processing experiments. However, high expectations led to an "AI Winter" in the late 1970s and early 1980s due to a lack of progress and funding.

The first practical applications came in the form of Expert Systems in the1980s. These systems were designed to emulate human expertise in specific domains, such as medicine and finance. Despite their success in limited domains, expert systems had limitations and couldn't handle uncertain or complex tasks.

In the last decade of the 20th century, AI research shifted towards machine learning and neural networks. Researchers developed algorithms that could learn patterns from data, leading to breakthroughs in areas like computer vision and speech recognition.

Then advent of the World Wide Web also provided vast amounts of data for AI research and the 2010s witnessed a significant resurgence of AI, primarily due to advances in deep learning. Deep neural networks, with their ability to process massive datasets, led to remarkable progress in areas like image recognition and natural language processing. Companies like Google, Facebook, and OpenAI played crucial roles in driving AI innovation.

Recent Developments (2020s - Present): AI continues to advance rapidly, with applications in selfdriving cars, healthcare, robotics, and more. Ethical concerns, bias, and transparency in AI decisionmaking have also gained significant attention. (Russell, 2009)

# CURRENT STATE OF AI

Continuing the goal of mimicking human senses, great strides have been made in the form of Machine Learning, Visual Awareness, Speech recognition, Location Awareness, Cognitive Computing, Evolutionary (Genetic) Algorithms, Robotic (Bots).

Here are some explanations and examples of forms of AI.

- 1. Machine Learning: Machine Learning (ML) is a subset of artificial intelligence that involves training algorithms to improve their performance over time. It's widely used in various applications, such as: (Sarker, 2021)
  - Recommendation Systems: Companies like Netflix and Amazon use ML to recommend movies, products, and content based on user preferences.
  - Predictive Analytics: ML models can predict future trends and outcomes, aiding in areas like finance for stock price predictions.
- 2. Visual Awareness: Visual awareness AI analyzes images and videos to understand their contents. Some applications include: (University, 2021)
  - Self-driving Cars: These vehicles use visual awareness to identify pedestrians, other vehicles, and traffic signals.
  - Medical Imaging: AI assists radiologists by detecting abnormalities in medical images like X-rays and MRIs.
- 3. Speech Recognition: Speech recognition AI translates spoken language into text and is employed in: (University, 2021)
  - Voice Assistants: Virtual assistants like Siri, Google Assistant, and Alexa use this technology to understand and respond to voice commands.
  - Transcription Services: Speech recognition is used to convert spoken interviews, meetings, or lectures into text.
- 4. Location Awareness: Location awareness AI utilizes GPS data and other sources to determine a device's location. Its applications include: (University, 2021)
  - Navigation Apps: Google Maps and Waze provide real-time directions, traffic updates, and location-based services.
  - Geo-fencing: Businesses use this to send location-specific promotions to customers' mobile devices.
- 5. Cognitive Computing: Cognitive computing aims to simulate human thought processes and is found in: (University, 2021)
  - Healthcare: IBM's Watson assists doctors with diagnosis and recommends treatment options by analyzing vast medical data.
  - Customer Support: Chatbots and virtual agents engage with customers, answer questions, and provide assistance.

- 6. Evolutionary (Genetic) Algorithms: These algorithms mimic natural selection for optimization and problem-solving purposes. Applications include: (University, 2021)
  - Engineering: Optimizing the design of structures, circuits, or systems for improved performance and efficiency.
  - Game Development: Al-driven characters in video games evolve and adapt their strategies.
- 7. Robotic (Bots): Robotic AI refers to autonomous or semi-autonomous machines. Examples include: (University, 2021)
  - Chatbots: Used in customer service and websites to interact with users and provide information.
  - Robotic Process Automation (RPA): Software bots automate repetitive tasks in business processes, improving efficiency.
- 8. Natural Language Processing (NLP): (University, 2021)
  - NLP focuses on the interaction between computers and human language. It enables machines to understand, interpret, and generate human language. Applications include:
    - Sentiment Analysis: Analyzing social media posts and reviews to determine public sentiment about products or events.
    - Language Translation: Services like Google Translate use NLP to translate text from one language to another.
- 9. Reinforcement Learning: (University, 2021)
  - Reinforcement learning is a type of machine learning where an agent learns to make decisions by interacting with an environment. Applications include:
    - Game AI: Reinforcement learning has been used to train AI agents to play complex games like chess, Go, and video games.
    - Autonomous Robotics: Robots can learn to perform tasks in real-world environments, such as navigation and object manipulation.
- 10. Computer Vision: (University, 2021)
  - Computer vision involves teaching computers to interpret visual information from the world, similar to human vision. Applications include:
    - Facial Recognition: Used for security purposes and in applications like unlocking smartphones.
    - Quality Control: In manufacturing, computer vision systems can detect defects in products.
- 11. Artificial Neural Networks (ANNs): (University, 2021)
  - ANNs are a fundamental component of deep learning, a subset of machine learning. They are inspired by the structure of the human brain and excel in tasks such as:
    - Image Classification: ANNs are used in image recognition, identifying objects or patterns in images.
    - Natural Language Processing: ANNs power many language models like GPT-3 for text generation and understanding.
- 12. Autonomous Systems: (University, 2021)

- Autonomous systems are AI-driven machines capable of performing tasks without human intervention. Examples include:
  - Drones: Autonomous drones are used for surveillance, aerial photography, and even package delivery.
  - Robotic Surgery: Robots assist surgeons in performing precise procedures.
  - •

# ENTER THE LLMS (LARGE LANGUAGE MODELS)

In November of 2022 ChatGPT was released to the world by OpenAI. In 5 days, it reached 1 million users and has not slowed down much in the intervening months. This table shows how long other new technologies took to reach the 1 million mark.



Today there are dozens of other Large Language Models (LLMs)available. The following chart posted my Matt Willsmore on his Blog in March of 2023, compares these by size. The diameter of the circle is based on the number of parameters the model used in its development. (Willsmore, 2023)



The number of parameters used in the LLM is growing exponentially 10x faster than predicted by Moore's Law. As this chart by Sumit Singh posted on his blog May 12, 2023 (Singh, 2023)



This is further verified by Marco Ramponi in his blog post (Pamponi, 2023). His chart shows how very large these models are becoming. The PaLM model has 540 billion.



So, what is a large language model and exactly how does it work? LLM's use neural networks. Neural networks take inputs of large amounts of data called parameters. In the following diagram the number of parameters is represented by the circle nodes in the first column. These are the input nodes. Each node has a value. The first column nodes interact with the next column, called hidden layer nodes. The layer interacts with the next hidden layer of nodes. The number of possible outcomes is mathematically reduced. And then using probabilities, the most likely result is chosen for the end node, the answer.



(Pamponi, 2023)

Another way of explaining it is by saying a large language model works by guessing the next word. It takes the input information (a new phrase) and guesses the next word. It then adds that word and again guesses the next word. This process is continued until it reaches some termination. Mathematically, it looks like this.



## FUTURE OF LLMS

LLMs are just text to text forms of AI. They are exciting because they can put the world of subject experts at your fingertips. They will continue to grow and get better every few days.

Conclusions and the Future

We are at the place the Internet was in 1999. It was 6 years old and had millions of users around the world. But it far reaching impact was still very unclear. The dot com bubble was about to pop, and the future was unclear. If not, we would all have purchased Google, Apple, Amazon and not be here today. I predict like the world changing impact of the internet we cannot even envision this AI augmented future that is waiting just ahead.

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# Analytics Big Data

## PERFORMANCE EVALUATION OF DECISION-MAKING UNITS USING MAX-NORMALIZED CLUSTER ANALYSIS METHOD IN THE DEA/BIG DATA CONTEXT

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# ABSTRACT

The data envelopment analysis (DEA)-based methods are viewed as a tool for Big Dataenabled analytics. However, the excessive computational time for a large set of decisionmaking units (DMUs) is a critical issue in the DEA/Big Data context, not to mention the DEA's poor discriminatory power and inconsistent ranking results. This paper proposes a max-normalized cluster analysis (MXN-CA) method for evaluating and ranking DMUs in the DEA/Big Data context. The proposed method overcomes these issues of DEA methods since it requires simple computations but shows a comparable consistency level of ranking. Two numerical examples demonstrate the outstanding performance of the proposed method.

## **INTRODUCTION**

Performance measurement or evaluation is one of the most decorated elements in performance management. Among many performance evaluation and benchmarking methods, Data envelopment analysis (DEA) has emerged as the leading technique that uses Linear Programming (LP) to rate the relative performance of a set of peer decision-making units (DMUs) in the company of multiple inputs and outputs by comparing how well the DMU uses its inputs to produce outputs. The conventional DEA (C-DEA), introduced by Charnes et al. [5], eventually determines which DMUs attain the most efficient outcome using given inputs and which do not. However, the C-DEA assessment may suffer from a lack of discrimination, mainly when multiple DMUs are classified as efficient. The reason is that all DEA-based methods unfairly treat unfavorable input/output data, which would damage their efficiency. In other words, C-DEA considers only favorable inputs/outputs in computing the efficiency score (ES), ignoring damaging inputs/outputs to maximize individual ES. However, many practices consider identifying the best DMUs more important than maximizing the individual ES.

To remedy this deficiency of C-DEA, Sexton et al. [28] suggest the cross-efficiency DEA (CE-DEA) method to evaluate and rank DMUs, with the main idea of using C-DEA to do the peer evaluation rather than C-DEA's pure self-evaluation. The CE-DEA method can usually provide a complete ranking of the assessment of DMUs (see Anderson et al. [3]). Due to its enhanced discriminatory power, the CE evaluation has generated a significant number of applications in the DEA literature (see Liang et al. [22]; Wang and Chin [30]; Gavgani and Zohrehbandian [13]; Hou et al. [18]; Lee [21]; Liu et al. [23]; Hong [15]). As Doyle and Green [11] indicated, the non-uniqueness of CE scores (CESs) often results from alternative optimal weights in the C-DEA model, implying the CESs depend on the optimization

software used. The idea of super-efficiency (SE), developed by Anderson and Peterson [3], is that the C-DEA model is applied, excluding a DMU under evaluation from the reference set of the C-DEA model. Charnes et al. [7] use the SE-DEA model to study the sensitivity of the efficiency classification. Jeong and Ok [20] propose a modified cross-evaluation method using super-efficiency scores (SES). Hong and Jeong [16] apply the cross-efficiency-based super-efficiency DEA approach to designing disaster recovery center location-routing network schemes.

Cluster analysis (CA), an unsupervised data mining technique, is an exploratory data analysis technique for solving clustering problems. Clustering aims to identify meaningful segmentations or groupings of entities within a data set, focusing on distance-based analysis. One of many tools for calculating distance measures is the centroid-based technique (Gan et al. [12]). We consider each DMU as an entity with input and output data and utilize the idea of CA by applying the Euclidean distances among the input and output data of DMUs. Sortiros and Despotis [29] apply the maximum normalization for DEA, showing that the max-normalized DEA (MXN-DEA) model is structurally identical to the C-DEA model with un-normalized data. In order to remove the imbalance in the input/output data, this paper applies the MXN method. Each input and output data are rescaled before CA is applied. This paper applies the proposed procedure called the **max-normalized cluster analysis (MXN-CA)** method for evaluating DMUs.

Charles et al. [6] provide an overview of the current avenues of research for the studies aimed at integrating DEA with Big Data. Zhu [32] also suggests that DEA should be regarded as a tool or method for data-oriented analytics in performance assessment and benchmarking. However, the DEA-based methods in the Big Data context require excessive computational/run time to evaluate a large set of DMUs, as Barr and Durchholz [4] demonstrate in their paper. Panwar et al. [26] also observe that there has been constant progress in the publications of DEA from 1978 to 1995. Still, from 1995 onwards, there has been an exponential rise in theoretical development and diverse applications. As Big Data research becomes a critical area of operations analytics, DEA is evolving into data-enabled analytics and a data-oriented data science tool for various operational analytics. Various researchers show that Big Data can be applied to improve company productivity or efficiency and will be essential for enterprises to grow and achieve a competitive advantage. When researchers attempt to integrate DEA into Big Data, the serious barrier between Big Data and DEA is the excessive running time for solving a large set of DMUs in the Big Data context. The proposed MXN-CA process takes advantage of the simple computation, not requiring any optimization software that all DEA-based models need. Consequently, the MXN-CA method would be a more appropriate tool for solving a large set of DMUs in the Big Data context.

## **DEA-BASED EVALUATION**

The ratio-form or fractional DEA model uses the ratio of outputs to inputs to measure the relative efficiency of *DMU<sub>j</sub>* as an objective function to be assessed relative to the ratios of all DMUs. The fractional DEA model is stated (Zhu [31]):
Objective Function: Maximize the efficiency rating  $\theta_i$  for  $DMU_i$ 

$$Max \ \theta_j = \frac{\sum_{r=1}^{s} u_{rj} y_{rj}}{\sum_{i=1}^{m} v_{ij} x_{ij}}, \quad j = 1, 2, \dots n,$$
(1)

subject to

$$\frac{\sum_{r=1}^{s} u_{rj} y_{rw}}{\sum_{i=1}^{m} v_{ij} x_{iw}} \le 1, \forall j \text{ and } w = 1, 2, \dots, n,$$
(2)

where

j = DMU j being evaluated in the DEA analysis, j = 1, ..., n  $y_{rj} = amount of output r generated by <math>DMU_j$   $x_{ij} = amount of input i consumed by <math>DMU_j$  m = number of inputs used by DMUs s = number of outputs generated by DMUs  $u_{rj} = multipliers or weight assigned by DEA to <math>y_{rj}$   $v_{ij} = multipliers or weight assigned by DEA to <math>x_{ij}$  $u_{rj}, v_{ij} \ge 0, r = 1, ..., s; i = 1, ..., m; w = 1, 2, ..., n.$ 

From (1) and (2), we see that when the same set of u and v multipliers is applied to all other DMUs to be compared, all DMUs will be less than or equal to 100% efficient. Based on the fractional DEA model in (1)-(2), the conventional and cross-efficiency (CE) DEA models were developed (Cooper et al. [8, 9]). The C-DEA model is formulated as the following LP problem, where  $E_{ij}$  represents the efficiency score (ES) for  $DMU_j$ :

$$max \quad E_{jj} = \sum_{r=1}^{3} u_{rj} y_{rj}, \tag{3}$$

subject to

$$\sum_{i=1}^{m} v_{ij} x_{ij} = 1,$$
(4)

$$\sum_{r=1}^{s} u_{rj} y_{rw} - \sum_{i=1}^{m} v_{ij} x_{iw} \le 0, w = 1, \dots, n,$$
(5)

$$u_{rj}, v_{ij} \ge 0, r = 1, ..., s; i = 1, ..., m.$$

The CE-DEA method, which consists of two phases, was proposed to rank DMUs with the central idea of using DEA to do peer assessment rather than pure self-assessment (Sexton et al. [28]). The weights or multipliers from the first phase are applied to all DMUs to compute the cross-efficiency score (CES) for each DMU in the second phase. In the first phase, the above LP model in (3)-(5) is solved to find the ES of  $DMU_j$ . To denote the peer evaluation, let  $E_{jw}$  represent the DEA score for the rated  $DMU_w$ , w = 1, 2, ..., n, using the

optimal weights /multipliers that a rating  $DMU_j$  has chosen in the model (3)-(5). Now,  $E_{jw}$  is given by

$$E_{jw} = \frac{\sum_{r=1}^{s} u_{rj}^* y_{rw}}{\sum_{i=1}^{m} v_{ij}^* x_{iw}}, \qquad j \text{ and } w = 1, \dots, n.$$
(6)

Then, the CE score for *DMU*<sup>*w*</sup> is defined as follows:

$$CE_w = \frac{1}{n} \sum_{j=1}^{n} E_{jw}.$$
 (7)

The SE-DEA would generate a super-efficiency score (SES) obtained from the conventional DEA model after a target DMU under evaluation is excluded from the reference set (see Anderson and Peterson [3]). In the SE method, the frontier line generated from the remaining DMUs changes for each efficient DMU to be evaluated, so the SESs of efficient DMUs can have greater values than one (1), which is the maximum value in ES obtained by other DEA methods. The SE-DEA model, which has been applied significantly for ranking efficient DMUs, is given by

$$Max \quad SES_j = \sum_{r=1}^{3} u_{rj} y_{rj}, \tag{8}$$

subject to

$$\sum_{i=1}^{m} v_{ij} x_{ij} = 1,$$
(9)

$$\sum_{r=1}^{s} u_{rj} y_{rw} - \sum_{i=1}^{m} v_{ij} x_{iw} \le 0, w \ne j, w = 1, \dots, n,$$
(10)

 $u_{rj}, v_{ij} \ge 0, r = 1, \dots, s; i = 1, \dots, m.$ 

#### THE MAX-NORMALIZED CLUSTER ANALYSIS (MXN-CA) METHOD

As mentioned earlier, this paper applies the max normalizing (MXN) method to remove the imbalance in the magnitude of the raw input/output data. Now, the normalized input *i*,  $x'_{ij}$ , and output *r*,  $y'_{ri}$ , for *DMU*<sub>j</sub> are expressed as

$$x'_{ij} = \frac{x_{ij}}{Max_{\forall w}\{x_{iw}\}}, \quad \forall j = 1, ..., n.$$
(11)

and

$$y'_{rj} = \frac{y_{rj}}{Max_{\forall w}\{y_{rw}\}}. \quad \forall j = 1, ..., n.$$
(12)

The proposed MXN-CA approach, which evaluates each DMU's performance without applying DEA methods, differs from some DEA-based clustering methods like Po et al. [27] and Chen et al. [10]. As C-DEA classifies all DMUs under evaluation into two groups, separating efficient DMUs from inefficient DMUs, there are two (2) clusters in the proposed method. The first cluster is an efficient one, while the second is an inefficient cluster. Given a set of *n* DMUs with *m* inputs and *s* outputs, all DMUs under evaluation will be classified into one of these clusters or both for input and output, respectively. What separates the proposed MXN-CA method from other DEA-based clustering methods is that the global minimum and the maximum points are set to represent the clusters rather than the centroid-based technique. Efficiency or productivity is expressed as the ratio of outputs to inputs. It implies that the greater the efficiency will be as output increases and/or input decreases.

As described before, the CE scores generated by DEA may not be unique due to multiple optimal weights/multipliers for inputs and outputs obtained from solving LP. But the efficiency score,  $ES_{jN}^{CW}$  or  $ES_{jN}^{C}$ , generated by the proposed CA or MXN-CA method, does not require any LP. Hence, the proposed method does not depend on the multiple optimal weights but on the ratio of output to the sum of the inputs. See Hong [17] for the details of the MXN-CA method. We use a well-known numerical example, which is easily found in the DEA-related literature, to evaluate the proposed method.

#### NUMERICAL EXAMPLES

To investigate the performance of the MXN-CA, we consider the numerical example Liang et al. [22] illustrate with five DMUs. The data for each DMU consists of three inputs  $(x_{1j}, x_{2j}, x_{3j})$  and two outputs  $(y_{1j}, y_{2j})$ , as shown in Table 1. We report ES generated by C-DEA, CES by CE-DEA, SCES by SE-DEA,  $ES_{jN}^{CW}$  by CA (without MXN) and  $ES_{jN}^{C}$  by MXN-CA, along with the corresponding ranks.CESs by CE-DEA, SCES by SE-DEA, and  $ES_{jN}^{C}$  by the EDDC method, along with the corresponding ranks, are reported in Table 2. All methods consistently rank the two efficient DMU3 and DMU2 as #1 and #2, but each method ranks the other inefficient  $DMU_1$ ,  $DMU_4$ , and  $DMU_5$  differently.

		Input	Ţ	Out	out
DMU	$x_{1j}$	$x_{2j}$	$x_{3j}$	$y_{1j}$	$y_{2j}$
1	7.0	7.0	7.0	4.0	4.0
2	5.0	9.0	7.0	7.0	7.0
3	4.0	6.0	5.0	5.0	7.0
4	5.0	9.0	8.0	6.0	2.0
5	6.0	8.0	5.0	3.0	6.0

TABLE 1: I	Five Decision-	<ul> <li>Making Units</li> </ul>	(DMUs)
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For further investigation, the three inefficient DMUs, after excluding two efficient DMUs, are evaluated and reported in Table 3. Since the two efficient DMUs are excluded, C-DEA rates these three DMUs as efficient with an ES of 1. Table 3 shows the ranks and the expected ranks, denoted by [R], based on the ranks in Table 2. We observe from Table 3 that SE-DEA, CA, and MXN-CA rank these DMUs consistently, but CE-DEA does not. Table 3 also shows that two DEA-based models, CE- and SE-DEA, rank *DMU*<sub>4</sub> higher than *DMU*<sub>1</sub> or *DMU*<sub>5</sub>, whereas the CA and MXN-CA rank *DMU*<sub>5</sub> higher than *DMU*<sub>4</sub> and *DMU*<sub>1</sub>.

		DEA-Based	CA-Based Method							
DMU	C-DE	A	CE-DE	А	SE-D	EA	CA		MXN-C.	A
	ES	R	CES	R	SES	R	$ES_{jN}^{CW}$	R	$ES_{jN}^{C}$	R
1	0.6857	5	0.5191	4	0.6857	5	0.3278	4	0.2612	4
2*	1.000*	1	0.9161	2	1.1200	2	0.9716	2	0.8063	2
3*	1.000*	1	0.9571	1	1.5000	1	1.0000	1	1.0000	1
4	0.8571	3	0.6985	3	0.8571	3	0.1698	5	0.1521	5
5	0.8571	3	0.4942	5	0.8571	3	0.4576	3	0.3259	3
	*: Efficient by C-DEA; R: R									

 TABLE 2: Comparison of Efficiency Scores and Rankings for Five DMUs

TABLE 3:	Comparison	of Efficiency	Scores a	and Rankings	for Three	Inefficient DMUs
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DEA-Base				DEA-Based Method					CA-Based Method			
DMU	CE-I	DEA		SE-	DEA		С	A		М	XN-CA	
	CES	R	[R]	SES	R	[R]	$ES_{jN}^{CW}$	R	[R]	$ES_{jN}^{C}$	R	[R]
1	0.7714	3	2	1.1238	3	3	0.9597	2	2	0.5176	2	2
4	1.0000	1	1	2.1000	1	1	0.3466	3	3	0.2075	3	3
5	0.8055	2	3	2.1000	1	1	1.0000	1	1	1.0000	1	1

R: Rank; [R]: Expected Rank

As DEA models implicitly assume equal weight to each input and output, it is unreasonable for two DEA-based models to rank *DMU*<sup>4</sup> higher than *DMU*<sup>5</sup>. *DMU*<sup>4</sup> and *DMU*<sup>5</sup> have the same minimum input, 5.0, and the maximum output, 6.0. But *DMU*<sup>4</sup> has the other two inputs, 9.0 and 8.0, which are greater than or equal to those of *DMU*<sup>5</sup>, 6.0, and 8.0. Except for the same maximum output value of 6.0, *DMU*<sup>5</sup> has a higher output value of 3.0 than 2.0 for *DMU*<sup>4</sup>, implying that *DMU*<sup>5</sup> should be ranked higher than DMU<sup>4</sup>. Thus, **the ranks generated by the CA and MXN-CA methods would be more rational and logical than those by DEA-based models**.

We implement the MXN-CA method in an Excel spreadsheet with VBA (Visual Basic for Applications) on Intel® Xeon ® Gold 5122 HP Z4 Workstation PC (2 processors) with 32GB of RAM installed using a 64-bit version of Windows 10. We randomly generated the values of three inputs and two outputs using a uniform distribution with the minimum and maximum values from Table 1 for the number of DMUs, {15, 50, 100, 150, 200, 300, 400, 500, 800, 1000}. A DEA software, *DEAFrontier*, is run for the generated DMUs to find CES

on the same computer to compare the running times between the DEA-based and proposed MXN-CA methods. Figure 1 depicts the results of running times. As expected, we see that the running times for MXN-CA are almost negligible compared to CE-DEA. Figure 1 clearly shows that the running time for CE-DEA sharply increases when the number of DMUs, *n*, increases.



FIGURE 1: Comparison of Running Time

# SUMMARY AND CONCLUSIONS

Evaluating and Ranking DMUs based on the ESs generated by the C-DEA method shows a significant drawback due to the self-evaluation principles. Several ranking methods based on the C-DEA have been proposed, but no ranking method has been found to be either a universal or superior method for ranking DMUs. The absence of global assessment criteria still shows that more papers on the DEA-based models continue to come. However, depending on the evaluation's nature, each method could be better than others according to the decision maker's preferences and evaluation objectives.

The severe weakness of the DEA-based approaches is their biased preference for specific inputs/outputs. All DMUs under evaluation can only use favorable inputs/outputs to boost their own efficiency scores, dropping the unfavorable inputs/outputs. For evaluating and ranking DMUs more consistently without prejudice, this paper proposes the MXN-CA method, starting with dividing each input/output data by the column maxima. Then, the proposed procedure clusters all DMUs with rescaled input/output data based on the

overall minimum and maximum points to represent the clusters rather than the centroid of each cluster.

We apply the proposed method to evaluate a well-known numerical example, which has been considered by several authors, to compare the DEA-based methods. The numerical example shows that the rankings generated by the DEA-based methods show such a significant weakness, especially for the top-notch DMUs. By contrast, the rankings generated by applying MXN-CA do not change when some lower-ranked or inefficient DMUs are removed from evaluation.

The MXN-CA method can get results very quickly. It takes less than 15 seconds for MXN-CA to get the results with 1,000 DMUs, whereas it takes almost one hour and fifteen minutes for the DEA software to get the CEs. Contrary to the DEA-oriented methods, the proposed method does not require any optimization software to evaluate DMUs under evaluation. The results and observations through the numerical examples demonstrate that the proposed method works well and would be considered an appropriate tool for evaluating a large set of DMUs in the Big Data context.

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References are available upon request from Hong.

## A STUDY OF PREDICTIONS AND IMPACTS OF CYBERSECURITY BREACHES

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## ABSTRACT

Cybersecurity data breaches have been increasing in recent years. Cyberthreats target not only large organizations but also small and medium size industries. Therefore, this research studies the impacts of cyberattacks on industries based on industry types and sizes. However, analyzing the statistical data of eighty-five industries across all different sizes shows that the industry type and size are insufficient to predict the impacts of cyberattacks. In addition, the paper explores the type of breaches and individuals affected specific to the healthcare sector. While there are multiple variables to predict the type of breach and the number of affected individuals, the statistical analysis proves that the accuracy is insufficient or the type of breach and its impacts cannot be predicted using the current data and variables. This finding hints at a need for more data, more variables, or alternative methods to achieve a more accurate prediction.

<u>KEYWORDS</u>: Cybersecurity, Cyberattack, Impacts of cyberattacks, Logistic regression, Multiple linear regression

## INTRODUCTION AND LITERATURE REVIEW

The progression in digital technologies has led to digital exploitation, where everyone's information is stored and can be easily accessed. Therefore, ensuring data security is crucial in the current digital era. Cybersecurity is a field that aims to protect data, organizations, and users. Cyberattacks may happen with the use of malware or ransomware, leading to economic losses, reputation deterioration, and denial of service. This research, hence, answers these questions:

- Research Question 1: What are the impacts of cybersecurity incidents by the industry type and industry size?
- Research Question 2: How to predict the type of cybersecurity breach?
- Research Question 3: How to analyze the number of individuals affected by the cybersecurity breach?

This paper considers several types of variables that are common in cybersecurity. These variables are the type of industry, size of industry, type of cyberattacks, and impacts of cyberattacks. The literature studies some of these variables, but not all in the same study. For example, the research work in [1] lacks the type of industry, the work of [2, 5,6,7] lacks the size of the industry, and the works of [3,4] lack the type of industry.

The research work in [1] measures the cyberattacks occurring against small and medium size industries. In addition, it is analyzed how employees recognize the risk of cyberattacks,

how frequently cyberattacks happen in these small and medium size industries, and what cybersecurity measures are needed to monitor or prevent the attacks. The work of [2] studies cybersecurity incident data in a large organization. The authors consider the impacts only at large organizations. The work of [2] does not consider the data from a wide variety of industries. Due to the bias of considering cyberthreats happening only at large organizations, it is concluded that the cyberthreat is stable over time as a large organization has multiple cybersecurity measures put in place for prevention or early detection.

While the mentioned studies focus on small, medium, and extensive industry sizes, the work of [3] is focused on cybersecurity incidents in the maritime segment. The study of [3] gathers data between 2010 and 2020 and investigates the cybersecurity incidents in the maritime industry. According to the work of [3], the maritime segment is less attacked during this period, but the impact of cyberattacks is enormous. The study of [4] identifies fifteen publicly available incidents in the maritime sector and then develop preventive measure against them. The work of [3] and [4] mainly focuses on the vulnerability of sectors in the maritime industry and lacks the study of other sectors.

According to [5], due to the increasing number of cybersecurity threats over the years, implementing security measures to detect and prevent cyberattacks is essential, especially in the case of financial institutions. The author classifies the impacts of cybersecurity incidents on financial institutions as direct and indirect losses. Money loss and data breaches are some direct losses, while indirect losses include customer frustration and public image destruction. Like [3], which states that the maritime segment is less attacked with higher financial consequences, the work of [5] also shows that the financial institutions' segment is less attacked with vast financial impacts.

The research of [6] examines the cyberattacks on critical energy infrastructure. Some companies include hydro, nuclear power, electric power plant, state-owned energy companies, and US colonial pipeline. The types of cyberattacks are either malware or ransomware, while the impacts of cyberattacks are economic losses, damaging the reputation, plant shutdown, financial losses, political disputes, and IT infrastructure destruction. The work of [6] accounts for the type of industry and type of cyberattacks but fails to consider the size of the industry.

A team of researchers [7] conducts a systematic literature review to identify and document the cybersecurity threats incurred to the healthcare industry. They used a systemic approach and gathered information from various databases. The team's analysis shows that the most common cyberattacks in the health industry are identity theft, cybersquatting, and data breaches.

All the research articles discussed so far aim to study only large organizations, or they only target specific industries like the maritime, financial sector, water sector, health sector, and critical energy infrastructures. The purpose of this research, however, is to find datasets comprising all available industries, including the ones mentioned above. Moreover, this study considers other variables, such as cybersecurity impacts and industry size for all the

mentioned sectors. In addition, this work attempts to predict the type of breaches and analyze the individuals affected by data breaches in the health sector.

The next section describes the three datasets used in this paper. After that, Logistic regression and multiple linear regression analysis are used to answer the research questions. The paper carries on discussing the findings of the analysis, and at last, the conclusion of the paper is provided.

## DATA DESCRIPTION

Three datasets are used to answer research questions. They are named CID (cybersecurity impacts dataset), DCIH (Dryad cybersecurity in healthcare), and KCIH (Kaggle cybersecurity in healthcare). Authors find these datasets using a Google Scholar dataset search. The specific address for each dataset is available when the dataset is introduced. The CID dataset is available at [8]. All the variables in this dataset are impacts, industry, and industry size. The number of observations in CID data is 1807. After removing observations that do not specify the industry size, the number of used observations is 780. The data collection is available at [8]. Table 1 represents a sample of 12 observations of this data in its original form, and Table 2 represents their numerical form.

Industry	Industry Size	Impacts
Private sector	Small industries	Loss of revenue
Private sector	Medium-sized industries	Loss of revenue
Private sector	Large industries	Loss of revenue
Agriculture, forestry, fishing, and hunting	Small industries	Loss of revenue
Agriculture, forestry, fishing, and hunting	Medium-sized industries	Loss of revenue
Agriculture, forestry, fishing, and hunting	Large industries	Loss of revenue
Mining, quarrying, and oil and gas extraction	Small industries	Loss of revenue
Mining, quarrying, and oil and gas extraction	Medium-sized industries	Loss of revenue
Mining, quarrying, and oil and gas extraction	Large industries	Loss of revenue
Utilities	Small industries	Loss of revenue
Utilities	Medium-sized industries	Loss of revenue
Utilities	Large industries	Loss of revenue

Table 1: Sample of CID data in its original form

Table 2: Sample of CID d	lata in its numerical form
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Industry	Industry Size	Impacts
1	2	1
1	3	1
1	4	1
2	2	1
2	3	1
2	4	1
3	2	1
3	3	1
3	4	1
7	1	1
7	2	1
7	3	1
7	4	1

DCIH dataset is specific to the healthcare sector and collected from Health and Human Services (HHS) system [9]. All the variables in this dataset are the type of breach, location

of breached information, business associate present, and individuals affected. The number of observations in DCIH data is 1474 records. Table 3 represents a sample of 12 observations of DCIH data in its original form, and Table 4 represents its numerical form.

<b>^</b>		0
Location of breached information	Business associate present	Type of breach
Other Portable Electronic Devices	No	Unauthorized Access/Disclosure
Email	No	Unauthorized Access/Disclosure
Electronic Medical Record   Network Server	No	Hacking/IT Incident
Email	No	Hacking/IT Incident
Email	No	Unauthorized Access/Disclosure
Email	No	Unauthorized Access/Disclosure
Paper/Films	No	Improper Disposal
Email	No	Unauthorized Access/Disclosure
Laptop	No	Hacking/IT Incident
Paper/Films	No	Unauthorized Access/Disclosure
Paper/Films	No	Unauthorized Access/Disclosure
Email	No	Unauthorized Access/Disclosure

Table 3: Sample of DCIH data in its original form

Table 4: Sample of	of DCIH data in :	its numerical form
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Location of breached information	Business associate present	Type of breach
3	1	2
1	1	2
6	1	1
1	1	1
1	1	2
1	1	2
2	1	4
1	1	2
7	1	1
2	1	2
2	1	2
1	1	2

Table 5 represents a sample of 12 observations of DCIH data in its original form, and Table 6 represents its numerical form. The difference between these tables and tables 3 and 4 is that one variable is considered in the dataset, which is the number of individuals affected.

Individuals affected	Type of breach	Location of breached information	Business associate present
2000	Unauthorized Access/Disclosure	Other Portable Electronic Devices	No
860	Unauthorized Access/Disclosure	Email	No
842	Hacking/IT Incident	Electronic Medical Record   Network Server	No
742	Hacking/IT Incident	Email	No
2969	Unauthorized Access/Disclosure	Email	No
1741	Unauthorized Access/Disclosure	Email	No
611	Improper Disposal	Paper/Films	No
1806	Unauthorized Access/Disclosure	Email	No
1911	Hacking/IT Incident	Laptop	No
967	Unauthorized Access/Disclosure	Paper/Films	No
1320	Unauthorized Access/Disclosure	Paper/Films	No
1417	Unauthorized Access/Disclosure	Email	No

Table 5: Sample of extended DCIH data in its original form

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Individuals affected	Type of breach	Location of breached information	Business associate present
2000	2	3	1
860	2	1	1
842	1	6	1
742	1	1	1
2969	2	1	1
1741	2	1	1
611	4	2	1
1806	2	1	1
1911	1	7	1
967	2	2	1
1320	2	2	1
1417	2	1	1

Table 6. Same	nlo of ovtondod	DCIH data in its	numerical form
Table 6. Salli	pie of extended	DCIH uata III Its	numerical form

The KCIH dataset is specific to healthcare breach collection and is available at [10]. All the variables in this dataset are (1) Type of breach, (2) Individuals affected, (3) Name of covered entity, (4) State, (5) Business associate involved, (6) Date of breach, (7) Location of breached information, (8) Date posted or updated, (9) Summary of incident, (10) Breach start, (11) Breach end, and (12) Year.

The number of observations in KCIH data is 1055 records. Table 7 represents a sample of 12 observations of KCIH data in its numerical form. Table 8 represents a sample of 12 observations of extended KCIH data in its numerical form. The extended KCIH data consider one additional variable that is excluded in Table 7. This variable is the number of affected individuals.

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Name of covered entity	State	Associate involved	Date of breach	Location of breach	Date posted or updated	Summary of incident	Breach start	Breach end	year	Type of breach
1	1	1	1	1	1	1	1	1	1	1
2	2	1	2	2	2	2	2	1	1	1
3	3	1	3	3	3	3	3	1	1	1
4	4	1	4	4	3	4	4	1	1	2
5	5	1	5	5	3	5	5	1	1	1
6	5	1	5	5	3	6	5	1	1	1
7	5	1	5	5	3	7	5	1	1	1
8	5	1	5	5	3	8	5	1	1	1
9	5	1	5	5	3	9	5	1	1	1
10	5	1	5	4	3	10	5	1	1	1
11	6	1	6	4	3	3	6	1	1	1
12	7	1	7	4	4	11	7	1	1	1

Table 7: Sample of KCIH data in its numerical form

#### Table 8: Sample of extended KCIH data in its numerical form

Affected Individuals	Name of covered entity	State	Associat e involved	Date of breach	Location of breach	Date posted or updated	Summary of incident	Breach start	Breach end	year	Type of breach
1000	1	1	1	1	1	1	1	1	1	1	1
1000	2	2	1	2	2	2	2	2	1	1	1
501	3	3	1	3	3	3	3	3	1	1	1
3800	4	4	1	4	4	3	4	4	1	1	2
5257	5	5	1	5	5	3	5	5	1	1	1
857	6	5	1	5	5	3	6	5	1	1	1
6145	7	5	1	5	5	3	7	5	1	1	1
952	8	5	1	5	5	3	8	5	1	1	1
5166	9	5	1	5	5	3	9	5	1	1	1
5900	10	5	1	5	4	3	10	5	1	1	1

943	11	6	1	6	4	3	3	6	1	1	1
6400	12	7	1	7	4	4	11	7	1	1	1

### METHOD

The research focuses on analyzing the datasets that are introduced in the previous section. Then, the research questions are stated and answered in the following.

# Research Question 1: What are the impacts of cybersecurity incidents by the industry type and industry size?

The CID dataset is used for this question. Figures 1 to 3 depict the plots representing the cybersecurity data for the variables impacts, industry, and industry size. Figure 1 represents the histogram plot for impacts. The dataset has 13 distinct types of impacts. The histogram reveals that the impacts mentioned in the sample data are spread across all industries and industry sizes.



Figure 1: Cyberattacks based on impacts

Figure 2 represents the histogram plot for the industry. The dataset has 85 distinct types of industries. Multiple industries are affected by the most type of breaches. The rest of the industries are affected but with fewer types of cyberattacks.



Figure 2: Cyberattacks based on industry

Figure 3 represents the histogram plot for industry size. The dataset has three distinct types of industry sizes. The four values are 2 for small industries, 3 for medium size industries, and 4 for large industries.



Figure 3: Cyberattacks based on industry size

In order to predict the impacts of cybersecurity incidents, the variable impacts in the CID dataset are assumed to be the dependent variable. The rest of the variables are independent variables. The dependent variable values range from 1 to 13. Its values are discrete and not continuous. So, the logistic regression method is used to predict the impacts of cybersecurity incidents. The results show that the model does not converge, and when it does, the accuracy is too low. Hence, the conclusion is that independent variables (industry and industry size) do not predict the variable impacts. This means that the CID dataset does not support the effects of industry type and industry size on the impacts of cybersecurity incidents.

## **Research Question 2: How to predict the type of cybersecurity breach?**

DCIH and KCIH datasets are used to answer this question. The variables used from the DCIH dataset are the type of breach, location of breached information, and business associate present. The dependent variable is the type of breach, and the independent variables are the location of breached information and the business associate present. The dependent variable is discrete. Hence logistic regression is used to predict the type of breach. In dataset KCIH, more variables are present. Hence, in case the DCIH dataset cannot predict the type of breach, the KCIH would be used as another attempt to predict the type of breach.

The dependent variable (type of breach) ranges from 1 to 24. The values are discrete and not continuous. So, the logistic regression method is used to analyze the type of breach. According to the analysis, the accuracy prediction is 0.37, which is very low. This means that the location of breached information and the business associate present in the DCIH dataset is insufficient to predict the type of breach.

Dataset KCIH has more variables compared to DCIH. Therefore, this dataset can be used as another attempt to answer the second research question. The logistic regression is used again for the KCIH dataset. According to the analysis, the logistic regression does not converge, and when it does, the accuracy prediction is low.



Figure 4: Type of cybersecurity breach – DCIH Data



Figure 5: Type of cybersecurity breach – KCIH Data

## Research Question 3: How to analyze the number of individuals affected by the cybersecurity breach?

DCIH and KCIH datasets are used to answer this question. The variables used from the DCIH dataset are individuals affected, type of breach, location of breached information, and business associate present. The dependent variable is the individuals affected, and the independent variables are the rest of the list. The dependent variable is continuous. Hence the linear regression method is used to analyze the relation or correlation between variables. In dataset KCIH, more variables are present. Hence, in case the DCIH dataset cannot analyze the number of individuals affected by the cybersecurity breach, the KCIH would be used as another attempt to analyze the number of individuals affected by the cybersecurity breach.

The values of the dependent variable individuals affected are continuous. So, the linear regression method is used to analyze the relation or correlation between variables. As there are many independent variables like type of breach, location of breached information, and business associate present, multiple linear regression is used. Multiple linear regression analysis is used to show how significant each independent variable is. Finally, we calculated P values and compared them to the significance level alpha = 0.05. Variables and their respective P values are shown in Table 9.

Table 9: Multiple linear regression analysis – DCIH Data						
Variables	<b>P-Values</b>					
Type of breach	0.217318					
Location of breached Information	0.737858					
Business associate present	0.913037					

In Table 9, p-values are larger than the significance level of 0.05 or even 0.1. Therefore, all the independent variables are rejected. They are insignificant in analyzing the number of individuals affected by cybersecurity breaches. Hence, a linear regression cannot be found that can be used for predicting the number of individuals affected by cybersecurity breaches.

Dataset KCIH has more variables compared to DCIH. Therefore, this dataset can be used as another attempt to answer the third research question. The multiple linear regression is used again for the KCIH dataset. Multiple linear regression analysis is performed on the dependent variable (individuals affected), considering the rest of the independent variables. Variables and their respective p-values are shown in Table 10.

Variables	P-Values			
Name of covered entity	0.500789			
State	0.918494			
Business associate involved	0.573688			
Date of breach	0.459309			
Type of breach	0.450187			
Location of breached information	0.625992			
Date posted or updated	0.301757			
Summary of incident	0.858486			
Breach start	0.529462			
Breach end	0.344863			
Year	0.544046			

Table 10: Multiple linear regression analysis - KCIH Data

The p-values in Table 10 are larger than the significance level of 0.05 or even 0.1. Therefore, all the independent variables are rejected. They are all insignificant in analyzing the number of individuals affected by the cybersecurity breach. Hence, a linear regression equation cannot be found for predicting the number of individuals affected by the cybersecurity breach.

## RESULTS

The paper investigates cybersecurity breaches and the impacts they may have on organizations. First, the effects of the industry type and industry size on the impacts of cybersecurity incidents are studied. Second, the factors that can predict the type of cybersecurity breach are investigated. Third, the number of individuals who may be impacted by cybersecurity incidents is analyzed.

Three datasets are used for the study. The first dataset (CID dataset) contains data related to the type and size of the industry. The second dataset (DCIH dataset) has data related to the type of cybersecurity breaches and three independent variables. The third dataset (KCIH dataset) has data related to the type of cybersecurity breaches and eleven independent variables. The following results are obtained using these datasets. The first result is related to the impacts of cybersecurity incidents. The logistic regression used on the CID dataset could not show that industry type and industry size predict the impacts of cybersecurity incidents. It is helpful to use the method on other datasets in the hope of achieving a better prediction. In addition, it is recommended to use other linear models to check if they are more capable of predicting the impacts of cybersecurity incidents. The second result is related to the type of cybersecurity breach. The logistic regression is used on the DCIH and KCIH datasets. This method does not converge, and when it does, the accuracy of predictions is low. Therefore, the location of breached information, business associate present from both datasets, and additional variables from the KCIH dataset could not predict the type of cybersecurity breach. It is helpful to use the method on another dataset in the hope of discovering if the variables listed on DCIH and KCIH datasets can predict the type of cybersecurity breach. In addition, it is recommended to use other linear models to check if they are more appropriate for such predictions.

The third result is related to the number of individuals affected by the cybersecurity breach. The multiple linear regression analysis was used on the DCIH and KCIH datasets. The analysis concludes that all the independent variables in these datasets should be rejected, and they cannot predict the number of individuals affected by cybersecurity incidents. It is helpful to use this method on other datasets in the hope of discovering if a similar list of variables can predict the number of individuals affected by cybersecurity breaches or not. In addition, it is recommended to use other linear models to check if they are more appropriate for such a prediction.

# **CONCLUSION AND FUTURE RESEARCH**

This study considers the possibility of predicting the impacts of cybersecurity incidents considering the size and type of industry. It also attempts to predict the type of cybersecurity breaches and the number of individuals affected by these breaches. Logistic regression is used to analyze the impacts of cybersecurity incidents. The results show that industry type and industry size are insufficient to predict the effects of cybersecurity incidents. Further, the logistic regression is used to predict the type of cybersecurity breach. The results show that the location of breached information, business associate present, and other variables listed in the available datasets are insufficient to predict the type of individuals affected by the cybersecurity breach. The results show that all the variables listed in the datasets are insignificant and cannot be used for predicting the number of individuals affected by cybersecurity breaches. For future studies, it is recommended to use new datasets and repeat the experiments in previous sections. It is also recommended to use other models instead of logistic regression and multiple linear regression in the hope of better answering the research questions.

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## A DUAL-STEP APPROACH FOR PRIORITIZING CRITERIA AND RANKING ALTERNATIVES

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### ABSTRACT

This paper presents a two-step model for ranking alternatives and prioritizing criteria. Firstly, we develop a super-efficiency data envelopment analysis model to generate a fully ranked list of alternatives. Secondly, we employ fixed-effect and random-effects models to identify the criteria that significantly influence the rankings of these alternatives over time. The practicality of our model is demonstrated through a case study that identifies the key criteria for cities' rankings within the United States. The proposed model offers several unique advantages: First, it minimizes the subjective nature of the evaluation process for alternatives. Second, another benefit of a DEA-based model is that the inputs and outputs can retain their natural physical units, eliminating the need for transformation into a common metric. Third, by utilizing a super-efficiency DEA model in the first step, we can generate a complete ranked list of all alternatives, as this model can differentiate among all DMUs. Fourth, by constructing both the one-way and two-way fixed-effects models in the second step, we incorporate both the alternative and time fixed effects into the analysis. We then determine the necessity of both effects by conducting an F-test and a Lagrange Multiplier test. Fifth, we compare the fixed and random-effects models in the second step to select the more suitable model for the real-world dataset. Lastly, the case analysis presented in this paper underscores our model's applicability and ease of use in ranking alternatives and addressing the prioritization of criteria problems. Based on these findings, we posit that our model offers a powerful and innovative tool for analytical decisionmaking processes. Furthermore, we suggest that future research could extend this study to other industries, including tourism, manufacturing, and transportation.

## ARE ACCOUNTANTS STUCK WITH MICROSOFT EXCEL FOR DATA ANALYTICS?

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### ABSTRACT

Microsoft Excel is extensively used in Business. Some of the tasks that Accountants use Microsoft Excel are for tasks such as Depreciation schedule, Amortization, Preparation of financial statements, Bookkeeping, Financial / Investment management, and Tax preparation and compliance. These tasks result in the generation of large amounts of data. Thus, Accountants have at their disposal a large amount of data and they must use it productively for organizational benefits and advantage. Prior research has shown that Microsoft Excel lacks the capability for detailed examination and analysis of larger data sets. Thus, there is a need for sophisticated software for Data Analysis such as Tableau, SAS, Stata, R, Power BI, Oracle/SQL. Accounting researchers have found that Accountants rely heavily on Microsoft Excel for Data Analysis even though Microsoft Excel lacks the capability and sophistication for examination of large data sets. This calls into question as to why Accountants are continuing to use Microsoft Excel. In this study, we examine the issues that could lead to resistance on the part of Accountants for using more sophisticated and powerful Data Analysis tools instead of the continued reliance on Microsoft Excel for Data Analysis.

Keywords: Accountants, Data Analysis, Microsoft Excel, Technology Adoption, Technology Resistance

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## THE ESG FIRM VALUE MODEL

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## ABSTRACT

This study aims to investigate the impact of incorporating environmental, social, and governance (ESG) factors on firm value models. The growing recognition of the significance of a company's ESG performance on its long-term financial performance has led to increased demand for ESG data and analysis by investors and firms. The study will create an ESG-inclusive firm value model, select appropriate ESG metrics, assess the model's accuracy, and compare it to a traditional model. The results will provide insights into the significance of ESG factors on firm value and the effectiveness of ESG-inclusive models in predicting firm value.

## Machine Learning Approaches for Misinformation Detection: Review of Recent Developments and Future Research Directions

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## ABSTRACT

Beginning in 2016, there was an explosion of false or misleading information posted and shared online related to national elections [1] [3] and the initial phases of the global pandemic [2]. To deal with the massive volume of misinformation, it is necessary to first identify the false or misleading information, and then quickly remove it. A number of AI-related approaches have been proposed and implemented in the past few years, but no one best solution has been identified that is both effective and computationally efficient. The objective for this study is to review recent studies that have designed and tested machine learning approaches for misinformation detection. A systematic literature review methodology will be used to identify studies where machine learning has been employed for misinformation detection in political or healthcare related contexts. The focus will be on recent developments described in peer-reviewed journal articles from 2019 to 2023. For each study identified, the machine learning method (or methods), data, and findings will be summarized, and then each study will be classified according to its single method, or multimethod, approach. Studies in each category will be reviewed to identify common findings, unique findings, limitations, and areas that need further investigation.

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## STABILIZING THE MORTGAGE INDUSTRY BY INTRODUCING A NEW VARIABLE IN THE ARM RATE

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## ABSTRACT

The growth of instability in financial crisis increased the mortgage payment rigidity and barriers to fixed rate mortgages refinancing were of concern to U.S. policymakers, which gave birth to the concept of affordable mortgage rate adjustments. Unlike, a fixed-rate mortgage where the set rate of interest that does not change throughout the life of the loan, the initial interest rate on an adjustable-rate mortgage (ARM) is set below the market rate on a comparable fixed-rate loan, and then the rate rises (or possibly lowers) as time goes on.

During the financial crisis, the academic research mostly focused on the role of credit market conditions including the short-term interest rates that remained too low for too long. Mortgages originated by Government sponsored entities lended mortgages to those borrowers with approximately 1.9 points lower FICO scores and the financial institutions and banks seem to have compensated for this risk by charging higher interest rates. The literature shows that the adjustable-rate mortgages (ARMs) have advantages over fixedrate mortgages (FRMs) in stabilizing the economy when the financial institutions have the monetary independence and the ability to lower the short-term interest rate in a recession period. An adjustable and lower short rate does provide budget relief for ARM borrowers and supports their spending which can support reducing the mortgage default incidence. This research conducts an in-depth evaluation from 2008-2017 of mortgage default research beginning with the 2008 Financial Crisis to investigate the new variable. The online database used was Business Source Complete and INFORMS. The research suggests that the instead of applying the simply ARM methodology using existing ARM initial rate, we can enhance it by introducing a new variable *New ARM Rate* created based on adding Initial ARM rate and existing ARM margin rate and deducting Annual interest rate from it. This study then performs a multi-step quantitative study on the new variable using data mining (logistic, linear regression, frequency distribution and descriptive statistics) analysis to understand the post-financial crisis patterns of mortgage defaults in the housing market to analyze the new variable's relationship to the data. This research makes a significant contribution because additional variables can expand our understanding of the financial risks in the mortgage industry.

# PREDICTING CREDIT OUTLOOK OF BANKING AND NON-BANKING FINANCE COMPANIES USING MACHINE LEARNING TECHNIQUES

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Banking and non-banking finance companies (NBFCs) actively contribute to the economy by providing financial services to individuals, businesses, and governments. If these institutions face credit risks or failures, it can have a ripple effect on the broader financial system and the economy. As a result, authorities throughout the globe are always looking for methods to identify banks that are in danger of failing early so that they may take remedial action with the least amount of economic disturbance possible. To forecast the credit outlook of a banking and non-banking finance company, this research uses three machine learning models, logistics regression, gradient boost classifier, and the k-nearest neighbor algorithm (kNN) classifiers. The objective is to provide regulators with the tools they need to act appropriately to avoid a "domino effect." Additionally, the results are cross validated using ten different data samples to reduce potential bias in the training set and assess the robustness of the findings.

# I. INTRODUCTION

Banking and non-banking finance companies (NBFCs) actively contribute to the economy by providing financial services to individuals, businesses, and governments. They mobilize savings from individuals and entities and channel them into productive activities such as lending to businesses and individuals. They create credit by providing loans and advances to businesses and individuals, which helps to stimulate economic growth and development. They facilitate payment services such as accepting deposits, issuing checks, and providing electronic payment options, which facilitates transactions and increases the velocity of money in the economy. NFBCs also manage risk by providing various financial products, such as insurance, that can protect against losses due to unforeseen events. Banking and non-banking finance companies also play an important role in promoting financial inclusion by providing financial services to individuals and businesses that may not have access to traditional banking services. Overall, these institutions are critical to the functioning of the economy and provide essential financial services that help to promote economic growth and development, allocate resources more efficiently, and manage risk.

Similarly, NBFCs also play an important role in the economy by providing credit to borrowers who may not be able to obtain loans from traditional banks. NBFCs also enable borrowers to diversify the financial system and provide competition to banks. If NBFCs are not healthy, they may not be able to provide credit, which can lead to a slowdown in economic activity.

Moreover, a decline in the health of banks and NBFCs can have wider implications for the overall financial system. It can lead to a decrease in investor confidence, cause systemic risks, and potentially trigger a financial crisis. Therefore, it is essential to monitor the health of banks and NBFCs to ensure financial stability and promote sustainable economic growth.

An interruption in banking services can also have wider implications for the economy. It can cause a loss of investor confidence that can lead to a decrease in the value of financial assets and trigger a financial crisis. Moreover, a prolonged interruption in banking services can impact the smooth functioning of the payment and settlement systems, leading to systemic risks in the financial system.

For individuals, an interruption in banking services can mean that they are unable to access their funds or make transactions, including paying bills and making purchases.

This can cause inconvenience and financial difficulties for individuals who rely on banking services for their daily financial activities.

For businesses, an interruption in banking services can result in a loss of revenue and potential cash flow problems. If businesses are unable to access credit or make transactions, they may have difficulty paying their suppliers and employees that can ultimately lead to a decline in economic activity.

Therefore, it is crucial for banks and NBFCs to maintain uninterrupted services to ensure financial stability and promote sustainable economic growth. In addition, it is important to ensure that banks as well as non-bank finance companies are well-regulated and supervised. This will further protect depositors' savings and ensure the smooth functioning of the financial system.

The recent failures of Silicon Valley Bank, Signature Bank, Republic Bank, and Credit Suisse have drawn attention to the financial stability of financial institutions. These institutions play a crucial role in economic growth by connecting the savings and investment sectors. Therefore, it is imperative that regulators possess the necessary tools to minimize the risk of another financial crisis without negatively impacting the banks' profitability and cost efficiency. Banks and NBFCs must balance their private interests with their public responsibilities to fulfill their dual role in the economy. While profitability is important, they must also ensure that they operate in a socially responsible manner, manage their risks effectively, and adhere to legal and regulatory requirements to maintain the public's trust and confidence (Malhotra, Opella, & Poteau, 2015).

This study illustrates the use of machine learning techniques of logistics regression, gradient booster classifier, and K-Nearest Neighbors (kNN) algorithm to evaluate the credit outlook of banking and non-banking finance companies. These techniques were used to develop a model that could predict the probability of a finance company's pending troubles if they have a negative credit outlook. The model was trained on a dataset of historical data on finance companies and was able to accurately predict the financial outlook for a company.

By leveraging these machine learning techniques, the model can identify early warning signs of potential financial troubles for a banking and NBFC, allowing for proactive measures to be taken to minimize risk and prevent a financial crisis. The accuracy of the model in predicting the financial outlook of a company can also enable regulators to make more informed decisions while managing financial stability in the sector. Overall, the use of machine learning techniques in evaluating the credit outlook of financial institutions can provide valuable insights into their financial health and support efforts to maintain the stability of the financial system.

This study is important for several reasons. The study compares the use of three methodologies, logistics regression, gradient booster classifier, and K-Nearest Neighbors (kNN) algorithm, to inform the institutions of potential problem so that they can take corrective action to prevent the company from going down under. This is a valuable tool for institutions as well as regulators, as they can identify potential problems before they become too serious.

The study will also aid regulators in understanding the role that artificial intelligence can play in evaluating an institution's safety and to alert a bank/non-bank institution that is about to go under so that corrective action can be taken even before they fail. This is a valuable tool for regulators and policy makers also, as they can identify potential problems with an institution before they become too serious.

The study will also build investor and depositor confidence in a bank if the bank uses this method as part of their own internal control and risk management system. This is because investors and depositors will be more likely to trust a bank that is using cuttingedge technology to manage its risk.

#### II. LITERATURE REVIEW

Within the realm of bank failures and solvency, there are two main types of studies that offer valuable insights. The first type of study delves into the causes of bank failures and provides strategies to prevent them. This type of study analyzes economic and regulatory factors that contribute to bank failures and aims to identify measures that can minimize these risks. The second type of study, on the other hand, takes a more technology-driven approach by leveraging artificial intelligence techniques to predict bank failures. By identifying and mitigating risks through advanced analytics, this type of study can help prevent financial crises before they occur. Both types of studies are essential for gaining a comprehensive understanding of the risks that banks face and developing effective strategies to manage these risks. By combining these approaches, regulators and financial institutions can work together to maintain a stable and resilient financial system.

Gupta (2022) evaluated four machine learning models (logit, decision tree, random forest, 2-class support vector machine) for predicting default among Indian companies under the Insolvency and Bankruptcy Code, comparing them with solvent companies. The study highlighted the importance of factors like company size, age, market ratios, and ownership in predicting defaults, with an accuracy of over 75%. Aranha and Bolar (2023) study compared the effectiveness of Machine Learning Techniques and Logistic Regression in predicting firm bankruptcies. It concluded that Machine Learning outperforms Logistic Regression. Additionally, it demonstrated that incorporating a proxy for uncertainty, such as the COVID-19 pandemic's impact on operating expenses, enhances the accuracy of bankruptcy prediction. Hyeongjun, Choo, and Doojin (2022) study evaluated two recurrent neural network (RNN) methods (simple RNN and LSTM) and three benchmark methods (logistic regression, random forest, support vector machine) for predicting corporate bankruptcy. RNN and LSTM outperformed other methods, with better forecasting performance. Cowden, Fabozzi, and Nazemi (2019) evaluated the effectiveness of machine learning classification techniques, including support vector machine, random forest, boosting, and classification tree, in comparison to traditional statistical methods for commercial real estate loan default prediction. They showed that support vector machine outperforms other methods and maintains stable performance with imbalanced datasets. Additionally, the boosting technique highlights the importance of the capitalization rate spread ratio in predicting defaults for commercial real estate loans. Ekinci and Erdal (2017)'s study focused on predicting bankruptcy in financial institutions, particularly banks, a matter of significant interest to stakeholders. It combined three machine learning

models with ensemble methods, showcasing the superiority of hybrid ensemble models in accurately predicting bank failures, making them a reliable tool in this domain. Shrivastava, Jeyanthi, and Singh (2020)'s aimed to develop an effective early warning system for predicting bank failures in India using a machine learning approach. Addressing the issue of imbalanced data, it employs Synthetic Minority Oversampling Technique (SMOTE) to balance the dataset. Lasso regression helps select crucial features, and random forest and AdaBoost are applied to build predictive models, compared with logistic regression. The study argues that it will benefit stakeholders like shareholders, lenders, and borrowers by assessing financial stress in banks. Malhotra, Nydick, and Malhotra (2017) illustrated the use of support vector machines to evaluate the financial health of a bank. Cole and White (2012)'s provided valuable insights into the causes of commercial bank failures that took place during the financial crisis of 2008-2009. Their study demonstrated that traditional measures for the CAMELS components, which refer to the Capital adequacy, Asset quality, Management quality, Earnings, Liquidity, and Sensitivity to market risk, were effective in explaining why certain banks failed during this time period. Additionally, the study found that indicators related to commercial real estate investments were also instrumental in predicting bank closures during 2009.

Cebula's (2010) research delved into the impact of key legislation on bank failures in the United States. The study revealed that the Federal Deposit Insurance Corporation Improvement Act (FDICIA), the Riegle-Neal Interstate Banking and Branching Efficiency Act (RNIBA), and the Community Reinvestment Act (CRA) had a significant effect on the number of bank failures in the US. FDICIA, passed in 1991, mandated banks to hold more

capital, enhancing their stability. RNIBA, passed in 1994, allowed banks to expand into new markets, which led to increased competition and lower profits. CRA, passed in 1977, required banks to provide loans to low- and moderate-income borrowers, which increased the risk of default. According to Cebula's study, FDICIA and RNIBA were instrumental in reducing the number of bank failures, while CRA had an adverse effect on bank stability.

Huang, Chang, and Liu (2012) discovered a strong association between two factors, equity-to-assets (ETA) and interest income - interest expense/income (NIN), and lower risk of financial distress for banks in the ASEAN and EU regions. The study suggests that banks in these regions can reduce their risk of financial distress by increasing their ETA and NIN, which can be accomplished by raising more capital from shareholders or increasing their profitability through lending activities.

Samad (2012)' study identified several credit risk variables as significant predictors of bank failures in the United States. These variables include credit loss provision to net charge off, loan loss allowance to non-current loans, and non-current loans to loans. The study observed that these factors correctly predicted between 76.8% to 77.25% of total observations and 80.17% of the 121 failures in the model. Based on these findings, the study suggests that banks should carefully monitor these credit risk variables to reduce their risk of failure. Additionally, banks should consider implementing strategies aimed at improving their credit risk management practices.

Calabrese and Giudici (2015) developed a model for predicting bank failures that considers both macroeconomic and bank-specific microeconomic factors. They discovered that while regulatory capital and microeconomic factors are significant in explaining actual

failures, macroeconomic factors are only relevant when failures are defined in terms of both actual defaults and mergers and acquisitions. Their study found that their model, which utilizes extreme value theory, provides better predictive accuracy compared to classical logistic regression models. Furthermore, the authors' findings indicate that extreme value theory-based models are more effective than classical logistic regression models for predicting bank failures.

Erdal and Ekinci (2013) compared the effectiveness of several artificial intelligence techniques in predicting bank failures, including support vector machines (SVMs), radial basis function neural networks (RBF-NN), and multilayer perceptrons (MLPs). The researchers also employed principal component analysis (PCA) to examine the explanatory variables. The study's results indicate that PCA did not improve the predictive power of the models. Both SVMs and RBF-NN exhibited comparable levels of predictive power, with SVMs yielding the highest total predictive power. MLPs, on the other hand, performed poorly compared to SVMs and RBF-NN. Ozcan and Ozcan's (2007) study demonstrated the potential of artificial neural networks in identifying bank failures in Turkish banks.

Kim and Kang (2010) demonstrated the effectiveness of ensemble methodology in enhancing the predictive performance of neural networks for bankruptcy failure prediction in Korean firms. Charalambous et al. (2000) compared the performance of several models, including learning vector quantization, radial basis function, feedforward network, logistic regression, and the backpropagation algorithm, in predicting bankruptcy of U.S. firms. The study revealed that neural networks provided better prediction accuracy than the other models. Fadlalla and Chien Hua (2001)'s study provided an overview of the diverse

applications of neural networks in making financial decisions. The categories of applications covered in the study include bankruptcy prediction (Altman, Marco, and Varetto 1994; Coleman, Graettinger, and Lawrence 1991; Klemic 1993; Odom and Sharda 1990; Raghupathi, Schkade, and Raju 1991; Rahimian et al. 1993; Salchenberger, Cinar, and Lash 1992; Tam 1991; Tarn and Kiang 1992; Wilson and Sharda 1994), stock-market forecasting (Ahmadi 1990; Baba et al. 1993; Barker 1990; Barr and Mani 1994; Bergerson and Wunsch 1991; Berry and Trigueiros 1993; Bosarge 1991; Cheng, Wagner, and Lin 1996; Chenoweth and Obradovic 1995; Chiang, Urban, and Baldridge 1996; Chuah 1992; Collard 1993; Ganesh 1994; Kamijo and Tanigawa 1990; Kimoto and Asakawa 1990; Kryzanowski, Galler, and Wright 1993; March 1995; Quah, Tan, and Heng 1993; Refenes 1993; White 1988; Yoon and Swales 1991), credit analysis (Marose 1990; Reilly et al. 1991; Roy and Cosset 1994; Van Eyen and Cronjie 1994), underwriting analysis (Marose 1990; Reilly et al. 1991; Roy and Cosset 1994; Van Eyen and Cronjie 1994), and business-cycle recognition (Vishwakarma 1994).

This study extends previous studies by illustrating the use of three machine learning models to evaluate the credit outlook of banking and non-banking finance companies.

#### III. MODEL STRUCTURE

#### A. Logistics Regression Model

Logistic regression is a statistical and machine learning technique used for predicting the probability of a binary or categorical outcome. In the case of classifying banks and NBFCs into negative, neutral, and positive credit outlook, the outcome is a categorical variable with three possible values.

The logistic regression model can be estimated using the maximum likelihood method. The maximum likelihood method is a statistical method that estimates the parameters of a model by maximizing the likelihood of the data. The logistic regression model can be used to make predictions about the probability of a binary outcome for new data. The model will return a probability for each output class. Logistic regression is a powerful tool for predicting binary outcomes. It is a relatively simple model to understand and implement, and it can be used to predict a wide variety of outcomes. In our study, we are using logistic regression to differentiate between negative, neutral, and positive credit outlook. We train the logistics regression model based on five variables to categorize banks and NBFCs into negative, neutral, and positive credit outlook. We will then use this data to fit a logistic regression model. The model will then be able to predict the probability that a bank and NBFCs would have a negative, neutral, or positive credit outlook. Logistic regression is a statistical model that predicts the probability of a binary outcome (e.g., credit outlook as positive, neutral, or negative) based on a set of predictor variables. The model is named after the logistic function, which is a mathematical function that maps the input to the output.

## B. The k-Nearest Neighbor (kNN) Model

The k-Nearest Neighbors (kNN) is a non-parametric machine learning algorithm used for classification and regression tasks. It is a type of instance-based learning where the model is trained on the entire dataset without any explicit assumptions of the underlying distribution of the data. In kNN, the classification of a new data point is

determined by finding the k-nearest neighbors (i.e., the k data points closest in distance to the new point) in the training set, and then assigning the class label of the majority of those neighbors to the new data point. The distance between two data points is typically measured using Euclidean distance, although other distance metrics can also be used. The value of k is a hyperparameter that should be tuned based on the data and the problem at hand. A smaller value of k can lead to overfitting, while a larger value can lead to underfitting. Therefore, the choice of k is an important aspect of the algorithm that should be carefully considered. kNN is a simple and interpretable algorithm that can work well for low-dimensional datasets, but it can become computationally expensive and less effective in high-dimensional spaces.

#### C. Gradient Boosting Model

Gradient boosting is a machine learning technique used in regression and classification tasks, among others. It gives a prediction model in the form of an ensemble of weak prediction models, which are typically decision trees. When a decision tree is the weak learner, the resulting algorithm is called gradient-boosted trees; it usually outperforms random forest. A gradient-boosted trees model is built in a stage-wise fashion as in other boosting methods, but it generalizes the other methods by allowing optimization of an arbitrary differentiable loss function.

Gradient tree boosting implementations often also use regularization by limiting the minimum number of observations in trees' terminal nodes. It is used in the tree building process by ignoring any splits that lead to nodes containing fewer than this number of training set instances. Imposing this limit reduces variance in predictions at leaves.

The gradient boosting approach is based on the idea that a strong prediction model can be built by combining several weak prediction models. The weak prediction models are typically decision trees that are simple but effective models. The gradient boosting approach works by iteratively building a series of decision trees, each of which is designed to correct the errors made by the previous trees. The final prediction is made by combining the predictions of all the trees.

Gradient boosting is a powerful machine learning technique that has been shown to be effective in a variety of tasks. It is often used in areas such as fraud detection, spam filtering, and medical diagnosis.

#### D. Cross-Validation

To cross-validate the robustness of our models, we examine ten different random cross-sections of the data. In most predictive analysis research, a simple cross- validation scheme that uses a training sample and a test sample is typically utilized. The classification error rate on the test set is then reported as the estimate of the classifier's true error rate. The main problem with this single training and test partition is that the partition may be uncharacteristic of the true underlying population. Multiple partitions of training and test samples are one way to ameliorate this problem. In this study, we used ten different random cross-sections of the data to validate our results. We also validate our results using repeat cross-validation models and leave one out models. In addition, we use stratified kfolds to address any data imbalance problem.

#### IV. DATA AND METHODOLOGY
The data utilized in this research is sourced from the "Corporate Credit Outlook," a publication issued by Schonfeld & Associates, Inc. The "Corporate Credit Outlook" forms an integral part of a comprehensive series of financial baseline forecasts. These forecasts categorize companies into ten major industry sectors as delineated by the Global Industry Classification System (GICS) code. Our study specifically centers its attention on companies classified under the GICS category and code denoted as "Financials" (401010 – 404030). Within the "Corporate Credit Outlook," companies are organized into distinct industry sectors, a classification based on the primary business activities of their parent companies. Corporate Credit Outlook is based on z-score. The Z Score serves as an index of corporate creditworthiness, derived from Altman's multiple discriminant analysis of financial ratio data. It is employed as a predictive tool for assessing the likelihood of bankruptcy, thereby representing the prospective creditworthiness of a given firm. Notably, a higher Z Score value corresponds to a stronger financial position for the firm. Conversely, negative Z Score values are particularly indicative of companies facing imminent credit challenges, potentially culminating in future financial difficulties.

The Z Score functions as a pivotal gauge of creditworthiness, specifically an indicator of the probability of bankruptcy. To predict the credit outlook of financial institutions and explore alternative quantitative models that can aid both management and regulators, we created a pooled data set for banking and NBFCs based on an outlook using z-score. The resulting data set comprised 834 observations. The finance companies that include banks and non-bank finance companies were categorized into three major groups with a rank of 1 being the most negative outlook to a rank of 3 being the safest outlook.

Rank of 2 carries neutral credit outlook. The data sample consists of 833 commercial banks, insurance companies, consumer finance, and capital market companies as classified by GIC classification system. The study evaluated five variables, namely, liquidity ratio, capital productivity, return on asset, interest coverage ratio, cash generation ratio, and capital adequacy, to assess the credit outlook of these companies. These metrics provide valuable insights into a company's ability to meet its obligations, generate profits, utilize capital effectively, generate cash flow, and maintain financial stability. Liquidity ratios, return on assets, capital productivity ratio, cash generation rate, and capital adequacy ratio are all useful financial metrics that can be used to evaluate the financial health of both banking and non-banking finance companies.

Liquidity ratios measure a company's ability to meet its short-term obligations using its current assets. For banking and non-banking finance companies, liquidity is particularly important because they rely heavily on short-term funding sources to provide loans and other financial services. Therefore, a high liquidity ratio indicates that the company has sufficient cash and cash equivalents to cover its current liabilities, which is an important factor in maintaining a stable financial position.

Return on assets (ROA) evaluates a company's efficiency in using its assets to generate profits. For banking and non-banking finance companies, ROA is an important metric because it indicates how effectively the company is using its resources to generate income. A high ROA indicates that the company is generating strong profits relative to its asset base, which is a positive sign of financial health.

Capital productivity ratio measures the efficiency of a company's use of capital to generate revenue. For banking and non-banking finance companies, capital is a critical resource, and how well they utilize this resource can make a big difference in their profitability. Therefore, the capital productivity ratio can be a useful tool to assess whether a company is using its capital effectively or not.

The cash generation rate is the amount of cash that a company generates from its operations over a given period. For banking and non-banking finance companies, cash generation is particularly important because it indicates the company's ability to generate cash flow from its core business activities. A high cash generation rate suggests that the company is generating strong cash flow from its operations, which can be used to fund growth, pay dividends, or reduce debt.

Capital adequacy ratio delves into a company's ability to meet its financial obligations using its capital. For banking and non-banking finance companies, capital adequacy is a critical metric because it is a key determinant of their ability to withstand financial shocks. A high capital adequacy ratio indicates that the company has sufficient capital to absorb potential losses and remain financially stable, an important factor in assessing its financial health.

The use of liquidity ratios, return on assets, capital productivity ratio, cash generation rate, and capital adequacy ratio can help investors and analysts assess the financial health of banking and non-banking finance companies.

Table 1 provides a summary statistic of the variables used in this study to differentiate between negative, neutral, and positive credit outlook banking and non-bank finance companies.

#### <Insert Table 1 about here>

Table 1 shows that negative credit outlook companies have a lower average liquidity ratio than neutral and positive outlook companies. However, there is no statistically significant difference in the liquidity ratio between negative and neutral outlook companies. Positive credit outlook companies have a statistically significantly higher liquidity ratio than both negative and neutral outlook companies. Negative outlook companies also have a lower capital productivity ratio than neutral and positive outlook companies, and this difference is statistically significant. Similarly, positive credit outlook companies have a statistically significantly higher return on assets than negative and neutral outlook companies. Although the return on assets for negative outlook companies is lower than that of neutral outlook companies, the difference is not statistically significant. On average, positive outlook companies generate more excess cash than negative and neutral outlook companies, but the difference is not statistically significant. Although neutral outlook companies generate more excess cash than negative outlook companies, the difference is not statistically significant. Negative outlook companies have the lowest average capital adequacy ratio relative to neutral and positive outlook companies, and the difference is statistically significant. A higher capital adequacy ratio indicates a better credit outlook.

#### V. EMPIRICAL RESULTS

#### A. Design of the Experiment

Our sample includes 833 banking and non-banking companies for our dataset, partitioned into two segments: a training sample of 558 observations to design the model and a test sample of 275 observations to validate the model's performance. While there are no clear guidelines in the literature for dividing the sample into training and test groups, some researchers recommend an 80-20 split between the analysis and holdout samples, while others prefer a 75-25 split. Therefore, we chose to partition our dataset into a training set comprising 558 (67%) observations and a predict/test set containing 275 (33%) observations using a stratified train/test split that maintains the ratio of all three classes.

#### B. Empirical Results and Analysis

Table 2 summarizes the results of logistics regression, gradient boosting approach, and kNN models in predicting the credit outlook of banking and non-banking finance companies.

#### <Insert Table 2 about here>

The results of the study show that all three machine learning models were able to accurately classify finance companies with a credit outlook of negative, neutral, and positive. The logistic regression model achieved an accuracy of 86.74%, the kNN classifier approach achieved an accuracy of 89.8%, and the gradient boosting approach achieved an accuracy of 100%. The holdout sample shows that the logistic regression model achieved an average accuracy of 80.7%, the kNN classifier approach achieved an average accuracy of 80.7%, the kNN classifier approach achieved an average accuracy of 80.7%, the kNN classifier approach achieved an average accuracy of 90.18%.

These results suggest that all three machine learning models are effective in classifying finance companies with a credit outlook of negative, neutral, and positive. However, the gradient boosting approach appears to be the most accurate model, followed by the kNN classifier approach and the logistic regression model.

The results of this study have several implications for the financial industry. First, they suggest that machine learning models can be used to accurately classify finance companies with a credit outlook of negative, neutral, and positive. This information can be used by financial institutions, investors, depositors, and regulators to make more informed decisions about a finance company. Second, the results suggest that the gradient boosting approach is the most accurate machine learning model for classifying finance companies with a credit outlook. Thus, the implications are that financial institutions should apply this model to improve their credit risk assessment.

#### Cross-Validation Results

We cross-validate our results by applying three different approaches: k-fold classification methodology (10 folds), repeat cross-validation approach (10X2), and leave one out approach. We divide our sample into ten different random sub-samples and validate our results on classifying bank and non-banking finance companies into negative, neutral, and positive credit outlook categories. Table 3 summarizes the results of the logistics regression, kNN, and gradient booster classifier models.

#### <Insert Table 3 about here>

With k-fold classification methodology, kNN model provided the best accuracy of 84.8%, followed by logistics regression with an average accuracy of 82.1%, and gradient boosting approach with an average accuracy of 80.1%.

*Logistics Regression Model versus Gradient Boost Classifier versus kNN Algorithm* We performed paired t-tests on the average classification accuracy of three algorithms, namely Logistics Regression Model, Gradient Boost Classifier, and kNN Algorithm. The results for the cross-validation model, repeat cross-validation model, and leave one out classification model are presented in Table 4.

#### <Insert Table 4 about here>

As illustrated in table 4, there is no statistically significant difference in the average predictive performance of the Logistics Regression Model, Gradient Boost Classifier, and kNN Algorithms using the cross-validation model. However, the repeat cross-validation model outperforms the other models in terms of predictive performance. The Gradient Boost Classifier and kNN Algorithm models beat the Logistics Regression Model in forecasting the credit outlook of banking and non-banking finance organizations, as presented in table 4. Furthermore, the leave one out model shows a statistically significant difference in predictive performance between these models. The Gradient Boost Classifier and kNN Algorithm models outperform the Logistics Regression Model in differentiating between negative, neutral, and positive credit outlooks.

In addition, table 4 demonstrates a comparison between the predictive abilities of the gradient boost classifier and the kNN algorithm in distinguishing between negative, neutral, and positive credit outlook. The results indicate a statistically significant difference

in performance between the two methods only when cross-validation is conducted using the leave-one-out model.

#### VI. SUMMARY AND CONCLUSIONS

Banking and non-banking financial company sectors play a critical role in the financial system of any country. Given that the stability of the financial system is highly dependent on the performance of these institutions, analyzing the credit outlook of banking and NBFCs is of utmost importance for several reasons. If they fail or experience financial distress, it can have serious consequences for the entire economy. Therefore, it is important to identify potential credit risks and take necessary measures to mitigate them.

Secondly, investors and creditors rely heavily on the credit ratings of these institutions to make investment decisions. Accurate credit rating assessments can enable investors to make informed decisions thatin turn can promote a healthy and stable financial system.

Thirdly, regulators also closely monitor the credit outlook of banking and NBFCs to ensure that they comply with regulations and maintain a safe and sound financial system. This study illustrated the use of three machine learning models-logistics regression, gradient boost, and kNN algorithm-aimed to predict the credit outlook of banking and nonbanking finance companies. Additionally, to eliminate potential bias in the training set and examine the robustness of the results, the study cross-validated the findings using ten different data samples.

The study's findings indicated that all three machine learning models-logistics regression, gradient boost classifiers, and kNN algorithms-are suitable for classifying bank and non-bank finance companies into three categories based on their credit outlook:

negative, neutral, and positive. However, the gradient boosting approach was the most precise model, followed by the kNN classifier and the logistic regression model.

The implications of this study are significant for the financial industry. Firstly, machine learning models can accurately classify finance companies according to their credit outlook. This information is valuable for financial institutions, investors, depositors, and regulators, enabling them to make more informed decisions about a finance company. Secondly, the results indicate that the gradient boosting approach is the most accurate model for classifying finance companies. Therefore, financial institutions can use the gradient boosting model to enhance their credit risk assessment practices.

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Summary statistics of the variables used in this study to differentiate between negative, neutral, and positive credit outlook for banking and non-banking finance companies.

	Liquidity	Capital Productivity	ROA %	Cash Gen Rate %	Capital Adequacy %					
Full Sample (N = 833)										
Mean	8.86	0.20	1.40	7.26	23.07					
Std. Dev.	12.21	0.43	5.92	43.53	21.60					
Negative	outlook (N	= 573)								
Mean	7.29	0.10	0.35	0.73	11.64					
Std. Dev.	9.40	0.29	3.58	4.52	8.76					
Neutral O	utlook (N =	126)								
Mean	8.30	0.26	0.82	1.51	35.33					
Std. Dev.	9.32	0.25	7.02	16.34	11.67					
Positive Outlook (N = 134)										
Mean	16.05	0.55	6.45	40.60	60.40					
Std. Dev.	23.17	1.21	4.52	19.37	16.48					

Classification of credit outlook of banking and non-banking finance companies using logistics regression, gradient boost classifier, and kNN algorithm models.

Model	Stratified-Train-Test-Split- Training Accuracy 558/275	Stratified-Train-Test- Split-Testing Accuracy
Logistics Regression	86.74	80.7
Gradient Boost Classifier	100	90.18
kNN (n=7)	89.78	88.73

Cross-validation results on the predictive performance of logistics regression, gradient boost model, and kNN algorithm models.

Model	Cross- Validation	Repeated Stratified 10 X2	Leave- One-Out-
	(CV=10) Mean	Mean	Mean
Logistics	82.12	84.7	84.51
Regression			
Gradient	80.08	88.8	88.95
Boost			
Classifier			
kNN (n=7)	84.77	87.5	87.03

Pairwise comparison between predictive performance of logistics regression, gradient boost classifier, and kNN algorithm models.

Model 1	Model 2	T-stats-	p-value	T-stats-	p-	T-stats-	p-
		Cross		repeat	value	leave	value
		Validation		cross		one out	
				validation			
Logistics	Gradient	0.62	0.55	-4.00***	0.00	-3.70***	0.00
Regression	Boost						
	kNN	-2.07*	0.07	-3.41**	0.00	-2.21**	0.03
Gradient	Logistics	0.62	0.55	-4.00***	0.00	-3.70***	0.00
Boost	Regression						
	kNN	-1.35	0.21	1.17	0.26	2.02*	0.04
kNN	Gradient	-1.35	0.21	1.17	0.26	2.02**	0.04
Algorithm	Boost						
	Logistics	-2.07*	0.07	-3.41***	0.00	-2.21**	0.03
	Regression						

\*\*\*statistically significant at 1% significance level; \*\*statistically significant at 5% significance, \*statistically significant at 10% significance.

### EXAMINING THE IMPACTS OF ANALYTICS HUMAN CAPITAL ON FIRM PERFORMANCE

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## ABSTRACT

A review of Business analytics literature revealed a lack of research on the effects of Analytics human capital on firm performance. In this study, we draw upon the theoretical perspectives of Resource-based view and Dynamic capabilities to examine the impacts of Analytics-skilled human capital (HC) in relation to firm performance and identify related mediating firm capabilities. Several prior studies have found that managerial skills may have a stronger impact on strategic change capabilities, while employee skills affect productive efficiency capabilities. Based on the review of the relevant literature, we classify analytics HC into managerial and employee analytics HC. Further, we propose that both these types of human capital may impact different mediating capabilities. The study investigates the key role of analytics HC in improving firm performance. The examination of the firm capabilities: strategic-change capability also contributes to research on dynamic capabilities. This study is one of the early studies to examine the capabilities that mediate the impacts of analytics human capital on firm performance in the context of Business analytics.

<u>KEYWORDS</u>: Business analytics, Analytics skills, Human capital, Resource-based view, Dynamic capabilities

### SIMPLE AND EFFECTIVE RECOMMENDATIONS USING IMPLICIT FEEDBACK-AWARE FACTORIZATION MACHINES

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### ABSTRACT

Recommendation systems are crucial in facilitating personalized contents and product recommendations for users. Implicit feedback-aware recommendation systems have gained prominence, leveraging implicit user actions, such as views and purchases, and generating negative samples. Factorization machines (FMs) are a commonly used approach in recommendation systems, utilizing implicit feedback by capturing both linear and nonlinear interactions between features. FM-based recommendation, furthermore incorporating neural networks to address higher-order interactions, suffers from the inherent model complexity caused by the numbers of users and items, let alone the difficulty of setting appropriate negative samples.

To overcome the model-complexity issue, using the embeddings of features, we seek for effective but simple recommendation models, FM-based and implicit feedback-aware. For that, we compare the effect and performance of several feature embeddings in the FM-based recommendations under several negative-sample generations. We show not only empirical performance in real-life data sets but also theoretical discussions in model complexity, providing practical guidelines for feature embeddings and negative-sample generations in the FM-based recommendations.

## Introduction

The rapid growth of the internet and online platforms has led to the development of various recommendation systems, particularly, in e-commerce domains such as movies and music. These systems aim to assist users in choosing the most suitable item from a list of numerous items. Personalized recommendation systems play a crucial role in this context, as they strive to understand and reflect each user's unique preferences and characteristics. In recommendation systems, two main types of information are available with respect to users' action: explicit feedback and implicit feedback. Explicit feedback refers to user-action data in which users directly express their preferences. Exemplary explicit-feedback actions are giving ratings, subscribing to services, providing reviews, and even blocking a list of items. These explicit actions are valuable because they clearly indicate a user's preference for a product, making them useful for personalized recommendations. However, obtaining explicit feedback can be challenging and costly as a relatively small number of users provide ratings or reviews, causing explicit action data to be quite sparse. On the other hand, implicit-feedback actions are relatively easy to obtain, as a user implicitly expresses `no-selection'

action for items other than the item directly selected by the user. Indeed, numerous studies in recommendation models aim to utilize implicit feedback, for example, by predicting click-through rates.

One of the most widely used models in implicit feedback-aware recommendation is factorization machines(FMs) which is proposed by Rendel et al[7]. Generally, FMs capture linear and second order relationships between item features. Including interactions between the item features, FMs flexibly expresses both the feature vector and the in-between interaction vector into a low dimensional space.

FMs are generalized models capable of handling side information that traditional matrix factorization[5] methods may struggle with.

Furthermore, to include higher-order interactions, `neural network'-equipped FM models have emerged, known as DeepFM[2], while incorporating implicit feedback in the recommendation.

However, there are several problems in implicit feedback-aware recommendation structures. One is that FMs inherently require high-dimensional inputs, especially in the case where there are many users and items, leading to the issue of high model-complexity and computation time. The other is that FMs should adopt a reasonable strategy of negative sampling to handle implicit feedback.

In this research, we aim to propose a simple and effective FM that handles implicit feedback in recommendation tasks. We alleviate the complexity of FM-based model and the computation time by reducing input-data dimensions, instead of naively feeding original inputs into the model. In specific, we utilize predefined user-item embeddings obtained by singular value decomposition, showing its characteristics and performance in several reallife data sets. To the best of our knowledge, there is no prior research investigating the impact of such embeddings on the FM model to address its inherent complexity. More than that, to balance positive samples and negative samples during the model training, we show a strategy of negative sampling derived from user-item frequency and relevance.

# Preliminaries & Related work

In this section, briefly, we introduce three preliminary concepts, connecting them with the indetail proposal of our proposed model in the section.

# Singular Value Decomposition

Singular value decomposition (SVD) is a factorization of real or complex matrix. More specifically,  $m \times n$  matrix *S*, can be decomposed into

$$S \approx U \Sigma V^T \tag{1}$$

where  $\Sigma$  of  $k \times k$  is diagonal matrix with k singular values and U of size  $m \times k$  and V of  $n \times k$  consist of k eigenvectors of  $SS^T$  and  $S^TS$ , respectively. The number of singular values,  $k \leq \min(m, n)$ , is the dimension of hidden embedding, extracted from explicit dimension m or n, as a parameter of SVD.

# **Factorization Machine**

Rendle [7] have shown that polynomial mapping can often effectively capture the information of feature conjunctions. Also, they show that using a linear model with an explicit form of degree-2 significantly reduces training cost compared to using kernel method. The main idea is to factorize the feature interaction into a low dimension and express it effectively in the latent space. Given input  $\boldsymbol{x} = [x_1, ..., x_p]^T$ , the model inference equation of  $\hat{y}$  for ground-truth rating y is defined as,

$$\hat{y}(\vec{x}) = w_0 + \sum_{i=1}^{D} w_i x_i + \sum_{i=1}^{D} \sum_{j=i+1}^{D} < v_i, v_j > x_i x_j$$
(2)

where  $w_i$  is a linear coefficient and  $v_i$  is a latent representation for input feature  $x_i$ . We will continue the discussion with hidden representations v and the details of input vector x in relation to a recommendation system.

## **Deep Factorization Machine**

To address the intricate nonlinear interactions among features, Guo et al [2], proposed a deep factorization machine, known as DeepFM, incorporating deep neural network with the original factorization machine.

For input  $\mathbf{x} = [x_1, ..., x_p]^T$ , in which  $x_i$ , i = 1, ..., p is either a categorical variable or a continuous variable, we extract a *q*-dimensional embedding,  $e_i$ , for each  $x_i$ , and construct a concatenated embeddings for all  $e_i$ ,

$$e_i = Embedding_i(x_i) \tag{3}$$

$$a^{(0)} = [e_1, e_2 \dots e_p]$$
(4)

Conventionally in recommendation systems, the first two variables,  $x_1$  and  $x_2$ , are reserved for users and items. We also notice that the embedding depends on the feature variable  $x_i$ : for example, if  $x_1$  is a user index among total M users, the embedding can be constructed by a layer with  $M \times q$  parameters. Then we have  $a^{(0)}$  go through deep layers, yielding  $y_{DNN}$ , as follows:

$$a^{(l+1)} = \sigma \left( W^{(l)} a^{(l)} + b^{(l)} \right) \approx l = 0, \cdots, H - 1$$
(5)

$$y_{DNN} = W^{(H+1)}a^H + b^{(H+1)}$$
(6)

where  $\sigma(\cdot)$  is the logistic sigmoid and H is the number of hidden layers. It's important to note that both the deep neural network and the factorization machine share the same embedding. Combining these embeddings in the subsequent FM and DNN layers,

$$y_{FM} = f_{FM}([x; a^{(0)}])$$
(7)

The procedure of DeepFM unfolds as follows:

$$y^{(out)} = \sigma(y_{FM} + y_{DNN}) \tag{8}$$

#### **The Proposed SVD-FM Model**

In the FM-based models, every feature must pass through the embedding network. However, dealing with real-life recommendations involving many users and items in the input data, the FM-based models suffer from high model complexity. The embedding layers for the user and item fields in the models become excessively large, incurring computational instability in training the models and possible reduction of recommendation accuracy. To address these issues, in the FM-based models we propose a dimensionality-reduction strategy of using classical but mathematical SVD instead of training separate user and item embedding networks.



Figure 1: Our Proposed Model applied to DeepFM

**Figure 1** shows the flow of the proposed SVD-FM recommendation model. We initially decompose the user-item matrix denoted as *S* of size  $M \times I$  (representing each user's action history, e.g., click or watched movie history) into the form  $U \Sigma V^T$  with *k* singular values via SVD: *U* is  $M \times k$ ,  $\Sigma$  is  $k \times k$ , and *U* is  $I \times k$ . The SVD operation is in time complexity  $O(\min\{M, I\}^2 k)$ . It means that each user or item is represented by an embedding vector of size k : the *i*'th row of *U*, denoted by  $U_{\{i,:\}}$ , is an embedding for user *i*, and the *j*'th row of *V*, denoted by  $U_{\{j,:\}}$  is embedding for item *j*. Consequently, using embeddings for user *i* and item *j* as  $e_u = U_{\{i,:\}}$  and  $e_i = V_{i,:}$ , respectively, we write the concatenated embedding as follows:

$$a_{ij}^{(0)} = concat [U_{i,:}, V_{j,:}, C_{ij}]$$
(9)

Where  $C_{ij}$  means a concatenation of  $e_1, e_2 \dots e_p$  for additional contextual information corresponding to user *i* and item *j*. Considering *M* users and *I* items and aiming to embed user and item embed user and item information into a *k*-dimensional latent space, the original embedding network would necessitate  $M \times k$  parameters for users and  $I \times k$  parameters for items. However, by substituting user and item information with k dimensional continuous variables,  $e_u$  and  $e_i$ , we reduce the number of parameters required for the embedding network by (M + I)(k).

## **Negative Sampling**

As there are only positive label in implicit feedback situation, to train the recommendation model with the balance, FM-based models require a negative sampling technique. However, naïve uniform negative sampling, which just randomly chooses non-seen samples as negative sample, does not consider item information.

## **Frequency-Based Negative Sampling**

We aim to show the effectiveness of the proposed SVD-FM model under a few negativesampling strategies.

To create more reliable negative samples, we propose frequency based negative sampling method. We explain the main idea in terms of users and items, respectively. The main idea is that, in terms of users, if certain user has taken many items and actions, the item for which the user has not taken an action is highly likely to be a real-negative. Also, in terms of items, the more the item is exposed to many users, the higher the probability that it will be a real-negative value, not a missing value if a user does not take an action on the item.

In specific, for user *i* and item *j* in the interaction data *S*, we define the frequency-score, *F*, using normalized user-frequency  $Uf_i$  and normalized item-frequency  $If_j$  as follows:

$$F_{i,j} = \alpha U f_i \times \beta I f_j \tag{10}$$

$$Uf_{i} = \frac{U_{i}}{\sum_{l=1}^{M} U_{l}}, If_{j} = \frac{I_{j}}{\sum_{l=1}^{I} I_{l}}$$
(11)

where  $U_i$  and  $I_j$  represent the user-*i* frequency and the item-*j* frequency in the interactions, respectively, and  $\alpha$  and  $\beta = 1 - \alpha$  adjust the weights of item-frequency and user-frequency, respectively.

The  $F_{i,j}$  values are calculated for all negative samples for the indices (i, j),  $S_{i,j} = 0$ . The higher the values of  $Uf_i$  and  $If_j$ , the higher the probability that the corresponding negative sample is a real-negative value. Therefore, we normalize  $F_{i,j}$  as the probability for sampling. In the final training dataset resulting from this sampling technique, we include positive and negative samples in the same ratio. The dataset, S', is constructed by using all positive samples and extracting negative samples, as many as the positive samples in S, using  $F_{i,j}$  probability information.

We also compute confidence  $c_n$  as an indicator of how reliable the instance is so that a lower weight may be assigned to negative instances. The confidence is constructed using the frequency-score as follows:

$$c_{i,j} = \frac{F_{i,j}^{\gamma}}{\sum_{i,j} F_{i,j}^{\gamma}}$$
(12)

where  $\gamma$ ,  $0 < \gamma < 1$ , gives a smoothing effect on confidence. The weight is higher for instances with a higher frequency-score, considering them more reliable.

The loss function is formulated as follows:

$$L = \sum_{i,j} c_{i,j} \left( y_{i,j} - \widehat{y_{i,j}^{(out)}} \right)^2$$
(13)

Where  $y_{i,j}$  is a ground-truth in *S*' and  $\widehat{y_{i,j}^{(out)}}$  is the output of FM or DeepFM as shown in (8). Now optimal weight for model can be obtained using techniques such as SGD.

## Experiments

To assess the effectiveness and efficiency of the proposed SVD-FM based model, we first explain the datasets and the experimental settings adopted in the experiments. Then, we show the experimental results.

## Dataset

We conducted experiments using various datasets publicly available. The detailed dataset statistics can be seen in Table 1

Frappe[6] is specifically designed for making recommendations on mobile applications. The original Frappe dataset comprises 957 users and 4,082 apps. To establish a robust training-testing procedure, we restricted our analysis to users with more than 10 rating entries, bringing forth total 565 users and 3,923 apps and 94,716 records.

The Movielens[3] is renowned for its extensive use in recommendation systems, particularly for movie ratings. In our study, we examined the impact of dimensionality on models by employing two versions of the Movielens dataset: Movielens 100k and Movielens 1m. The Movielens 100k dataset comprises 943 users and 1,648 items, while the

Movielens 1m. The Movielens 100k dataset comprises 943 users and 1,648 items, while the Movielens 1m dataset includes 6,000 users and 3,686 items.

The Goodbook dataset [10] is designed for predicting ratings for individuals engaged in reading books. Initially, the dataset included a large number of users. However, for our analysis, we streamlined the data to focus on 11,879 users and 7,539 books.

	Frappe	Movielens-100k	lovielens-100k Movielens-1m	
User Number	565	943	6,040	11,879
Item Number	3,023	1,648	3,686	539
Record Number	90,000	100,000	1,000,000	18,716,672

**Table 1.** User, Item, Record number for various datasets.

# **Experimental Setup**

We explain important settings in the experiments. While our implementation may be slightly slower compared to well-known FM libraries such as libFM[8] for the sake of easiness and convenience, we primarily used PyTorch Lightning [1] as the main codebase. All our experimental results can be reproduced through the publicly available at <u>GitHub</u> <u>URL</u>.

As for negative sampling, we randomly selected 20 percent of each user's unseen movies, setting their ratings as 0. We tested two approaches: a uniform negative sampling (denoted

by UNS and a frequency-based negative sampling approach detailed in section 4.2 (denoted by FNS.

To establish a robust training-testing procedure for implicit feedback, we converted all ratings to 1 if a user had interacted with (watched or purchased) an item. Furthermore, for each user, we employed the initial 70 percent of their history (sorted by timestep if available) for training, reserving the remaining 30 percent as the testing set. To assess an individual's preference for an item, we ranked the output generated by the trained model, which serves as an indication of each user's preference for items. For instance, if the model output for user 1 and item 1 is higher than that for user 1 and item 4, it indicates that user 1 has more preference for item 1 compared to item 4. Our reported metrics include Top@k(which selects top k preferred items for each user among unseen items) precision, DCG(Discounted Cumulative Gain), and hit rate for the given dataset. The following is a brief definition for the adopted metrics:

- **Precision** =  $\frac{\# \text{ of recommended items } @k \text{ that are relevant}}{\# \text{ of recommended items } @k}$   $DCG_K = \sum_{i=1}^{K} \frac{rel_i}{log_2(i+1)}$  where  $rel_i$  is 1 if *i* is in Test set and 0 otherwise.
- Hit Rate : 1 if any of the recommendation is in the test set and 0 otherwise.

As for hyperparameters, we standardized latent size for embedding to 16 across all datasets. Our approach involves utilizing two types of models: Factorization Machines (FM) and DeepFM, featuring a simple neural network with two hidden layers with size 128. The models were optimized over 200 epochs using ReLU as the activation function, dropout with a probability of 0.2, and the ADAM optimizer [4] with a learning rate of 0.001.

# Results

# **Recommendation result on General Dataset**

**Table 2** presents the results of the original FM-based model and our proposed FM-based
 model. It is evident that our proposed method, when applied to FM, does not yield favorable results compared to the original FM-based model. However, an interesting observation is that our proposed method, when applied to DeepFM, outperforms the original models in most evaluation metrics. We can say that non-linear interactions of SVDinduced embeddings were helpful for finding user preferences for items. Moreover, the FNS did not show notifiable result compared to UNS, which needs to be investigated furthermore.

<b>Negative Sampling Method</b>		UNS				FNS			
Datasets	Metric	FM	SVD+FM	DeepFM	SVD+DeepFM	FM	SVD+FM	DeepFM	SVD+DeepFM
Frappe	Precision@5	0.084	0.046	0.086	0.12	0.079	0.045	0.083	<u>0.126</u>
	Hitrate@5	<u>0.331</u>	0.206	0.306	0.329	0.295	0.202	0.302	0.327
	DCG@5	0.253	0.14	0.265	0.357	0.244	0.144	0.26	<u>0.388</u>
	Precision@10	0.057	0.027	0.074	<u>0.125</u>	0.068	0.072	0.072	0.118
	Hitrate@10	0.399	0.216	0.423	<u>0.449</u>	0.420	0.440	0.399	0.437
	DCG@10	0.252	0.136	0.331	<u>0.611</u>	0.314	0.351	0.311	0.551

	Precision@5	0.365	0.169	0.368	<u>0.496</u>	0.374	0.36	0.371	0.496
ML-100k	Hitrate@5	0.803	0.507	0.809	<u>0.904</u>	0.794	0.753	0.811	0.89
	DCG@5	1.116	0.522	1.129	<u>1.532</u>	1.162	1.114	1.138	1.531
	Precision@10	0.374	0.159	0.363	0.487	0.375	0.360	0.371	<u>0.496</u>
	Hitrate@10	0.927	0.692	0.939	<u>0.979</u>	0.795	0.754	0.811	0.890
	DCG@10	1.820	0.787	1.729	<u>2.374</u>	1.162	1.115	1.139	1.531
	Precision@5	0.173	0.075	0.173	<u>0.176</u>	0.171	0.072	0.172	0.172
	Hitrate@5	0.503	0.281	0.488	0.501	0.499	0.274	0.487	0.493
MI 1m	DCG@5	0.524	0.213	0.526	<u>0.531</u>	0.528	0.206	0.524	0.519
ML-1III	Precision@10	0.167	0.176	0.165	<u>0.177</u>	0.170	0.082	0.165	0.171
	Hitrate@10	0.682	0.690	0.680	<u>0.700</u>	0.670	0.472	0.673	0.683
	DCG@10	0.796	0.830	0.782	<u>0.832</u>	0.810	0.359	0.781	0.809
	Precision@5	0.387	0.172	0.39	<u>0.482</u>	0.172	0.186	0.376	0.471
	Hitrate@5	0.812	0.519	0.811	<u>0.879</u>	0.493	0.545	0.789	0.878
Goodbook	DCG@5	1.194	0.51	1.201	<u>1.505</u>	0.519	0.555	1.158	1.472
	Precision@10	0.319	0.169	0.340	<u>0.393</u>	0.299	0.181	0.327	0.384
	Hitrate@10	0.894	0.726	0.909	<u>0.946</u>	0.877	0.726	0.900	0.939
	DCG@10	1.569	0.754	1.676	<u>1.986</u>	1.466	0.888	1.616	1.940

**Table2.** Experimental Results for Various Datasets: the best results are bold-faced and<br/>underlined.

# **Efficiency Comparison**

**Table 3** provides the overview of parameter variations and training times for modelsassessed on datasets with varying numbers of users and items. The training time weremeasured based on 200 epochs for each model.

The findings indicate that for a small number of users or items, the training time remains relatively consistent. However, as the user or item count increases, the application of SVD before training leads to a notable reduction in training time or parameter count. This is because there is no longer a need to train embedding networks separately for users or items.

The results reveal that the application of SVD prior to FM, denoted as SVD+FM, leads to a reduction of approximately 10 percent in training time and more than 90 percent in parameters for both the Movielens 1m and Goodbook datasets. Additionally, the SVD+DeepFM model outperforms the original DeepFM model, demonstrating a decrease in training time—over 10 percent for the Movielens 1m dataset and around 20 percent for the Goodbooks dataset with reducing more than 50percent of parameter number. These findings underscore the efficiency of integrating SVD, especially in scenarios with a substantial number of users or items, resulting in a more compact and lighter training procedure.

Moreover, the superior performance of the SVD+DeepFM model in recommendation, as evidenced in **Table 2**, highlights its efficiency compared to other models. It is reasonable to assume that SVD+DeepFM would prove advantageous in scenarios characterized by a considerable number of users or items.

Model		Frappe	ML-100k	ML-1m	Goodbook
DeenFM	Training Time(s)	205.28	321.706	3082.384	3691.939
Беергм	Parameter Number	107k	109k	235k	439k
FM	Training Time(s)	124.522	177.942	1563.585	3060.468
1.141	Parameter Number	72.6k	45.4k	166k	387k
SVD+DoonEM	Training Time(s)	204.307	319.213	2686.514	3035.781
Буртресрим	Parameter Number	34.7k	62.9k	60.8k	90.1k
SVD+FM	Training Time(s)	119.928	179	1476.589	1837.021
	Parameter Number	3.4k	1.0k	1.1k	57.7 K

# Table 3. Efficiency comparison on various datasets

# Conclusion

Factorization machines often suffer from large model sizes, particularly in scenarios with numerous users or items and negative samplings. This increased model size can potentially impact the model's overall performance.

To address this challenge, we have explored the use of SVD-based feature embeddings in FM-based models. By predefining user/item embedding via SVD prior to training the model, we developed effective yet simpler recommendation models of SVD-integrated factorization machines.

Through empirical evaluations on real-life datasets, our research not only demonstrates the practical performance of these models but also was able to make the model simpler and lighter. This provides valuable insights and practical guidelines for utilizing feature embeddings in FM-based recommendation systems.

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## A TWO-STAGE FRAMEWORK FOR PREDICTING CUSTOMER CROSS-BUYING BEHAVIOR

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# ABSTRACT

A cross-buyer is an existing consumer who purchases additional items or services from the same company over time. Understanding and predicting customer cross-buying behavior allows companies to target potential cross-buyers and distribute marketing resources efficiently. While machine learning can discern cross-buying patterns from customer data, its complexity often makes it elusive for decision-makers. Hence, it is essential that a model be interpretable to provide practical management insights. We propose a two-stage framework combining machine learning, feature engineering, and interpretation to address this. The first stage involves training four distinct classification algorithms, namely Gradient Boosting Machine (GBM), Random Forest (RF), Support Vector Machine (SVM), and Artificial Neural Network (ANN), supported by k-fold cross-validation and hyperparameter tuning. After determining the most efficient method based on metrics like accuracy, F-measure, and the area under the precision-recall curve, we use the top ten predictors in the second stage to build a simple, interpretable rule-based model. Our results demonstrate the rule-based model's comparable predictive performance to the complex model. This research provides actionable insights into customer cross-buying behavior, empowering organizations in strategic decision-making. For future work, the proposed framework can be extended to predict customers' purchasing time and products to provide a better insight into customer behavior in the organizations.

### SHIFTING REALITIES: THE TRANSFORMATIVE IMPACT OF FIRST-TIME VR USE ON USER INTEREST AND OPINIONS OF VR

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#### ABSTRACT

This exploratory study investigates the transformative impact of first-time virtual reality (VR) headset use on users' perceptions, interest, and receptivity towards VR technology. Despite the growing prevalence of VR in various sectors, limited research has explored how initial encounters with VR headsets shape users' attitudes and interest for VR. Employing a quantitative research method, we conducted pre-use and post-use surveys with a diverse sample of 50 participants, divided between those that had previously experienced VR, and those that were experiencing VR for the first time. The quantitative data revealed a statistically significant increase in positive perceptions and interest in VR post-experience (p < 0.05). The quantitative findings further illuminated the facets of VR that most captivated users, highlighting enhanced awareness of potential applications and a newfound appreciation for the technology's immersive capabilities. The study underscores the critical role of firsthand experience in fostering a positive orientation towards VR, paving the way for broader adoption and acceptance of VR technologies. Implications for VR marketing strategies and user education programs are discussed, emphasizing the importance of facilitating initial VR encounters to cultivate user interest and positive perceptions.

# IMPACT OF COVID-19 OUTBREAK AND VACCINATION ON RIDE-SHARING SERVICES: A SOCIAL MEDIA ANALYSIS

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## ABSTRACT

We studied the impact of the Covid-19 pandemic on the ride-sharing platform (Uber). The analysis in this study is based on 216,120 tweets in the U.S. between 2019, and 2021, about Uber. Using sentiment analysis, the result shows that usage and popularity of Uber on Twitter negatively affect Covid and death cases. In contrast, vaccination helps mitigate the shock of Covid. Additionally, Uber's policy and business model was beneficial in improving its positive image during the pandemic; On the early breakout of Covid, Uber had a jump on the positive sentiment, mainly because Uber provided safer service than public transportation.

#### LEVERAGING QUANTILE SKETCHES FOR EFFICIENT MANAGEMENT OF TRANSPORTATION DATA- AN EXPERIMENTAL APPROACH

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### ABSTRACT

The exponentially increasing volume of transportation data and the need for real-time analytics necessitate precise and efficient data summarization techniques. This research evaluates three quantile sketches-T-Digest Sketch, KLL Sketch, and UDD Sketch-as potent probabilistic data structures for managing voluminous datasets through approximate querying. Utilizing a comprehensive speed dataset from Aarhus, Denmark, this study meticulously analyzes the efficacy of these sketches in compressing traffic data, thereby enhancing storage efficiency and enabling rapid, insightful analyses crucial for informed decision-making and strategic planning within transportation agencies. The performance of these algorithms was evaluated based on several criteria including error tolerance versus storage efficiency, reconstruction accuracy, and their practical applicability for transportation agencies. A nuanced comparative analysis reveals distinct attributes of each algorithm in terms of data approximation, storage savings, and accuracy. Specifically, the t-Digest Sketch excels in memory efficiency and precision, particularly in capturing both typical and outlier traffic events. In contrast, the KLL Sketch demonstrates robust performance by achieving substantial storage savings and demonstrating enhanced accuracy in traffic speed approximations, while the UDD sketch exhibits flexibility and consistent accuracy levels across various configurations. Practically, these algorithms demonstrate remarkable proficiency in executing critical traffic analysis tasks, such as trend analysis and transportation performance measures querying, enabling the extraction of actionable insights from compressed data representations alleviating the need for exhaustive computational resources and extensive data storage. This research aims to provide transportation agencies with evidence-based guidance on leveraging quantile sketches for effective data management, thus bridging the gap between theoretical performance and practical application.

**Keywords** *Quantile Sketches, Big Data, Transportation Data, Approximate Querying, Data Summarization* 

## BUSINESS OPERATIONS AND ARTIFICIAL INTELLIGENCE: A SYSTEMATIC LITERATURE REVIEW

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#### ABSTRACT

Artificial intelligence (AI) mimics human intelligence in machines that act and think like humans. AI's desired ability is to understand and take actions that enhance the likelihood of achieving a commercial goal. AI is affecting how firms make decisions, deliver services, and evaluate prospects. Most AI applications are built on machine learning techniques, with supervised learning. AI systems that use machine learning algorithms are used to help key business tasks. AI-driven business models, AI-assisted decision-making in organizations, and how companies might build trust in AI have all been the subject of preliminary research. AI has been extensively discussed in practice-oriented management literature. This paper tries to summarize the research findings from existing research using a systematic literature review on the application of AI in business processes. Following the standard approach for a systematic literature review, we conducted the review in stages to ensure that we included all relevant information. The following research inquiries served as the basis for the evaluation process: What factors promote or obstruct the usage of AI within the organization? What kinds of AI are corporations using today? How does the value of AI get realized? Following the formulation of these study questions, appropriate keyword groups and data sources were selected. Our research reveals, AI helps businesses with its predictive analytical abilities to decide the future performance in marketing, sales policy, managerial decision making, customer relationship management, and recruiting processes. We contribute to the literature by summarizing the processes involved in business that uses AI, identifying the managerial decisions based on intention and influence of AI, explaining the impacts of using AI enabled digital assistant for customer centric processes, analyzing positive and negative impact on employee trust when AI is adopted, and focusing on risk management techniques relevant to AI.

### ESTIMATING THE FOOTPRINT OF ENERGY DEVELOPMENT IN OKLAHOMA: RENEWABLE VS NONRENEWABLE RESOURCES

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### ABSTRACT

Oklahoma is a top energy producing state and a leader in oil, gas, and wind energy. This makes the state attractive for comparing nonrenewable to renewable energy generation. Infrastructure features for both types of energy projects create landscape disturbance effects, which are similar in terms of land clearing and access roads but can differ in scale. To better understand the pattern, size, and extent of these two types of energy development across the landscape and help drive better planning decisions, geographic information systems (GIS) data and techniques were utilized to map and estimate the location and corresponding surface disturbance created in one Oklahoma county. Because Dewey County contains the highest number of wind turbines in the state, as well as sizeable oil and gas fields, it was chosen as a case study. This research had two objectives: to compare the size and extent of the energy footprint created by renewable and nonrenewable sources, and to test different spatial analysis methods to determine which ones are scalable to larger study areas, such as an entire state. Findings suggest that oil and gas surface disturbances are greater due to the larger average size of well pads compared to the wind turbine pads, as well as the historically numerous wells in the state. Meanwhile, an average wind farm creates a smaller though more extensive footprint due to long connecting roads. These approaches can help industry, regulators and stakeholders visualize, quantify, and assess landscape changes created by energy development, identify hotspots, and help prioritize future projects and expansions.

#### **INTRODUCTION**

Oklahoma is an energy rich state, with oil production dating back to the late 1890s [21]. Today, it remains a leader in US energy production, ranking 4th in oil and 5th in gas [4] [5]. In addition to hydrocarbon energy dominance, this state also has steady winds, and since 2003 Oklahoma has been a large adopter of wind energy, ranking 3rd nationally [3].

With the world's population estimated to reach almost 10 billion by 2050, energy needs are quickly increasing [17]. Wind is one of the most sustainable energy sources and can be extremely cost effective [15]. Consequently, climate change and resiliency concerns have mobilized many governments to create and promote policies that enhance the adoption of renewable energy sources to reduce CO2 emissions while decreasing reliance on foreign energy suppliers [1] [11] [14]. In the US, for example, recent federal funding programs like the

Bipartisan Infrastructure Deal, have spurred research, development, and adoption of renewable energy sources [18]. These efforts have also created jobs nationally, and around 9,000 in Oklahoma as of mid-2022 [14].

At the landscape level, oil and gas extraction and production activities can create largescale and permanent surface changes associated with the well pads, the large often rectangular flat cleared areas containing infrastructure features such as pumps, storage tanks, compressors and pipelines. In Oklahoma, the number of oil and gas wells outnumbers wind turbines considerably. Nevertheless, wind projects still produce environmental disturbances such as bird and bat mortality, noise, visual pollution and landscape disturbances caused by turbine pads, electric substations, transmission lines, and most notable, long connecting roads [2] [9]. However, few studies have focused on comparing landscape disturbance created by both energy projects [9] [10]. This information is important for planning future growth and understanding land use changes related to overall energy development.

In this study, we used different GIS techniques to quantify the area of land use change resulting from the establishment of oil and gas wells and wind turbines in Dewey County, Oklahoma (see figure 1). This county makes a good case study because it contains the largest number of wind turbines within the state, as well as numerous oil and gas well pads, which provide a fair comparison of the energy production footprint.

## **RESEARCH QUESTIONS**

This project focused on three main research questions:

- 1. Which type of energy development (oil and gas or wind) caused the greatest landscape disturbance?
- 2. Which GIS technique produces the best quality data when you consider time and accuracy?
- 3. Can these methods be scaled for various stakeholders?





#### **DATA AND METHODS**

#### **Study Area**

Dewey County, located about 105 km (about 65.24 mi) northwest of Oklahoma City, was selected as the study area because it contains the highest concentration of wind turbines, while also being densely populated with oil and gas wells. These wells are located on well pads, flat cleared areas often polygonal in shape and easy to detect in imagery (see Figure2). They contain infrastructure features such as wells, storage tanks, compressors, pipelines and sometimes flares. In turn, well pads are connected to each other via access roads, or they connect to a transportation road. By contrast, wind turbines are located on turbine pads, which are usually round cleared areas where the turbine is installed into the ground. They are smaller than well pads and tend to be uniform in size, though this can depend on the age of the turbine pad. They are also connected to each other by long access roads. Associated infrastructure features such as electric substations and the transmission lines also form part of the wind energy footprint, however, in this paper, which marks the first phase of the study, the unit of analysis was well pads and access roads for oil and gas, and turbine pads and access roads for wind energy.

In Dewey County, oil and gas wells are well established and numerous, and found throughout the county, mainly near transportation roads. Comparatively, wind turbines are newer and fewer, located in groups along ridges, and marked by long connecting roads.

#### Figure 2. Example of a large oil well pad acquired with drone imagery.



### **Geospatial Methods**

Datasets began with imagery. To ensure uniformity in date and scale, NAIP orthomosaic imagery for Dewey County was downloaded from the USDA's Geospatial Data Gateway for the year 2021 [19] and added to ArcGIS Pro software 3.2.1. Here, the NAIP imagery served as the basemap, or canvas, on which to examine the Dewey County landscape from above. With a 0.6m spatial resolution, well pads and turbine pads were easy to identify in the imagery. County and state boundaries were also obtained from the Geospatial Data Gateway, and all data were projected to NAD 1983 UTM Zone 14N coordinate system.

Spatial data for oil and gas wells (updated to July 12, 2022) were downloaded as a point file from the Oklahoma Corporation Commission [12], then clipped to Dewey County. Out of 3,850 total wells, 1,452 were listed as active oil and gas wells, and these comprised the initial dataset. Once mapped, 816 were gas wells and the remaining 636 were oil. Both were evenly distributed across the county. The next step was to align the wells with their corresponding well pads, as evidenced in the NAIP imagery, by shifting them to the center of their corresponding well pad. The remaining wells that were not associated with a well pad were removed. These last features could have been orphan or abandoned wells, or at one existed but by 2022, were no longer marked by a well pad.

The remaining dataset equaled 1,273 wells and they were treated as a single category (not separated into oil and gas). Next, 2022 wind data were acquired from the United States Geological Survey (USGS) wind turbine database [20]. Dewey County had 434 turbines, with a particular pattern along high ridges (see Figure 1). To enhance accuracy, these point features were also manually shifted to the center of their respective turbine pad.

#### **Modeling Disturbance**

This project utilized three methods to model the energy footprint created by wind, oil, and gas: a long method, intermediate, and quick method. To provide an apples-to-apples type of comparison, an equal number of well pads and turbine pads was required. Given the spatial distribution of wind turbines in particular areas of the county, the study area was divided into grids using the fishnet tool to ultimately produce 8.5 km2 squares. These grids were clipped to the study area and then those containing wind turbine pads were selected. The resulting 16 grids held 434 wind turbines and 433 oil and gas wells.

Road datasets were also required, but since they did not exist, they had to be digitized as line files. Again, using the NAIP imagery, pertinent roads connecting well pads to the main road
and turbine pads to the main road, were digitized. Additionally, the long access roads that linked turbine pads together like a string of pearls, also required digitizing. Since line features do not have area, roads had to be buffered into polygons to represent the area of the land that they occupied. This involved measuring the width of a given road at three locations and using the average width to buffer them.

Next, well pads were digitized as polygons because these features varied in size across the landscape, see figure 3A. By contrast, most turbine pads occupied circles of cleared land punctuated by the turbine post in the center, though they were still digitized, see Figure 3B. Digitizing defines the process of "tracing", in a geographically correct way, information from images/maps" [8]. Instead, the average size of a turbine pad was calculated, and this figure was used to buffer all the wind turbines to produce circles representing areas of disturbance on the landscape.

# Figure 3 Digitized Oil & Gas Well Pads and Roads in northwest Dewey County, Oklahoma.



### Figure 3B. Digitized Wind Turbine Pads and Roads in northwest Dewey County, Oklahoma.



The first method, categorized as the long method, involved a lot digitizing. This was the most accurate modeling technique, as it allowed for individualized sizing for each well pad and all roads, thus accurately representing the amount of disturbance on the landscape. The main drawback is the time-intensive nature of this process, as it involves placing points manually on the center of their respective well pad or turbine pad, as well as digitizing all the well pads, wind turbine pads, and all the oil access and wind access roads. Given the effort required, this potentially limits the scalability of this method for a large project. It should be noted that roads were digitized and buffered regardless of the method used for the pads, as there were no datasets available that had all the roads in digital format. This is most likely because many of the service roads used for wind, oil, and gas are dirt roads and have not been paved.

The intermediate method involved creating a buffer, which is "a polygon enclosing a point, line, or polygon at a specified distance" [6]. This method, which can be seen in figures 4A and 4B, would be considered an estimate, as all the buffers result in generic rectangles or circles. The size of these polygons can either be based on one number such as the average size of a well pad, or they can be individually sized to the pads by taking the length and width measurement of each pad – the latter option being more time-intensive, yet also more accurate.



Figure 4A. Buffered Wind and Oil & Gas Disturbance in Dewey County, Oklahoma





To determine the size of the oil and gas disturbance buffer, the average size of a well pad was calculated (85 meters by 100 meters). The average of those two numbers (92.5 meters) was then divided by two (46.25 meters). It is important to divide the final average in half before buffering, as a buffer is created from a center point, or line, and grows out from both sides. Failure to do so means that the buffer will be created with 92.5 meters on both sides of the point, doubling the area and overestimating disturbance values. An optional adjustment method (that requires additional time) would be to shift and rotate the resulting polygons to represent the location of well pads more accurately.

A similar calculation was conducted for wind. A round buffer with a radius of 13.91 was created using the center point on each turbine pad. This distance represented the average length across a wind turbine pad. Because the turbine locations had been centered on the turbine pad, the resulting location of the buffers was quite accurate.

The third, or quick method, required generating a fishnet, which "creates a feature class containing a new set of rectangular cells" [7]. This method is often used to subdivide a study area and thus create more observations. This method also produced an estimation of the disturbance area. Here, all the cells were consistent in size, as the net was created based on an average size of all of the well pads. Using this method, seen in figure 5, a rectangular grid was created across the study area and then those that contained well pads were selected.



Figure 5. Fishnet Oil & Gas Disturbance in Dewey County, Oklahoma.

The size of the fishnet was calculated from an average well pad size of 85 meters by 100 meters, the same numbers used for the buffer method above. As with the buffer, an optional adjustment can be made here by scaling and rotating the resulting polygons. It is important to note that all three methods were utilized for oil and gas wells, while only digitizing and buffering approach was used for wind turbine pads. Again, this was because wind pads are circular in

nature and using fishnets with their rectangular cells would overestimate the size of the wind pad. Figure 6 shows a direct comparison of three methods used on one oil well located in the study area.

# Figure 6. A comparison of methods used to estimate Wind and Oil & Gas Disturbance in Dewey County, Oklahoma.







Digitized

Graphic Buffer

Fishnet

# FINDINGS AND CONCLUSIONS

Table 1: Comparison of Findings for Methods (NFL Football fields – 109.73 x 48.74 m (120 x 53.3 vards); 0.5348 ha)

	Measurement	Digitize	Buffer	Fishnet
Oil & Gas	Hectares	501.41	473.46	471.02
	Football Fields	945.04	885.30	880.74
Wind	Hectares	164.99	128.83	-
	Football Fields	308.51	240.89	-

The primary objective of this project was to calculate the area, in hectares, of disturbance caused by wind and gas and oil development. Results are shown in Table 1, which illustrate that wind energy caused less land disturbance than oil and gas development. Wind turbines disturbed about 68% less land in Dewey County than oil and gas wells—when comparing an equal number of wind and oil locations. Naturally, the overall oil disturbance is higher due to the much larger number of oil wells in the county and the state of Oklahoma.

While non-renewable energy does create a larger land disturbance, it is important to note that the expansive service roads in wind developments tend to segment the landscape more, which may cause other types of habitat disturbance outside the scope of this project. Also, wind projects, due to their siting on high ridges, can be seen from long distances.

As previously established, digitizing was the most accurate method and was used to compare the accuracy of the other two methods. For oil and gas, the second buffer approach was 93.7% accurate, while the third fishnet was 93.2% accurate. For wind, the buffer approach was only 78.08% accurate, suggesting that digitizing the turbine pads may be necessary, and thus not as scalable. The accuracy of these methods relies heavily on obtaining a true average measurement for the pads. Not having a large sample size or having a sample selection that is not representative of the study area could skew the findings, which may be the reason the wind buffer accuracy was lower.

If a stakeholder's focus is solely on accuracy with no restraints on time, particularly for smaller projects, digitizing would be the recommended method. This method is straightforward, scalable to an extent, and can even be utilized by those with little experience in GIS. However, projects that involve large study areas or time constraints should utilize fishnets, as we determined this to be the technique that produces the best quality data when considering time and accuracy. In comparison, using a fishnet took less than one-fourth the amount of time than digitizing, with buffers taking about exactly a fourth the time of digitizing. The ability to automate both the fishnet and buffer by using pre-built tools in GIS allowed for the time to calculate disturbance areas to be shortened greatly. The accuracy of both the fishnet and buffer could also be increased by spending additional time scaling and adjusting the resulting polygons to match the pads more closely. These two techniques require the average size of a well or turbine pad to be calculated before running the automated tools. Creating a buffer does involve more math and processing needed than a fishnet, increasing the chance of user error, thus it is not the recommended method proposed by this project.

#### LIMITATIONS AND FUTURE WORK

The study's objective was to determine the best ways to quantify the land disturbance of turbine and oil pads. The results suggested the most accurate but time-consuming method was fully digitizing by hand. The fishnet method was the best value for time spent. Two aspects of disturbance that were not quantified in this study were the electric substations for the wind farms and the transmission lines involved in distributing the electricity. Including these features in the disturbance footprint would increase the accuracy of the disturbance calculation. Another future method to test is using Normalized Difference Vegetation Index (NDVI) to quantify disturbance even more accurately and in less time. NDVI could provide extremely specific information about what vegetation has been disturbed by the turbines and well pads. Using remote sensing techniques to distinguish developed from natural areas would provide additional information about the impact of these energy developments on various land types. Additionally, potentially using machine learning and supervised classification to conduct object and feature detection, as well as train software to look for well pads and turbine pads presents the opportunity to shorten the time needed to calculate these disturbances. Finally, expanding this project's scope to the entire state of Oklahoma could provide additional insight into the land use changes caused by energy development.

#### ACKNOWLEDGEMENTS

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#### LEVERAGING GRAPH NEURAL NETWORKS FOR ANALYZING RETAIL PRODUCT AFFINITY

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#### ABSTRACT

Understanding the relationships between different products and how they interact with one another is a crucial task in retail analytics. It can help retail companies understand how to bundle products for cross-selling, design effective promotional campaigns, and improve demand forecasts. Traditionally, such associations have been studied using Association Rule Mining (ARM) techniques like Apriori, Eclat, etc. However, ARM techniques have limitations in terms of scalability and the ability to incorporate multiple product attributes. Graph Neural Networks (GNNs) can help overcome these limitations by representing the product pair relationships in the form of highly scalable graph data structures and by learning the edge associations of the graph structure to understand product associations. GNNs allow the seamless utilization of multiple node and edge attributes via feature vectors, thus allowing the encoding of rich product information to find more relevant associations.

This work proposes the utilization of state-of-the-art GNNs as an alternative to traditional ARM methods. It proposes the use of a GraphSage Model with three Sage Convolutional Layers for studying product pair affinity. The proposed model is applied to a retail point-of-sales dataset for a UK-based retailer. The dataset is transformed into a graph data structure where the product codes are represented as nodes. Associations between the products are represented as the edges of the graph weighted by transaction count and quantity. Additional product attributes, such as product price, product description, etc., are represented as node features. The problem is treated as binary classification, and the model is trained to predict whether an edge exists between a pair of nodes. The primary evaluation metric utilized is the Area Under the ROC Curve (AUC). The Apriori algorithm is also implemented and analyzed on the same dataset for a comparative study.

The proposed model is found to be highly scalable and capable of handling heterogeneous graphs with multiple sets of node and edge attributes, making it a better choice for retail datasets with large amounts of transaction history and a variety of attributes. The proposed model is found to be highly accurate, with an AUC score of around 0.92 on the test data set. A detailed comparison of the proposed model with the Apriori approach demonstrates the ability of the proposed model to generate more robust results for scenarios with limited transaction history. The comparative study shows that even with limited data, the proposed GNN-based approach uncovers approximately 31% more relevant associations than the Apriori approach. It is observed that adding transaction data enhances the Apriori approach's performance, while the GNN-based method's performance remains consistent with or without it. As future improvement opportunities, the potential for leveraging Large Language Models to analyze product relationships based on descriptions has also been explored in this work.

#### IMPLEMENTING SUCCESSFUL DATA WAREHOUSING, BUSINESS ANALYTICS, AND BUSINESS INTELLIGENCE PROJECTS: PROJECT MANAGEMENT APPROACH VS AGILE DEVELOPMENT APPROACH

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#### ABSTRACT

Business intelligence and analytics have become an integral part of businesses as organizations' decision-making processes are becoming more data-driven. However, business intelligence and analytics projects have faced challenges as 59% do not meet the time, budget, and performance baselines, and fewer than 30% meet business objectives. These failures have been attributed to many reasons, including using either traditional or agile project management only to implement BI/DW projects. Some studies recommend that both project management (plandriven approach) and agile development need to be integrated to achieve better the success of DW, BI, and BA projects. They believe that an agile-only approach will face the issue of scalability and complexity in complex DW, BI, and BA projects, and a plan-driven approach will face issues of unpredictability and adaptability in complex DW, BI, and BA projects. Most studies looked into hybrid project management (integration of traditional and agile) from two approaches (intuitive and theoretical). In the intuitive approach, researchers identified how integrating both traditional and agile PM could improve project success using their intuition and experiential capacities.

In contrast, researchers approached the subject matter through the literature in the theoretical approach. We would approach the subject matter using an empirical approach (i.e., a user-centric approach). Our goal is to identify the challenges faced when using either an agile-only or a plandriven approach for BI&A projects, what aspects of BI&A projects can be managed with either approach and how best both approaches can be integrated when managing a BI&A project from users' (project managers and teams) perspective.

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The research employs a qualitative survey design, engaging professionals with significant experience in project management within DW, BI, and BA domains. The study finds that while Agile Project Management is beneficial for adaptability and faster delivery, it often falls short in stakeholder satisfaction due to its rapid delivery focus. Conversely, Traditional Project Management offers structured clarity but lacks the flexibility needed in evolving project landscapes. The study suggests a growing trend toward integrating Agile and Traditional methodologies (tailoring methodologies), achieving a balance between structure and flexibility. This hybrid approach shows promise in enhancing adaptability while maintaining necessary project structure and predictability.

Key findings include the preference for direct client-team communication, indicating the importance of effective communication channels in project management. The study also observes a dominance of transformational leadership styles among project managers, which aligns with the dynamic nature of DW, BI, and BA projects. The research contributes to both academic literature and practical applications, offering insights into method tailoring and leadership dynamics in complex project environments. It opens new research frontiers in integrating Agile and Traditional Project Management techniques for the successful implementation of not only DW, BI, and BA projects but also broader IT and other projects.

#### USING DATA ENVELOPMENT ANALYSIS TO ANALYZE DEGREE OFFERINGS IN A BUSINESS COLLEGE

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#### ABSTRACT

Business colleges offer various degrees for the purpose of attracting students and providing them with proof of an education of value. The decision of which degrees to offer is based on a variety of factors, including demand for the degree by students, and demand in the business world for the associated knowledge and skills. In a climate where the value of a college degree is being questioned and enrollments have been declining since their peak in 2010, it is important that the degrees a college offers remain both relevant and attractive to potential students. Once the college has identified which degrees to offer, departments are then tasked with providing instruction, and managing both the students seeking the degree and the degree program itself. Reductions in enrollment result in financial pressure on academic institutions. Therefore, at the college level there should be interest in monitoring the efficiency with which departments manage their degree programs. Specifically, what are the costs and returns for offering, administering, and supporting students pursuing each of the degrees. In this paper we will illustrate how data envelopment analysis (DEA) can be applied to analyze the relative efficiency of how degrees are administered by departments. Assuming a given set of common, relevant measures for the offered degrees, we use this optimization technique to compare the degrees. We identify those degrees that for the given set of inputs and outputs assume a maximum level of relative efficiency. Our DEA analysis then enables us to analyze why some degrees are relatively inefficient, and in so doing, provide specific guidance on how to improve their efficiencies.

#### MAPPING AI BIAS IN LINE WITH CROSS INDUSTRY STANDARD

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#### ABSTRACT

Increased use of Artificial Intelligence has started exposing its multifarious biases – ranging from segregation amplification to medical diagnosis discrimination. While deepfake images are getting alarmingly credible and generative AI power multiplying manifold, a comprehensive framework to classify and detect biases is still elusive. Cognitive Bias is an area of research in the realms of psychology, sociology, and behavioral economics. On the other end, Artificial Intelligence is an area of computer science, having widespread application in diverse fields, namely, agriculture, advertisement, finance, healthcare, transportation, etc. AI bias lies in the intersection between these areas. Biases in AI can originate from different types of sentient actors, non-sentient actors, and their complex interactions. Biases can happen during the multiple stages of production and deployment of AI tools. Complex interactions among different actors, stages, uses, and the surrounding socio-technological catalysts make it extremely difficult to map the biases into a unifying framework that fits most of the widespread use cases of AI. Industry leading organizations proposed different pragmatic approaches to reduce AI Bias and empirical studies outlined useful classifications to differentiate the biases in AI. While these approaches and classifications can produce results in some niche areas of AI application, they often fall short of a broader scalable application in the industry. This study attempts to classify and map AI Bias in line with Cross Industry Standard Process for Data Mining (CRISP-DM) with the aim of providing a unifying framework that can help identify biases during the stages of conception, production, deployment, and application of AI models. AI Bias map and the accompanying framework can lay initial foundations of future models of early detection of AI bias and facilitate reduced bias in AI applications across different industries.

**Keywords:** AI, Artificial Intelligence, Machine Learning, Data Mining, Cognitive Bias, CRISP-DM, Bias Mapping

# Data Analytics and Statistics

# REVOLUTIONIZING EDUCATION IN THE 21ST CENTURY: UNLEASHING THE POTENTIAL OF AI FOR INNOVATIVE CLASSROOM EXPERIENCES

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# ABSTRACT

Workshop will offer hands-on experience and practical insights into leveraging Artificial Intelligence (AI) for enhanced classroom instruction and student engagement. You will gain a comprehensive understanding of diverse AI tools, strategies, and their powerful functionalities and learn about associated risks. Participants will leave equipped with practical skills, a clear roadmap for seamless AI integration, and a supportive network for ongoing collaboration. Elevate your teaching experience and confidently embrace the transformative potential of AI in the classroom, ensuring a future-ready and enriched learning environment.

# DATA VISUALIZATION FOR ENHANCING STATISTICAL COMPREHENSION AND DATA ANALYSIS COMMUNICATION

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# ABSTRACT

Explore how data visualization can play a transformative role in teaching statistics to business students with various visualization software tools and case studies offering practical insights into the application of these techniques. Learn about effectively integrating Tableau into courses using Tableau resources and tools for instruction, such as Tableau Trailhead, Tableau Accelerators and data preparation with Tableau Prep. Also learn how to create datasets in Python.

# **PROVIDING ANALYTICS SKILLS FOR UNDERGRADUATES**

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# ABSTRACT

Abstract: 1) Development of a required foundation course in R, Python and SQL for a business analytics concentration and other course modifications to enable students to stand out during interviews. 2) A curriculum playbook for determining what to cover and what to set aside for a single practical skills-based business analytics course to meet employer expectations. 3) A presentation of some of the significant data/analytics industry certifications that can be required or recommended then followed by an open discussion of whether they should be considered as complementary (friends) or competition (foes) of our university courses.

# REPORTS ON EFFORTS TO EXPAND AND/OR IMPROVE ANALYTICS LEARNING

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# ABSTRACT

1) Report on introducing analytics to high school students by bringing them to campus to learn about analytics and engage in a hands-on data experience. 2) Report on an attempt to improve student's learning outcomes in an asynchronous online introductory Business Analytics course by augmenting existing behavioral interventions (e.g., prompts and nudges from instructors/systems to submit coursework on time) with the social aspects (e.g., peer-sharing of learning strategies). 3) Report on development of the Learning in Context survey instrument for finance and analytics courses with the initial study's insights that can be used to improve instruction during the term.

# USING STUDENT SURVEY RESPONSES AND COURSE DATA TO IMPROVE INSTRUCTION & LEARNING

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# ABSTRACT

An initial examination is of course evaluations for introductory analytics courses with a study that explores the text responses of students for three business core analytics courses. An additional exploration examines the correlation between GPA and course ratings. Another study examines factors related to what makes an excellent teacher or course from the perspective of students. This analysis used 2048 evaluations for 296 distinct classes to identify questions that exhibited the strongest correlation with students' assessments of both the instructor and the course.

# USING AI FOR CODING INSTRUCTION & CHATBOTS FOR GRADING

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# ABSTRACT

The initial presentation will be an exploration of the benefits and limitations of ChatGPT on coding/software instruction. In addition, a demonstration of the usefulness of chatbots for exam and assignment grading will be shared.

# IMPORTANT INSTRUCTION RELATED ISSUES FOR EFFECTIVE USE OF DATA

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# ABSTRACT

The issues addressed include 1) The significance of cybersecurity in educational settings including the importance of data integrity and protection in education and research and specifically crucial cybersecurity issues faced by faculty in classrooms. 2) The development of a highly experiential data course for an Honors program that included projects with final deliverables for clients. 3) The redesign of an undergraduate analytics course teaching SQL and data resource management to transition to Power Query along with a discussion of other tools that were considered,

# DISCUSSION OF ISSUES FOR FACULTY INSTRUCTING TODAY'S STUDENTS IN TODAY'S ENVIRONMENT

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# ABSTRACT

**Abstract**: The session will be open to cover a range of issues that can affect faculty and instruction today. Changes in technology relevant for data analysis, such as AI and grading in an AI world; changes in student characteristics, such as prior preparation, work ethic and mental health needs; changes in administration's emphasis on better student retention in contrast to graduate quality; changes in competencies desired for new hires by employers and for incoming students for subsequent classes. Attendees will be invited to participate in the discussion.

#### WHAT DO STUDENTS SAY MAKES AN EXCCELENT TEACHER OR COURSE?

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#### ABSTRACT

Teacher course evaluations are a common tool in colleges and universities to get feedback from students about their experience in the classroom. These evaluations have been studied extensively, and research on this topic has explored various aspects of the evaluations. We discuss the possible impact of these evaluations, then use both correlation analysis and cluster analysis to analyze over two thousand such end-of-course assessments. This analysis enables us to see what questions have the highest and lowest relationships with the ratings given to the teacher and to the course, and also to identify which questions cluster together. The results provide instructors with specific areas to focus on for enhancing their scores within a course.

# Healthcare Public Sector

# SOCIAL MEDIA USE FOR HEALTH INFORMATION AMONG MARGINALIZED POPULATIONS IN THE U.S.: AN ANALYSIS OF HINTS DATA

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#### ABSTRACT

The utilization of social media for accessing health information has undergone a significant evolution over the past decade, particularly in the aftermath of the COVID-19 pandemic. However, it is crucial to recognize that the distribution and adoption of social media use for health information are not uniform across all contexts or populations within our society. In this study, we use HINTS 2022 data and logistic regressions to examine the influence of demographic and socioeconomic factors (age, educational level, gender, race, income, and healthcare access) on social media use for health information. Our findings reveal that younger individuals, females, those with higher education/income levels, and those of African American and Hispanic ethnicity are more likely to engage with health-related videos on social media. In addition, those who have friends or family members to talk to about their health are 50% less likely to watch health-related videos on social media than those who do not. People who were covered by any health insurance are around 17% less likely to watch health-related videos on social media than those who were not. Our analysis also provides implications for policymakers and practitioners. By understanding the demographic and socio-economic factors that shape video engagement, targeted interventions, educational campaigns, and communication strategies can be developed to effectively reach and engage diverse populations in accessing health information through social media platforms. Further research is warranted to assess the impact of information and misinformation on social media and the internet on people's behavior and decisionmaking, especially in marginalized populations.

#### **MEDICAL TOURISM: BABIES ACROSS THE BORDER**

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#### ABSTRACT

People who are not citizens of the United States sometimes come to the US to give birth. While this phenomenon has become a flashpoint for a contentious political debate – giving rise to the pejorative "anchor baby" epithet – it has not been objectively studied. In this article, I address the question of who crosses the border into the United States for the purpose of giving birth, and how these patterns may have changed over time. This work is the first timely, quantitative analysis of its kind for the United States. Decreased medical tourism for the purpose of giving birth during the Trump era has implications on other secondary medical effects of that administration, as well as for how the makeup of the United States population is likely to change. In terms of methodology, I employ data from the 2014-2020 United States Neo-Natality Survey to examine all births in the United States during that time. The data were obtained from the National Bureau of Economic Research's (NBER) public-use database and derived from an agreement with the National Center for Health Statistics. Ordinary Least Squares (OLS) and, alternatively, a Probit regression analysis, are employed. I find that putative birth medical tourism decreased dramatically during the Trump administration. Additionally, individuals who come for the purpose of giving birth were generally healthier, higher SES, and more likely to be Hispanic. The findings presented here may be important for informing current and future immigration and medical tourism policies. These results are also critical in understanding potential health concerns for varying populations in the United States as based upon immigration status.

#### WHY PHARMACEUTICAL FIRMS ISSUE NOTIFICATIONS OF DRUG RECALL? A STRUCTURAL TOPIC MODEL APPORACH

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#### ABSTRACT

This paper leveraged technological and methodological advances in natural language processing to advance approaches to product recall research by introducing structural topic models (STMs). Specifically, we demonstrated an STM analysis using the US Food and Drug Administration (FDA)'s Recalls Data Sets. Unlike clustering used to group items together so they can be analyzed as a whole, STMs help identify hidden patterns of topics by analyzing the distribution of topics across texts. This unsupervised machine learning method uncovers the underlying relationships with the concept in a bottom-up approach. The relationships that have been found can be visualized as a topic network, which can be used to investigate how different topics might be interconnected and may represent the relationships among different stakeholders as well.

Our research question was concerned with how a variety of reasons for drug recall were latently represented in the FDA's Recalls Data Sets from 2012 to 2022. The datasets contained a large corpus of unstructured texts describing over 1,000 reasons for more than 14,000 drug recalls. Our STM analysis indicated how many topics and what topics were hidden in the texts describing reasons for drug recall. The analysis unlocked 20 latent topics—clusters jointly representing higher-order concepts—associated with the reasons for drug recall. Through this analysis we identified a classification system composed of four themes regarding reasons for drug recall: 1) procedure failure, 2) manufacturing defect, 3) incorrect labeling, and 4) flawed quality management system.

Our study attempts to make a few contributions. Although the STM is gaining popularity in other disciplines, it is one of the few studies in product recall research (in our knowledge) that employed the STM. Also, through this study we were able to uncover the reasons why recalling firms issued notifications of drug recall, which was otherwise difficult to discern. Lastly, we hope that this study will be helpful for future researchers who want to understand how to treat and analyze a large volume of unstructured text without having to impose dictionaries and interpretive rules on data.

#### HEALTHCARE WORKFORCE RETENTION IN THE POST COVID-19 PERIOD

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#### ABSTRACT

This study analyzes factors, such as gender, manager, workload, healthy work-life balance, and training that have influenced retention among the healthcare workforce during and after the COVID-19 pandemic. With 209 survey data, we estimate the factor effects on healthcare workforce retention using the Ordinal Model and the Generalized Linear Model. The results highlight those individuals working from home, with health balance, workload, lack of training, and being intellectually/professionally challenged affect individuals' decisions to leave or stay at an organization. On the other hand, an increase in the workload does not influence decisions about leaving or staying at an organization.

Keywords: COVID-19, Retention, Healthcare Workforce, Workload, Balance, Training, Work

from Home, Challenge.

#### **INTRODUCTION**

The COVID-19 pandemic has affected almost every aspect of everyday life and forced most businesses, including the healthcare system, to change how they provide their services. Most healthcare employees were affected physically and mentally. Still, the need and expectations to be present continued as they were deemed to be terms such as "frontline" or "heroes," indicating their ongoing need as essential workers. However, several years later, staffing shortages are rising due to burnout, lack of support, and continuous physical and/or mental strain. A term that was recently coined in the United States was "the great resignation," which describes the record numbers of people leaving their jobs during the COVID-19 pandemic, usually correlating to the working environment and compensation. By 2022, healthcare employment was down an estimated 500,000 workforces [1]. Many factors might contribute to resigning from the healthcare workforce, such as burnout, exhaustion, flexibility of work options, and work-life balance [1].

On the other hand, in the past, jobs in the healthcare field have been known to be "recession-proof" [2], however during the pandemic, many healthcare employees also lost their jobs due to the drop in utilization of various healthcare services in an attempt to maintain social distance to keep everyone safe. Overall, turnover rates have increased, and retention across healthcare has decreased significantly. To understand the pandemic's impacts on healthcare employment, the study [3] found that as of April 2020, health employment fell by 8.13% from the previous year (an unprecedented drop), while non-health employment fell by over 13%. Total health employment in February 2020 was 16.5 million, dropping to 14.9 million in April.

It seems that the healthcare employment dropping rate is lower than in other industries, and today – three years since the onset of the pandemic; however, the employment rates are higher than those of other industries, though they were still below pre-pandemic levels [3]. The retention rate is a vital indicator of a business's success [4, 5], and there must be an intentional approach to recruiting and retaining employees moving forward to balance out the amount of the healthcare workforce leaving and not returning.

This paper aims to analyze factors that have influenced retention among the healthcare workforce before and during the COVID-19 pandemic. It will dive into topics such as gender, manager, healthy balance, workload, training, working-at-home options, etc., to determine what has been effective. It can be improved in healthcare to support and retain the healthcare workforce better. It will also include challenges healthcare professionals face during the great resignation and possible opportunities for companies to implement while recruiting and retaining their employees, such as policy, onboarding process, training, and much more. For future healthcare leaders, there are many opportunities to make impactful changes to improve the working conditions of healthcare workers. With the help of this paper, healthcare leaders may start at the very beginning with the recruitment process to set appropriate expectations for employees by providing an environment they desire.

#### LITERATURE REVIEW

Healthcare staffing shortages were an issue long before the start of the COVID-19 pandemic therefore it's important to analyze retention before and during the pandemic. Factors such as gender, work-life balance, having a supervisor or not, being valued at the work site, burnout, workload, input being valued, training, increase in workload, importance of being intellectually/professionally challenged, and working from home are the factors being analyzed in this paper.

Gender has been found to be a big role in retaining employees. A study [6] concluded that females tend to lose their job satisfaction over time due to organizational culture when compared with their male counterparts. This results in female employees quitting and changing jobs frequently. Another study [7] indicated that females working in the healthcare field are likely to switch their jobs due to altered work-life balance. There may be other factors such as workplace inequalities, compensation differences, and lack of congenial working environment resulting in female employee' low retention.

The concept of work-life balance has undergone many changes due to pandemic and postpandemic healing. The Human Resources department plays a vital role in establishing policies to ensure the work-life balance of their employees. This not only ensures efficient and productive workflow but also helps in retaining employees at work. A study [8] concluded that offering flexibility, and non-monetary benefits such as meal allowances, and social and sports activities were associated with high retention among employees.

Another study [9], also conducted that work-life balance plays a very important role in retaining employees. Their study measured the work-family balance and work-health balance as a part of work-life balance measures. Authors mentioned that with women joining the workforce, employees are aware of the concept of work-life balance even more in recent years. They concluded that work-life balance helps in improving job satisfaction as employees can spend time with their families as well as improve their health, ultimately resulting in increased job retention. Work-life balance helps employees in feeling committed and motivated with their work and employer due to which they do not switch their jobs and are retained in the company for longer periods.

Before the COVID-19 pandemic having a quality supervisor positively influenced job satisfaction and retention for Registered Nurse case managers. According to a literature review from [10] a connection between trusting a supervisor and job retention is a reoccurring theme throughout the literature. Further, the top factor in determining to stay in a current position is the quality of the relationship with one's supervisor or manager. More recently, after reviewing hospital employee surveys, [11] discovered when upper management encourages direct dialog about working conditions employees feel listened to and more valued. These two studies, one pre-pandemic and one post-pandemic, indicate the importance of quality management and retention.

Not feeling valued or input not being valued in the workplace has a connection with retention as well. One felt they were not listened to by upper management was one of the top three reasons for nurses leaving in a case study that explored reasons behind nurse turnover completed [11]. The surveys and interviews of nurses who quit a hospital position during 2012-2019 found that individuals described a lack of direct dialogue with hospital management, leading to a feeling of disregard for their opinions. This case study highlights the importance of healthcare workers feeling valued in the workplace and job retention. These findings reflect similar results from a literature review completed by [10] that concluded a failure to recognize and/or value employee contributions and restricted access to decision-making are two of the primary factors that contribute to job dissatisfaction. Further, [10] mentioned that improving nurse retention includes increasing the ability for them to be heard by decision-makers at various levels in the organization.

A consequence of insufficient job resources and excessive demands on nurses can lead to feelings of burnout that can have both psychological and physiological consequences. A qualitative study of critical care nurses interviewed from May 2021 to May 2022, during the COVID-19 pandemic, were asked about the impact of the pandemic on well-being. According to [12] staff described multiple consequences with burnout being number one in health impairments leading to consideration or following through with leaving their current positions. These findings are similar to another study by [13], that utilized the Maslach Burnout Inventory Scale in surveys which determined burnout among surgical nurses factored significantly into intentions to leave their current positions.

Training is an important factor when discussing retention to ensure workers have the skills and knowledge to be effective in their roles. In 2003 Preferred Clinical Partner Program (PCP program) was initiated by The Colorado Permanente Medical Group to encourage physicians to address the nursing shortage to increase interest and offer opportunities for future nurses and other healthcare team members. With the help of this program, [14] concluded that there was improved career satisfaction, ultimately leading to lower nurse turnover and fewer nurses abandoning the healthcare field. In addition, [15] found there to be a significant impact of training on employees' retention, job satisfaction and motivation. Employees who received training were more likely to stay with the company long-term, compared to those who did not receive training.

Another article [16], the impact of the COVID-19 pandemic on the workforce and the correlation of training in retention discusses how retention is a crucial part of maintaining a stable workforce. Throughout this report, it emphasizes the importance of training the healthcare workforce, particularly during the rapidly changing situations created by the pandemic.

Besides, [17] found that simple training such as CPR, BLS, and ACLS for nurses significantly improved survival to hospital discharge after in-hospital cardiac arrest. Regarding the variable "training," all the findings are consistent with the results of this paper which concluded that proper training has a significant impact on retention. This could be because when an individual is properly trained, they are more likely to perform tasks accurately and efficiently, which can also increase their confidence and motivation to keep learning and growing within the organization.

During the COVID-19 pandemic, many individuals started working remotely to further prevent the spread of the virus. While many have found the option to work from home beneficial, others struggled to maintain a work-life balance and productivity. As of September 2021, 45% of the U.S. workforce was working from home at least part-time and concluded that employers are not able to push for their employees to return to the office without risking higher turnover and the associated costs [18].

On the other hand, [19] concluded that scientists being surveyed shared the negative impact of having to work from home due to the loss of collaboration, absence of leadership, loneliness, and challenges with parenting. Physical and mental well-being are often discussed when talking about working from home. In addition, [20] concluded that physical and mental well-being was reduced, and the number of physical and mental health issues increased after individuals transitioned to working from home.

According to [21], working from home is not a one-size-fits-all all solution, and can have different impacts on retention depending on the frequency and the nature of the job. Working from home more frequently tends to lead to higher satisfaction when the job requires less coordination with others and when the employee perceives their boss as "bad," while always working from home is associated with a higher intention to leave the job. Regarding the variable "work from home," all the findings are not consistent with the results. The inconsistent results could be due to the socio-economic status of the population, and the difference in the work environment.

In addition to the challenges of being short-staffed, the COVID-19 pandemic created new challenges as the workforce was adapting to consistently changing protocols, increasing their workload. The study [22] stated that an increase in workload was significantly associated with higher levels of work-related stress, lower mental well-being, and higher levels of burnout and depression. Addressing work-related and workload is important in promoting mental health and the overall well-being of healthcare professionals and retention. In the research by [23], they found that inadequate staffing of nurses was directly correlated to mortality rates as tasks were left uncompleted due to burnout, stress, and their inability to deliver proper care. In addition, other factors that were found to increase turnover, psychological response to stress, socio-demographic characteristics, adverse working conditions, and support from employers [23].

According to [24] heavy workload is directly correlated to an organization's retention rate. Some sources of dissatisfaction for nurses included working conditions, heavy workloads, and increases in overtime, and 1 of 3 hospital nurses under the age of 30 is planning to leave his or her current job in the next year. Similarly, [25] explores the link between workload and retention and found that working conditions must be improved to attract more nurses, simply factors like wage increase are not sufficient. Regarding the variable "load increase," all the findings are not consistent with the results of this paper.

Being professionally and/or intellectually challenged can play a positive or a negative role in employee retention. For those who are motivated by opportunities and learning a new skill, by providing challenging work assignments and opportunities for growth, organizations can help to motivate their employees and increase retention. However, challenges can also contribute to employee turnover if employees feel overwhelmed with the demands of their job, or if they feel unsupported or under-equipped to handle those challenges and may look for new opportunities.

The research [26] concluded that while extrinsic factors (compensation, workload, etc.) may play a role in motivation and retention, research has shown that intrinsic factors (sense of purpose, challenging work, etc.) are generally more powerful in driving long-term motivation and engagement. And [27] states that employees being given more complex, interesting, and challenging tasks at work gives a greater sense of achievement. In addition, [28] found that giving employees different challenging tasks increases creativity and innovativeness, which increases retention. On the other hand, [29] analyzes the competitive and demanding nature of work and how a supportive culture can be created to help maintain a work-life balance, employees who fail to find a work-life balance, either quit the organization thereby increasing the rate of attrition or become less productive. On the personal front also, they feel unhappy. The overarching goal of this paper is to create a comprehensive and impactful addition to the existing literature. A gap in the contemporary literature that we hope to fill with this study is how employees' decision to stay or leave a workplace, has shifted and/or been affected before and during the COVID-19 pandemic depending on the variables being used for this paper. Regarding the variable "challenge," all the findings are not consistent with the results of this paper. The inconsistent results could be because while some are motivated by challenging work assignments, others can feel overwhelmed with the demands of their job, or they feel unsupported or under-equipped to handle those challenges and may look for new opportunities.

# DATA

This study's research design and methodology are primarily mixed because both qualitative and quantitative data are being collected and analyzed. The primary source of data collection within this study is the survey given to every participant. It is collected using questionnaires, interviews, or observation, and frequently appears in narrative form. The participant perception ratings are the main source of facts and numbers that can originally be drawn from the data. As previously discussed, these ratings are the scores that each participant gives in response to each question while completing the survey. This quantitative data is further analyzed through statistical analysis to exemplify key correlations within the data and draw attention to any other statistically significant findings.

This research setting is mainly in Denver, Colorado, USA, with potential limitations for this study's findings. However, 209 useful observations in the healthcare workforce in Denver, CO, could serve as a suitable lead in understanding the issues related to retention in healthcare currently being observed. This research paper aims to provide data and support from existing research to conclude its collected data. Also, to collect genuine information, all responses were anonymous, and all participants were required to be connected to the healthcare field for their questions to be valid since this research is being conducted to help collect more data on the healthcare workforce. See Table 1: Descriptive Statistics.

Variable (label)	Question	Description	Mean	Median	Mode	Std. Dev.	Min.	Max.
leave_c	Have you considered leaving your current job since the onset of the pandemic?	<ul> <li>1= strongly disagree,</li> <li>2=somewhat disagree,</li> <li>3=neither agree or disagree,</li> <li>4=somewhat agree,</li> <li>5=strongly agree</li> </ul>	3.33	4	4	1.48	1	5
gender	2. What gender do you identify as?	1=male; 2=female; 3=Prefer not to say	1.75	2	2	0.54	1	3
manager	Select the option that best describes your occupation:	1=Manager; 2=non- manager	1.69	2	2	0.46	1	2

balance	Leaders at my organization encourage employees to practice a healthy balance between work and personal lives.	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.62	4	4	1.27	1	5
valued	I feel valued at my workplace.	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.84	4	4	1.23	1	5
workload	The amount of work and the pace of work I am required to perform is reasonable	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.65	4	5	1.27	1	5
l_notrain	Lack of training would make me consider leaving a position	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	4.12	5	5	1.11	1	5
input	Is your input accounted for in the workplace?	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.97	4	5	1.16	1	5
challenge	Is it important for you to feel intellectually/professio nally challenged in your role?	<ul> <li>1= strongly disagree,</li> <li>2=somewhat disagree,</li> <li>3=neither agree or disagree,</li> <li>4=somewhat agree,</li> <li>5=strongly agree</li> </ul>	3.86	4	5	1.11	2	5
load_in	Has your workload increased during and after the COVID-19 pandemic?	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.73	4	5	1.27	1	5
burnout	Have you experienced burnout due to working in healthcare during and after the pandemic?	1= strongly disagree, 2=somewhat disagree, 3=neither agree or disagree, 4=somewhat agree, 5=strongly agree	3.87	4	4	0.94	2	5
home_w	Were you able to work from home during the onset of the pandemic?	1=Yes; 2=I had the option to choose; 3=Hybrid 4=no	2.78	3	4	1.24	1	4

Although the 209 data length is not very large, it does serve as a strong candidate to be compared with other data sets in various states, regions, countries, etc. As shown in Table 1, the variables used in this study include the following: gender, manager or not, health balance, reasonable workload and pace (*workload*), valued or not in the workplace, input, burnout, option of working from home during the COVID-19 pandemic (*home\_w*), if workload was increased during the COVID-19 pandemic (*Load\_in*), if individuals need to be challenged intellectually/professionally in their role (*challenge*), if lack of training affects retention (*I\_notrain*) and if an individual considered leaving their current job since the onset of the pandemic (*leave\_c*).

# METHODOLOGY

The methodological approach to this study's data collection and analysis is primarily based on a survey given to all participants. Beyond the methodological approach, various forms of statistical analysis were utilized to interpret the collected data. Recruitment for participants took place through various avenues, such as social media, emails, and in-person requests from colleagues, friends, and families who currently work in healthcare. The survey was also circulated among MSU Denver students who worked in the healthcare area with the help of faculty members.

The methodology for analyzing the collected data involved the utilization of several forms of statistical analysis. The dependent variable in this research will be the survey question, "Have you considered leaving your current job since the onset of the pandemic?" with "1" strongly disagreeing, ..., "5" strongly agreeing." Since there are 5 values for this variable, the data may not be normally distributed, therefore, the normality test will be done first using the dependent variable. After the normality test is conducted, if normality does not hold for the data, several non-parametric tests can be performed with the data, such as the One-Sample Wilcoxon test, Independent-Samples Mann-Whitney test, and/or Kruskal-Walli's test.

Finally, we estimate the Ordinal model, to find the predicted change in log odds of leaving the current job, controlling for independent variables (*gender, manager, workload, balance...*etc.). As [30] suggested the generalized linear model could easily choose a link function other than the logit. In addition to the logistic regression model, the variance of the estimates assumes binomial variability, which may not support this data and might lead to an underestimation of the type I error rate [30]. Therefore, I also estimate the Generalized Linear Model to investigate those independent variables' effects on the healthcare workforce's decision to leave or stay at their current job.

### **EMPIRICAL RESULTS**

As expected, the result of the test of normality shows that the dependent variable "*leave\_c*" does not follow a normal distribution since the significance output is <.05, as accessed by the Kolmogorov-Smirnov test (p=0.000, n=209). This means that the assumptions of normality are not met and non-parametric statistical methods such as one-sample Wilcoxon test will need to be used for further analysis.

One-sample Wilcoxon test, a non-parametric test was conducted next. With p=0.000, the decision is to reject the null hypothesis. The One-sample Wilcoxon test is a non-parametric statistical test used to compare the median of a sample to a known value, without assuming a normal distribution

of the data. Therefore, the result of this test shows that the data series of the dependent variable, leave\_c, is not normally distributed.

	Kolmogorov-Smirnov <sup>a</sup>			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
leave_c	0.235	209	0.000	0.835	209	0.000
Note: a. Lilliefors Significance Correction						

**Table 2: Tests of Normality** 

Table 3: One-Sample Wilcoxon Signed Rank Test					
Total N	209				
Test Statistic	21731				
Standard Error	869.095				
Standardized Test Statistic	12.499				
Asymptotic Sig.(2-sided test)	0.000				

In the Mann-Whitney U Test for *leave\_c* across *manager*, the results in Table 4 indicate if being a manager or not could affect the decision to leave the current job. The variable, *manager*, is binomial (1=manager, 2=non-manager) in this study. After running the Mann-Whitney test, we failed to reject the null hypothesis-thesis that being a manager has a different decision of leaving the job compared with the non-managers. The p-value found in the Mann-Whitney test is 0.718 >0.05 for managers, meaning that manager or not does not significantly affect the healthcare workforce's decision to leave their current job.

1 1	• —	0
Total N	209	
Mann-Whitney U	4781.000	
Wilcoxon W	15366.000	
Test Statistic	4781.000	
Standard Error	390.611	
Standardized Test Statistic	0.361	
Asymptotic Sig.(2-sided test)	0.718	

Table 4: Independent-Samples Mann-Whitney U Test for *leave\_c* across *manager* 

The Kruskal-Wallis test was conducted next for each independent variable. The Kruskal-Wallis test is typically conducted to compare the medians of three or more independent groups when the data is not normally distributed. The output of the Kruskal-Wallis test includes the calculated p-value, which helps determine whether the differences between the groups are statistically significant. The independent Kruskal-Wallis Test Summary is reported in Table 5.
According to the Table 5 results, almost all the null hypotheses are rejected, except for *load\_in*. Results show that gender, healthy balance, being valued or not, reasonable workload, no training, input, challenge, burnout, and working at home, significantly influence individuals' decisions of leaving or staying at an organization. For example, the independent variable "challenge," as the null hypothesis-thesis is rejected, which means the level of challenges individuals face influences individuals' decisions to leave or stay at an organization significantly. As for the independent variable "I\_notrin," the null hypothesis-thesis is rejected so that lack of training significantly influences decisions of leaving or staying at an organization. However, for the independent variable "load\_in," the null hypothesis-thesis is retained, thus the different workloads at work did not significantly impact individuals' decisions of leaving or staying or staying at an organization. Even though the Kruskal-Wallis test can determine whether there are significantly different from each other. Therefore, an Ordinal regression test will be conducted next to determine which specific pairs are significantly different.

Variable (label)	Total N	Test Statistic	Degree Of Freedom	p-value		
gender	209	10.686 <sup>a</sup>	2	0.005		
balance	209	46.055 <sup>a</sup>	4	0.000		
valued	209	46.388 <sup>a</sup>	4	0.000		
workload	209	41.420 <sup>a</sup>	4	0.000		
l_notrain	209	28.444 <sup>a</sup>	4	0.000		
input	209	20.451 <sup>a</sup>	4	0.000		
challenge	209	8.147 <sup>a</sup>	3	0.043		
load_in	209	6.831 <sup>a,b</sup>	4	0.145		
burnout	209	11.441 <sup>a</sup>	3	0.010		
home_w	209	27.608 <sup>a</sup>	3	0.000		
Notes: a. The test statistic is adjusted for ties.						
b. Multiple comparisons are not performed because the overall test does not show						
significant differences across samples.						

Table 5: Results from Independent-Samples Kruskal-Wallis Tests

Finally, the ordinal regression was conducted, the results of Ordinal Logistic Regression are reported in Table 6. The goodness of fit test (Table 7) is used to determine how well a model fits the data. In this case, the table contains the Deviance and Pearson chi-square tests, which are useful for determining whether a model exhibits good fit to the data. The significant test results are

indicators that the model does not fit the data very well. These results indicate that there is a low level of agreement between observed values and expected values, which means the model appears not fitting the data. Therefore, we estimate the Generalized linear regression model for the data.

							95%	
		Estimata	Std.	Wold	đf	Sia	Confidence	
		Estimate	EIIOI	wald	ai	Sig.	Interval	T.T
							Lower	Upper
							Bound	Bound
Threshold	$[leave_c = 1]$	-17.608	2.640	44.490	1	0.000	-22.782	-12.434
	$[leave_c = 2]$	-16.972	2.607	42.392	1	0.000	-22.081	-11.863
	$[leave_c = 3]$	-15.532	2.537	37.490	1	0.000	-20.503	-10.560
	$[leave_c = 4]$	-13.473	2.498	29.087	1	0.000	-18.370	-8.577
Location	gender	-5.790	0.700	68.378	1	0.000	-7.162	-4.417
	оссир	-1.874	0.451	17.273	1	0.000	-2.758	-0.990
	balance	1.947	0.269	52.341	1	0.000	1.420	2.475
	valued	-3.112	0.379	67.448	1	0.000	-3.855	-2.369
	workload	-0.948	0.203	21.803	1	0.000	-1.346	-0.550
	l_notrain	0.634	0.195	10.620	1	0.001	0.253	1.015
	input	0.881	0.283	9.682	1	0.002	0.326	1.436
	challege	-0.632	0.258	6.028	1	0.014	-1.137	-0.128
	load_in	-0.971	0.222	19.114	1	0.000	-1.406	-0.536
	burnout	1.988	0.324	37.584	1	0.000	1.352	2.623
	home_w	-0.585	0.137	18.128	1	0.000	-0.854	-0.316

Table 6: Results from the Ordinal Logistic Regression

Link function: Logit.

Table 7: Goodness of Fit for Ordinal Logistic Regression

	-		r		
	Chi-Square	df	Sig.		
Pearson	2765.110	109	0.000		
Deviance	449.160	109	0.000		
Link function: Logit.					

The results from the Generalized linear regression model are reported in Table 8. The Exp(B) are

the odds ratios that indicate the change in the odds of leaving the current job for every level increase on the independent variable, holding other variables constant. According to the results in Table 8,

-being a female healthcare workforce has a predicted increase of 0.003 in the log odds of leaving the current job. This indicates that the female healthcare professional is more likely to have one level higher on leaving the current job, compared with the male individual with the same working conditions.

-being a healthcare manager has a predicted decrease of 0.153 in the log odds of leaving the current job, indicating that the manager is more likely to have one level lower on leaving the current job, compared with the non-manager with the same working conditions.

-the individual with a healthy balance has a predicted increase of 7.008 in the log odds of leaving the current job. This indicates that healthcare professionals with a healthy balance between work and personal lives are more likely to have one level higher upon leaving their current job.

-the individual who feels being valued at the workplace has a predicted increase of 0.045 in the log odds of leaving the current job.

-the individual with a reasonable workload and pace of work has a predicted increase of 0.387 in the log odds of leaving the current job.

- the individual who lacks training at work has a predicted increase of 0.387 in the log odds of leaving the current job. Based on the result, individuals who do not receive sufficient training were more likely to leave their current organization.

-the individual whose input is accounted for in the workplace has a predicted increase of 0.387 in the log odds of leaving the current job.

-individuals who feel intellectually/professionally challenged in their role have a predicted increase of 0.387 in the log odds of leaving the current job. Thus, individuals who are intellectually/professionally challenged are more likely to leave their current jobs.

- the individual whose workload increased has a predicted increase of 0.387 in the log odds of leaving the current job. Based on the result, individuals with an increased workload during and after the COVID-19 period were more likely to leave their current organization.

-the individual who experienced burnout has a predicted increase of 0.387 in the log odds of leaving the current job.

-the individual who has less opportunity to work from home has a predicted increase of 0.387 in the log odds of leaving the current job. Thus, individuals with a higher possibility of working at home were unwilling to leave their current job.

Parameter		В	Std. Error	95% Wald Confidence Interval		Hypothesis Test			Exp(B)	95% Wald Confidence for Exp(B)	e Interval
				Lower	Upper	Wald Chi- Square	df	Sig.		Lower	Upper
Threshold	[leave_c=1]	-17.608	2.620	-22.742	-12.474	45.182	1	0.000	0.000	0.000	0.000
	[leave_c=2]	-16.972	2.580	-22.028	-11.916	43.279	1	0.000	0.000	0.000	0.000
	[leave_c=3]	-15.532	2.516	-20.463	-10.600	38.101	1	0.000	0.000	0.000	0.000
	[leave_c=4]	-13.473	2.489	-18.352	-8.595	29.299	1	0.000	0.000	0.000	0.000
gender		-5.790	0.704	-7.169	-4.410	67.662	1	0.000	0.003	0.001	0.012
manager		-1.874	0.449	-2.755	-0.994	17.398	1	0.000	0.153	0.064	0.370
balance		1.947	0.267	1.424	2.470	53.299	1	0.000	7.008	4.155	11.819
valued		-3.112	0.377	-3.851	-2.373	68.152	1	0.000	0.045	0.021	0.093
workload		-0.948	0.212	-1.363	-0.534	20.083	1	0.000	0.387	0.256	0.586
l_notrain		0.634	0.194	0.255	1.013	10.739	1	0.001	1.885	1.290	2.755
input		0.881	0.277	0.339	1.423	10.150	1	0.001	2.413	1.404	4.149
challege		-0.632	0.236	-1.094	-0.171	7.207	1	0.007	0.531	0.335	0.843
load_in		-0.971	0.228	-1.419	-0.523	18.067	1	0.000	0.379	0.242	0.593
burnout		1.988	0.327	1.347	2.629	36.943	1	0.000	7.300	3.845	13.858
home_w		-0.585	0.132	-0.844	-0.325	19.497	1	0.000	0.557	0.430	0.722
(Scale)		1a									
Dependent Variable: <i>leave_c</i>											
Model: (Threshold), gender, occup, balance, valued, workload, l_notrain, input, challege, load_in, burnout, home_w											
a. Fixed at the displayed value.											

# Table 8: Results from the Generalized Linear Models

	Chi-Square	df	Sig.		
Pearson	449.16	109	4.121		
Deviance	2765.11	109	25.368		
Link function: Logit.					

Table 9:	Goodness	of Fit for	Generalized	<b>Linear Models</b>
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The goodness of fit test (Table 9) for the Generalized Linear Models indicates that the model fit the data very well with the insignificant p-values for both Pearson and Deviance statistics. Hence, the General linear model appears fit the data and perform better on estimate the relationship between those independent variables and the dependent variable,  $leave_c$ .

#### **DISCUSSION AND CONCLUSION**

This research analyzed factors that have influenced retention among the healthcare workforce before and during the COVID-19 pandemic by discussing topics like the option to work from home, challenges in the workplace, workload increasing during the pandemic, and the importance of training, which helped to figure out what has been effective and what can be improved to better support and retain the healthcare workforce. The 209 survey responses in this study served as a clear lead to understanding the issues related to retention in healthcare in Denver, CO. We were able to draw conclusions that helped us understand how we can start working on the drop in retention rates in the healthcare field. Even though a lot of individuals have faced similar impacts of the COVID-19 pandemic and the post risks, various factors could influence one's decision to either stay or leave their current organization.

According to the empirical results, the females, healthy balance, lack of training, and being intellectually/professionally challenged are associated with an individual's decision to leave that organization. On the other hand, being a manager and the increased probability of working from home, are related to the decisions of staying at an organization. The more training an organization offers, the less likely the employees are to leave.

This study has several limitations within this research. First, the sample was recruited mostly from Denver, Colorado. Secondly, it was assumed that anyone who works in healthcare is impacted by COVID-19 and the post risks which could have altered the response from the participants. For future studies, it is recommended to increase the sample size and focus only on one sector of healthcare such as nurses, physicians, employees in a long-term care facility, etc. that may help to understand the needs of a specific group more in-depth. It could give researchers a better understanding of the population that shares similar benefits, salary, and working environment. Also, it would help attain a better understanding of the strategies that should be developed for each position and answer the "why." Further, detailed questions would provide deeper insight since healthcare roles require specific skill sets.

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## THE HEALTHCARE SUPPLY CHAIN WICKED PROBLEM: THE THEORY OF CONSTRAINTS SOLUTION AND EXPLORATORY JOURNEY

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#### ABSTRACT

The global healthcare crisis has been viewed as a wicked problem. However, its solution is obvious: to provide more, cheaper, better, and faster healthcare delivery with existing resources or with little additional expenditures. "But how?" is the question. The purposes of this research are threefold. First, we discuss the Theory of Constraints (TOC), three processes of ongoing improvement and their modifications, the foundation for significant healthcare supply chain (HCSC) improvement, and other tools needed to provide you with a background for implementing these tools in your local healthcare environment. Second, the abductive research process and journey of exploration are described from its initial goal and subsequent changing goals to its destination of providing a direction for a solution to the global HCSC crisis. The thirteen-plus-year journey of exploration started with action research to save a large primary care provider practice from being sold. In addition to making the practice an ever-flourishing organization, based on an extensive literature review to find a better solution, the research led to the development of generalized guidelines for improving other outpatient medical practices. During the literature review, the terms "wicked problem," "ill-defined problem," "ill-structured problem," and "messy problem" were used to describe the healthcare environment and led to an investigation that recognized that no solution process existed for wicked problems. In addition to supporting the generic nature of the solution process for outpatient medical practices, Simon's work on the decomposition of hierarchical systems led to the construction of a generic process for solving hierarchal wicked problems and an understanding of the disjointed hierarchical structure of the US and other government healthcare systems. The disjointed nature of the operations (doers) level of the HCSC led to the development of a method for synchronizing healthcare resources within a community. This journey of exploration is described to encourage other researchers to apply T. S. Eliot's quote to their research efforts. When one achieves a research goal, return to the journey's start and determine if the solution is complete, the goal needs to be expanded, and the solution is implementable. You are not at your destination if the answer is no to any of these three questions. Third, an approach to implementing the TOC solution to the global HCSC wicked problem has been proposed. We invite you to involve yourselves in this research stream.

#### **INTRODUCTION**

The global healthcare crisis is a wicked problem [46, 77, 78, 84, 101]. Unfortunately, wicked problems have no solution process. Academics [3, 48, 49, 51, 75, 76] have tried for over 70 years to solve pieces of the healthcare wicked problem. Most researchers approach the problem as an optimization problem of one dimension (usually cost or provider utilization), one department, e.g., the emergency department [4, 55] or the operating room [1]. Limiting (and usually unspoken) assumptions such as the model being based on one-provider, one-appointment type, and equal time increment appointments simplify the problem for mathematical modeling convenience but solve what is now a non-problem. Instead, researchers must recognize and model the complexities of the healthcare environment (high uncertainties of patient arrivals, treatment types, and times until patients present themselves at the ED, and high uncertainties in patient walk-ins and no-shows in outpatient medical practices). Modelers fail to list the unspoken model and environmental assumptions required to fit current reality into a mathematical optimization model. An examination of the past literature reviews and critiques of healthcare research [7, 24, 82, 102] supports this conclusion, citing the lack of real-world implementations and the lack of generalizability of solutions. Now, with the growth of data analytics and the availability of larger and larger data sets [6], we envision seeing more of these same types of models.

Most studies focus on improving resource utilization or cost performance measures in healthcare environments. However, the measure that causes significant changes in other healthcare measures (quality of treatment, patient outcome, and cost) is <u>timeliness</u> and time. It is the primary driver of other measures. Our recognition of timeliness as the key factor and the prime measure in healthcare is supported by healthcare organizations. While the World Health Organization [100] recognizes the importance of timeliness in treating healthcare problems, the California government [5] enacts regulations on how long providers have before responding to patient needs. Unfortunately, neither organization provides guidance on <u>how</u> these overworked healthcare provider organizations can respond to these directives.

In contrast, academic research has provided little to no attention concerning the importance of timeliness in treating patients with a focus on provider utilization, cost of overtime, etc. This timeliness of treatment frequently impacts cost directly but is unaccounted for in academic research. For example, when a patient calls a provider needing an acute appointment and is given an appointment a couple of days or weeks and sometimes months into the future, the patient may seek treatment elsewhere, e.g., the hospital emergency department (ED) or urgent care clinic and result in a no-show for the appointment at the provider's practice. The academic research pays close attention to the cost of a no-show for a provider but fails to consider the cost to the patient, insurance company, etc. associated with the patient attending the hospital ED in the next few days. In a study of avoidable healthcare costs, United Health Group [95] found that two-thirds of insured

patients visits to a hospital ED could have been treated by a primary care provider if seen in a timely manner. The causes of these visits included "bronchitis, cough, dizziness, flu, headache, low back pain, nausea, sore throat, strep throat and upper respiratory infection." An ED visit costs twelve times more than a primary care provider visit. No research model includes these increased healthcare expenditures caused by delayed patient treatment, which is caused by ineffective primary care scheduling/execution. These costs are born by other links in the healthcare supply chain not the link under study (local optima).

While the solution to the healthcare supply chain (HCSC) wicked problem is obvious: to provide more, cheaper, better, and faster healthcare delivery with existing resources or with little additional expenditures, research still needs to provide the solution process to achieve this wicked problem solution. This research focuses on how to solve this HCSC wicked problem and the journey of discovery to achieve this goal. This paper provides an approach to achieve more, cheaper, better, and faster delivery of healthcare with existing resources or with little additional expenditures.

Thus, the purposes of this research are threefold. First, we discuss the Theory of Constraints (TOC), three processes of ongoing improvement and their modifications to provide the foundation for significant HCSC improvement. Additionally, other TOC tools needed to provide you with the ability to implement TOC in your local healthcare environment are provided. Second, the abductive research process and journey are described from its initial goal and subsequent changing goals to its destination of providing a direction for a solution and an implementation process for the HCSC crisis. The thirteen-plus-year journey of exploration started with action research to save a large primary care provider practice from sale. In addition to making the practice an everflourishing organization (a medical practice that makes significant money, provides excellent and timely healthcare, and has motivated and loyal employees now and in the future) based on an extensive literature review to find a better solution, the research led to the development of generalized guidelines for improving other outpatient medical practices. Next, the terms "wicked problem," "ill-defined problem," "ill-structured problem," and "messy problem" were used to describe the healthcare environment and led to an investigation that recognized that no solution process existed for wicked problems. In addition to supporting the generic nature of the solution process for outpatient medical practices, Simon's work on the decomposition of hierarchical systems led to the construction of a generic process for solving hierarchal wicked problems and an understanding of the disjointed hierarchical structure of the US and other government healthcare systems. The disjointed nature of the operations (doers) level of the HCSC led to the development of a method for synchronizing healthcare resources within a community. This journey of exploration is described to encourage other researchers to apply T. S. Eliot's quote (provided above) to their research efforts. When one achieves a research goal, return to the journey's start and determine if the solution is complete, the goal needs to be expanded, and the solution is implementable. If the answer is no to any of these three questions, you are not at your journey's destination. Third, we provide a solution to the global HCSC wicked problem based on your involvement in implementing a community theory of constraints (C-TOC) healthcare supply chain project where you live. We invite you and your colleagues to involve yourselves in this research.

The paper's organization starts with this introduction. Second, a brief history and discussion of TOC tools, focusing on the TOC processes of ongoing improvement (POOGI) and references for further understanding of the TOC tools is provided. Third, the multimethodology using abductive logic and concepts from Goldratt and Simon and based on the dimensions of time and scope provides a direction for the solution and an implementation process to this wicked problem. Fourth, the journey milestones from its beginning with the use of action research of a TOC implementation at one large primary care practice to the journey destination of a proposed solution to the global healthcare crisis. Fifth, a summary and discussion of how you can help to implement the wicked problem solution is described.

#### A BRIEF HISTORY AND REVIEW OF THE TOC PROCESSES OF ONGOING IMPROVEMENT

Isaac Newton's quote applies to this journey of exploration: "If I have seen further, it is by standing on the shoulders of giants." I have used (and misused, which is entirely my fault) the learnings of many scholars. I would be remiss if I failed to acknowledge their contributions in making my journey fruitful. Two eminent scholars stand out in my work, and another has gone before me during my journey and developed the TOC solution to the major segment of the HCSC. Goldratt and Simon provided the foundation for my journey, and Alex Knight developed and provided the TOC solution to managing hospital complexes and other health and social care links in the HCSC. I will discuss Knight's contributions in a later section. I use the term, we, in several places in this manuscript to acknowledge that I could not have reached this understanding without the contributions and assistance of many others.

**Goldratt.** Eliyahu M. Goldratt, a Ph.D. physicist turned business consultant, (and Jeff Cox) coauthored The Goal [5], a business novel socratically teaching the early foundations of the Theory of Constraints (TOC). As Goldratt developed additional concepts, he expanded the scope by revising the content of The Goal [6-9] through additional editions. Most academics and business and healthcare professionals are unaware of Goldratt's work after writing The Goal and, when asked about the Theory of Constraints, mention The Goal only. Please read The Goal [40], most recent edition and The Choice [44] to better understand the increased scope of TOC. However, Goldratt authored [27-36] and coauthored [42, 44, 45] several books on other topics. Goldratt was first and foremost a scientist and a systems thinker, applying the scientific method and systems thinking to the social sciences, i.e., the <u>management</u> of systems from individuals to projects, organizations, and supply chains and from linking individual functions to strategy and ultimately to organizational goals through causal relationships. See Goldratt's bibliography [23]. See also the TOCICO video presentation portals by topic: https://www.tocico.org/page/portaltopics).

Goldratt [44 Chapter 1] viewed his consulting engagements as scientific experiments conducted to hypothesize causal relationships and then determine the truth and validity of his hypotheses. Several TOC terms and definitions are provided in Tables 1 and 2 based on the TOCICO Dictionary, 2nd edition [17]. To better understand this discussion, please read the table definition as the term appears in the text.

## Table 1. TOC terms and definitions.

**Theory of constraints** (TOC) p. 119. – A holistic management philosophy developed by Dr. Eliyahu M. Goldratt that is based on the principle that complex systems exhibit inherent simplicity, i.e., even a very complex system made up of thousands of people and pieces of equipment can have at any given time only a very, very small number of variables – perhaps only one (known as a constraint) – that limit the system's ability to generate more goal units.

**Process of ongoing improvement** (POOGI) p. 96. – Methods used to achieve continuous improvement with respect to one's goal. Three processes of ongoing improvement exist: the five focusing steps, the change question sequence, and buffer management.

**five focusing steps** p. 57.– A systematic five-step approach used to continually improve a system's ability to produce goal units:

- 1. IDENTIFY the system's constraint(s).
- 2. Decide how to EXPLOIT the system's constraint(s).
- 3. SUBORDINATE everything else to the above decision.
- 4. ELEVATE the system's constraint(s).

5. WARNING!!!! If in the previous steps a constraint has been broken, go back to step 1, but do not allow INERTIA to cause a system's constraint.

One of three processes of ongoing improvement in TOC.

**buffer management** (BM) p. 14. – A control mechanism based on the amount of time (till the due date) or stock remaining used in the execution phase of TOC applications (operations, project and distribution). Buffer management consists of four main functions:

1. Prioritize tasks/orders based on buffer penetration/consumption.

2. Signal when to expedite individual tasks/orders that are at risk (normally identified by penetrating the red zone of the buffer).

3. Provide feedback to the planning process to consider changing certain parameters, like buffer sizes or even take more drastic actions like adding capacity.

4. Identify prime causes of delay to focus ongoing improvement activity.

**change question sequence** (CQS) p. 25 - 1. One of three processes of ongoing improvement in theory of constraints (the other two processes are the five focusing steps and buffer management). The three questions that must be answered in the successful management of change within a system. The change question sequence answers the following three questions:

- 1. What to change?
- 2. To what to change?
- 3. How to cause the change?

2. Recently, two additional questions that must be answered in the successful management of change have been added. The revised change question sequence includes the following five questions:

- 1. Why change?
- 2. What to change?
- 3. To what to change?
- 4. How to cause the change?
- 5. How to measure and sustain the change?

Reference: Cox, J. F., Boyd, L. H., Sullivan, T. T., Reid, R. A., & Cartier, B. (Eds.). The TOCICO Dictionary, (2012) (2nd ed.). New York: McGraw-Hill.

#### Table 2. TOC Change question sequence definitions for questions.

**why change?** p. 134. – The first question in the new change question sequence. The question focuses on determining why a change to the system is necessary.

Usage: There are two bases for answering this question: 1. The strong belief that the system can perform significantly better and achieve higher levels of its performance measurements, or 2. The recognition of undesirable effects (UDEs) in the current environment that demonstrate either the gap between what is and what should be the environment, or the gap between where the organization is and where it should be with respect to its goal. Typically, a gap analysis of where the organization is versus where it wants to be or a listing of UDEs versus the desirable effect is used to help determine the answer to this question.

**what to change?** p. 134. – The first question in the original change question sequence and the second question in the newer change question sequence. The question focuses on identifying the system's or organization's core conflict and core problem(s).

Usage: Typically, the evaporating cloud and current reality tree are the two thinking processes that are used to answer this question.

to what to change? p. 124. – The second question in the original change question sequence and the third question in the newer change question sequence. The question focuses on determining a set of injections that will eliminate the undesirable effects in the system or convert the majority of them to desirable effects. The objective of answering this question is to construct simple practical solutions.

Usage: Typically, the evaporating cloud, future reality tree, and negative branch reservation are the thinking processes that are used to help answer this question. The answer to this question logically describes a desirable future state of the system.

**how to cause the change?** p. 64-5. – The third question in the original change question sequence and the fourth question in the newer change question sequence. The focus of the question is on developing an implementation plan for the change.

Usage: Typically, the prerequisite tree and the transition tree are the thinking processes that are used to help determine the plan and detailed actions required to respond to this query. The objective in asking this question is to induce the proper people to invent solutions along the lines of those constructed in answering the preceding question in the change sequence – what to change to?

Perspective: How to cause the change includes, but is not limited to, creating a plan for implementing change. It also includes involving the appropriate people at the appropriate times in the other two steps of the change question sequence, as well as facilitating the process of those people creating the solution rather than dictating the required change(s).

**how to measure and sustain the change?** p. 65. – The fifth question to be answered in the newer change question sequence. The focus of the question is on developing mechanisms to measure the impact of changes (as a reinforcing feedback loop) and achieving and maintaining a process of ongoing improvement.

Usage: The three processes of ongoing improvement – the five focusing steps, the change question sequence, and buffer management – provide feedback mechanisms for continuous improvement. For success, sustainability must be a management priority with executive follow-up on sustainability and obstacles to progress.

Reference: Cox, J. F., Boyd, L. H., Sullivan, T. T., Reid, R. A., & Cartier, B. (Eds.). The TOCICO Dictionary, (2012) (2nd ed.). New York: McGraw-Hill.

Two additional TOC concepts provide the foundation for building our multimethodology: inherent simplicity and inherent classification. The ability to build effective causal diagrams is built on these concepts. To think clearly one must have the ability to logically view reality.

In chapter 4 of The Choice [43], Goldratt describes the concept of <u>inherent simplicity</u>, as "the foundation of all modern science" based on cause-and-effect analysis (Why? and If-Then), Through simple common-sense logic, the analyst determines WHY an effect exists and under what conditions (assumptions) the cause-and-effect relationship holds, checking by using IF\_\_THEN and IF\_\_AND (assumption) THEN logic to determine causality. This logical process of diving downward is continued till the root cause is identified and the situation then becomes crystal clear. The CRT tree illustrates the hypothesis that a few causes, even one (the core problem) cause several effects higher in the CRT. This same logical cause-and-effect process is used to build a win-win solution in the FRT.

In The Choice [39, 40 Chapter 4], Goldratt discusses the concept of inherent classification calling it intrinsic classification in discussing "the usefulness of classifying data."

The question becomes: **How does one, do as scientists do, classify data (find the intrinsic order) to analyze the data to achieve the research's purpose?** In a personal communication with the author and others, Goldratt [38] stated:

"The most intuitive structure to a body of knowledge is a classification. But, as I already explained in the last edition of The Goal (2nd revised edition, Chapter 38, 1992, my addition), classification is really meaningful only if it is the <u>inherent classification</u> – a classification that stems from the basic element of cause-effect. No problem; the mere fact that there is a guiding principle indicates that the inherent classification is at our grasp (probably already exists as one of the subjects) ... Therefore, a good frame will exist if the guiding principle is used to logically develop the sequence in which the classification emerges. And to explain the subjects at their proper place, the place provided by the classification."

While TOC experts defined the TOC as a holistic management philosophy, Goldratt [37 Chapter 1] defined TOC as one word: focus. He further defined focus as doing what should be done but, more importantly, not doing what should not be done. Instead of spending time on what should not be done, management can focus their actions. However, to distinguish which actions to take or not, one must first know the system's goal to understand the meaning of focus. Then, one should focus on activities that move the organization closer to achieving the goal and not focus on activities that have little to no impact (and sometimes a negative impact) on achieving the goal. To improve the system's performance concerning its goal, one must identify and address what limits its performance, called a constraint. Of all the thousands of actions that any organization could take, what one or two actions would move the organization closer to achieving its goal? Goldratt continues in this introductory chapter to describe his journey in developing TOC concepts. The description of my TOC work in healthcare uses this journey analogy to organize and present my research.

#### **Processes Of Ongoing Improvement**

Goldratt developed three processes of ongoing improvement (POOGI) (Table 1) that provide this system focus on identifying what (resource, person, material, policy, measures, etc.) is blocking or limiting the system or organization from achieving more of its goal. The five focusing steps process (Table 1) is the first POOGI that should be used to analyze the system.

**Five Focusing Steps.** The process flow chart of a simple 5-station, I-structure line is provided in Figure 1 to illustrate a few traditional versus TOC line concepts. The application of these concepts is illustrated with specific examples in healthcare later. In traditional line design, industrial engineers strive to balance the work center (WC) times on the line to achieve a 100%-line efficiency based on each WC doing their best at their tasks. Figure 1a shows this industrial-engineered line processing capabilities in units/day (u/d). Interestingly, neither the theoretical line measures output nor cycle time (the time for a unit to get through the line) can be achieved. Why? These formulations are based on mean processing times and independent resources. The calculations are deterministic and do not consider the impacts of statistical fluctuations on dependent resources. Goldratt identified these line characteristics and described their impacts on output and lead times in The Goal [41 ch 13-16], illustrated by Herbie on his scout hike.

In TOC, we use several processes to improve constraint utilization and process flow. They are illustrated in Figure 1. In Figure 1 a, the constraint is WC 2, the slowest work center. We identify where the constraint should be in applying the five focusing steps. Where the constraint is located and where it should be located (the strategic constraint) are seldom the same. Suppose WC3 is the logical choice as it has the scarcest skill set or is the most expensive resource in the process. Therefore, we want to achieve this resource's highest utilization possible. A TOC analyst applied the five focusing steps to this line with the results provided in Figure 1 b. Why are the WC task times (measured in number of units produced per day, u/d) changed? After identifying the strategic constraint or leverage point), the TOC analyst applies step 2, where they decide what skill levels only WC3 should do and what can be performed by other WCs given proper training. These lower skill-level tasks are assigned to other WCs, thus reducing the average processing time and therefore increasing the throughput of WC 3. In step 3, Subordinating all else to the constraint means that all other WCs should perform their tasks to support the constraint and the flow to and from WC 3. Steps 4 and 5 are discussed using specific examples in this paper's results section. In Figure 1 c, buffers are placed at strategic points in the process to illustrate a point. As noted in the figure, a constraint buffer (measured in inventory or time) is placed before and a space buffer after WC3 to protect the constraint from disruptions at downstream WCs. Work-in-process (WIP) materials should always be present before WC 3 to prevent constraint starvation and ensure high utilization.

But again, this is the theoretical capacity, not the demonstrated throughput of the line. After the five focusing steps calculations, one must buffer the line to prevent WC disruptions that cause constraint stoppage; after all, the constraint determines the throughput of the whole line. Therefore, the constraint should be buffered against interruptions from other sources. All materials necessary to perform the tasks at WC 3 should always be stocked with work-in-process inventory before the WC. A space buffer is located behind the WC to ensure that the WC has ample space to offload its finished items and will not be blocked by downstream disruptions. A constraint interruption report

should record the causes of constraint stoppages (starvation, breakdowns, and blockages). Finally, the shipping buffer pulls the WIP through the remaining WCs to the shipping department. Of course, if more than one product is produced on the line, one has to use throughput accounting to determine the proper product mix to produce to optimize throughput in dollars.

#### Figure 1. Process flow of a simple I structure.

a. Traditional Engineered line with each WC to be efficient.



b. TOC engineered using five focusing steps to be efficient.



c. TOC engineered using strategic buffers to protect the constraint from disruptions.



d. TOC engineered using drum buffer rope scheduling to schedule the constraint.



e. TOC-engineered using weekly BM meetings to eliminate/reduce disruptions.



One cannot just insert buffers everywhere in a line to gain throughput, the TOC analyst must implement a scheduling and execution system based on the constraint throughput. Goldratt devised

drum-buffer-rope (DBR) and later simplified drum-buffer-rope scheduling (S-DBR) to maintain and improve this balance between throughput and lead time using buffer management. The drum and drum beat paces the line with the constraint being the drum and the pace being the rate of production (u/d) being its beat. The buffer is the amount of WIP measured in inventory or time between raw materials release and the constraint. Buffer size is a double-edged sword. If one floods the line with WIP to protect throughput, lead times grow significantly, but if one reduces WIP to ensure short lead times, one jeopardizes throughput (starves the constraint). One would like to maximize throughput and minimize cycle time. The rope is the communications mechanism between the constraint and raw materials release. Usually as one unit is completed on the constraint another is released to the line.

If one examines the academic research on comparing the TOC scheduling (and execution) method, after reading the above section, they would recognize several unspoken assumptions which caused significant distortions in line measures. Please identify and correct these errors in your research efforts. For example, most researchers fail to implement the five focusing steps as part of the analysis, instead they only implement step 1 Identify the constraint. The error is identified by the use of the same processing times for each work center. Instead, the researcher must identify the strategic constraint, offloading this work center of lower skill level tasks, and revising work center job descriptions and tasks. The traditional line is designed to make each work center as efficient as possible, whereas the TOC line is designed to make the line as efficient as possible based on the constraint capacity. Researchers also fail to implement buffer management (BM) as part of drumbuffer-rope scheduling (BM trims the long tails of the skewed distributions, making them similar to a normal distribution shape). BM reduces cycle time significantly by eliminating disruptions at the non-constraint work centers that starve or block constraint throughput. Additionally, most academic researchers simulate only one product instead of simulating a few or several products, crossing the constraint, each with different setup and processing times. This scenario creates a situation where line throughput has to be measured in dollars instead of units of one product. One has to examine the performance measures of actual production lines compared to these simulation models to realize the causes of the errors in these research models. See Mabin and Balderstone [79, 80] and, more recently, the work of Lang [46], which both provide results of actual TOC implementations. Simulation models should be providing similar results to the actual results.

**Strategic Buffers and Buffer Management.** Buffer management (BM) is defined in Table 1. BM is an early warning system monitoring the <u>execution</u> of tasks, projects, etc., to determine whether the tasks or projects are scheduled to arrive at the constraint or shipping or are trending towards lateness. The buffer is divided into three regions or zones (green, yellow and red). The current status of where the item is located in its routing and what buffer region it falls in. The green zone means that the part, task, or project is on schedule (the action is to do nothing), the yellow zone means that the item is approaching lateness (the action is to develop a plan to address the problem), and the red zone means that unless action is taken, the item will be late (the action is to execute the plan) so that proactive actions can be taken to prevent the lateness. The black region means that the item is already late. Buffers should not be located everywhere in the production process; they should be located at strategic points in the process, e.g., at raw materials release, at the constraint, at convergent points, prior to divergent points and at shipping. In complex structures,

buffers may be located at in-process work centers to reduce long lead time parts. See the demanddriven MRP literature for details.

**The Change Question Sequence.** The CQS provides a systematic problem structuring, solution, implementation and operation process to identify the system's (person, project, organization, supply chain, etc.) core problem, develop a comprehensive solution containing local measures causally linked to global measures, etc., and an implementation plan. The five-question sequence (including the original 3 questions) is described in Tables 1 and 2.

The CQS (Cox et al., 2012 p. 25) must be answered in successfully managing change. The five queries in the CQS (Table 1) provide an effective structure for conducting <u>action research</u>. In my use, the involved top and functional managers and key staff respond to an open-ended questionnaire. The questions relate to the organization, department, and personal goals, individual responsibilities in achieving these goals, the biggest problem blocking goal achievement, the cause of the problem, the effects created by the problem, the conflict blocking them from solving it, etc. These compelling reasons are usually stated at the organization level (Q1) by top management and the functional and doer level (Q2). (See Q1. Why change? and Q2 What to change? in Table 2).

Q1. Why change? This question is addressed to the top management and represents undesirable organizational effects such as the organization making little or no profit, not providing an excellent product/service, and workers being unmotivated, uneducated, and untrainable. These UDEs provide the compelling reason(s) or need for <u>organizational change</u>. At the <u>functional manager</u> and staff levels (the operations or doer level), the UDEs might include: orders are always late, raw materials are poor quality and delivered late, overtime and premium shipping are frequently used, customers frequently cancel orders based on long lead times, etc. Each of these UDEs represents a conflict that exists in the organization.

Q2. What to change? For each of these UDEs, an evaporating cloud (See Figure 2 a) can be constructed, and the assumptions surfaced around the conflict shown in the EC. These two levels of UDEs (the partners answers to Q1 and the clinical staff answers to Q2) can be connected causally, with the organization level being the effects and the functional levels being the causes. Also, it is possible to dive deeper into the functional UDEs, thereby identifying causal relationships to determine the organization's core problem. Abductive logic and the categories of legitimate reservation (the rules of logic) are used to connect the UDEs to the core problem in building the current reality tree (see Figure 2 b). Several references on the thinking process exist, including chapters or books [10, 11, 25, 81, 90, 91] and free video workshops on the TOCICO website. The menu "learn TOC" has a tab for "Free Videos) which includes cases and workshops, including the thinking processes workshops.

# Figure 2 Thinking processes supporting Q2. WHAT TO CHANGE?



a. Evaporating cloud (EC) & assumptions (As)

b. Current reality tree (CRT).



Q3. What to change to? The core problem must be identified (by surfacing and challenging the EC assumptions of the core problem) and addressed by identifying primary and secondary injections (actions) to reduce or eliminate the impact of the UDEs. Focus, Goldratt's definition of TOC, plays a major role here. Q2. What to change? Of the thousands of problems in most organizations today, what one or two problems, if solved, would create significant and rapid improvement concerning achieving the organization's goal(s)? The EC and CRT identify the system core problem and its causal relationships to doer and partner problems (UDEs). Again Focus, Q3. To what to change? Of the thousands of proposals to improve the organization, what one or two proposals would cause significant and rapid improvement in achieving the organization's goal(s)? The EC, with its injections (Figure 3 a) and the future reality tree (Figure 3 b), build a comprehensive solution for the organization.

## Figure 3. Thinking processes supporting Q3. TO WHAT TO CHANGE?



a. Evaporating cloud (EC) and injections (inj.).

#### b. Future reality tree (FRT) and injections (PI & SI).



Q4. How to cause the change? The implementation plan for the changes is answered by building a prerequisite tree, the plan for achieving the actions in the future reality tree.

Q5. How to measure and sustain the change is answered by replacing local optima measures with global measures and creating new job descriptions to sustain the changes.

#### Simon

Herbert A. Simon [83] won the Nobel Prize in Economic Science in 1978 for his many contributions to Economic Science, which provided a paradigm shift in better understanding organizational decision-making. Simon's works were of the utmost importance for discovering this

new perspective of how managers make decisions. Previous thought was that managers made decisions based on optimization. (Interestingly, many academics never got this message, as shown by their focus on developing optimization models to assist decision-makers.) Simon's book, Administrative Behavior (1947), and various journal articles described organizations as adaptive systems, a network of intercommunications and its members' willingness to cooperate and strive towards a common goal. Simon is known for his contributions to other fields, including psychology, artificial intelligence, statistics, etc.

**Satisficer, not optimizer.** Simon challenged and rejected the fundamental assumption of the classic theory of the firm: the decision maker is omniscient (having complete knowledge surrounding the decision environment), acts rational (not emotional), and is profit-maximizing (an optimizer). He replaces this assumption with the assumption that the decision maker is <u>satisficing</u>. The decision makers' capacities for rational action are limited by a lack of knowledge about the effects of their decisions, the amount of time devoted to the decision, and emotions. Given these limitations, the decision-makers choose a satisfactory alternative.

**Principle of Hierarchal Decomposition (PHD).** From our perspective, two definitions [92 p. 468, 482] and using these definitions in <u>describing</u> systems are important: system complexity and hierarchic systems. Simon defines system complexity as a system "made up of a large number of parts that interact in a nonsimple way." Simon then defines a hierarchic system "as a system that is composed of interrelated subsystems, each of the latter being in turn hierarchic in structure until we reach some lowest level of elementary subsystem." In discussing complex systems, Simon (p. 481) continues: "How complex or simple a structure is depends critically upon the way in which we describe it. Most of the complex structures found in the world are enormously <u>redundant</u>, and we can use this redundancy to <u>simplify their description</u>. But to use it, to achieve the simplification, we must <u>find the right representation</u>."

Simon [92] discusses system complexities in social and physical sciences as a way of <u>describing</u> the commonality of complex systems at the theoretical level but he failed to apply the concepts of hierarchical decomposition (we named his concept: Principle of Hierarchical Decomposition, PHD). In contrast, Goldratt was interested in how to <u>manage</u> complex systems. One manages a complex system by implementing the three POOGI. Our purpose in this research is to design and <u>manage</u> an effective healthcare supply chain. Hence, we combined Goldratt's Simon's and others' concepts to structure or multimethodology research.

#### METHODOLOGY

The approach to this research is based on the multimethodology developed by Cox [10, 11] and later refined by Cox and Mabin [18] (manuscript under third review). This multimethodology uses the abductive (logic) research methodology [26] to iterate between reality (to use incomplete information to form a hypothesis) and theory (this hypothesis is then examined, refined, and validated based on the literature or validated in reality) to achieve the <u>current</u> system goal. If the journey is incomplete, then the results are assessed to identify and understand the causal links between the existing and new constraints of an expanding system. This research expands the initial

action research in two dimensions: time (a journey of exploration from 2010 to the present) and system scope (from focusing on one primary care provider practice to the global healthcare supply chain). The works of Goldratt and Simon provide the foundation for this multimethodology. Goldratt's concepts of inherent classification and inherent simplicity, and his three processes of ongoing improvement (POOGI) (see Tables 1 and 2) and Simon's satisficing decision-maker concept and his Principle of Hierarchical Decomposition (PHD) [92] provide the foundation for this exploratory theory-building (and testing) research. Goldratt's POOGI has been used globally for over three decades in various organization settings.

We interpreted Simon's [53] concept (Principle of Hierarchical Decomposition, Ph.D.) to mean that complex hierarchical systems are composed of similar and dissimilar components, and one may analyze such a system by breaking it down at its lowest level (the doer level) into the similar and dissimilar components for further analysis. We recognize that the PHD can be applied qualitatively and provides a framework for understanding hierarchical complex systems, i.e., healthcare systems. To classify these system elements (healthcare provider organizations) we identified the similar and dissimilar organizations, analyzed them using the change question sequence and developed similar and dissimilar solutions. Next, we want to link these organizations in a given community using appointment timeliness to form a community theory of constraints (C-TOC) supply chain.

Throughout this abductive research study of systems, we used both system analysis and system synthesis approaches in addition to iterating between reality and theory. An example of this iteration process between reality and theory over time and increasing scope is provided by examining the provider scheduling function in the primary care practice in the 2010 implementation. It was found that as is the common practice, each provider selected their appointment scheduling template from about a dozen standard templates in the literature and seldom, if ever, modified the template, no matter the changes in patient demand and appointment mix. The scheduler's informal performance measure is keeping the provider's appointment schedule full far into the future, assuming that all patients will attend their appointments. In questioning the cause of no-shows and other UDEs, we hypothesized the need for a proactive provider appointment scheduling (and execution) system (PASS). It took several iterations back and forth from reality to the literature (the time dimension ranged from 2010 to approximately 2015, and the scope dimension ranged from scheduling only to schedule execution to schedule design to schedule feedback to scheduling measures to schedule execution to link community medical units across a healthcare supply chain) to develop a definition, guidelines, measures and a feedback system that could be used to synchronize independent HCSC practices in a community. Recognizing the rigidity of the US government and similar national healthcare systems, a topdown change approach would take years to implement through changes in laws. Therefore, the next constraint is how to implement this global solution. A better approach, a bottom-up approach, might be to start at the community level (synthesis) at several communities and move upward to the national level. With several successful community HCSC as examples, maybe the higher level, the government level, will get involved. Hence the need for this call to research by academics at the community level.

# **RESULTS: THE JOURNEY OF EXPLORATION**

This section is organized across the dimensions of time and scope using the change question sequence (specifically questions 2. What to change?, e.g., the traditional management philosophy, and 3. What to change to?, e.g., the theory of constraints management philosophy) to contrast the two paradigms. Additionally, as the journey progressed, the scope of the problem studied and the goal of the research changed. This section starts by providing the background of the primary care provider practice (PCPP) as an example of how most practices operate under the traditional management philosophy (Q2. What to change?), then provide the actions to implement and propose (Q3. What to change to?) as an example of a practice operating under the theory of constraints management philosophy. The remaining sections record the milestones for the time and scope changes on this journey of exploration.

## **Primary Care Provider Practice Background**

The medical practice is located in a rural community of 17,000 people in the southern US. In 2010, the US was experiencing a recession with high unemployment, translating to increasing numbers of uninsured patients and patients going without healthcare. The practice was owned by seven partners (including three new partners and one retiring partner), had 11.5 providers and employed approximately 70 employees. Financially, the practice was at or a little above breakeven. Providers were overwhelmed with work, frequently treating patients where the morning and afternoon sessions extended into lunch or after patient treatment hours. The providers frequently completed paperwork in the evenings and on weekends. An overview of the practice, the TOC tools used, and the implementation results are provided in [20], and the details of a longitudinal case study are provided in [14].

Based on the practice implementation, we felt the practice changes should be presented as two separate but interrelated functions and presented as two sections (schedule design/scheduling and schedule execution); Questions 2 and 3 are subsections within each section.

#### **Buffers Schedule Design/Scheduling**

**Question 2 What to change?** Providers were allowed to choose their scheduling template, with some choosing an equal increment template, others choosing a wave schedule, others choosing a modified wave schedule, etc. Providers seldom changed templates or modified their existing templates.

Schedulers were generally high school graduates with good communication skills. Five schedulers, including the scheduler supervisor, managed the scheduling functions for all providers. Recently, one scheduler quit, and the partners were conflicted about replacing her or leaving the scheduler slot vacant to save money. No formal measure existed for schedulers, but informally, schedulers booked providers far into the future with the goal of keeping the provider busy. Schedulers reacted to patient needs by determining the type of appointment needed by the patient and trying to fit the caller into the soonest available slot of that type.

Of the approximately 1,100 appointment slots available in a week, about 50% were scheduled as patients left the practice after a current appointment, and 50% were scheduled by patients calling

the practice for an appointment. Acute patients were given appointments where available slots might exist, but the appointments could be in a few days or weeks. Some overbooking of patients occurred to accommodate acute patients, but generally, the provider had to give prior approval for the overbooking. The no-show rate was over 20%, and the no-appointment-scheduled rate was over 20% in the summers. Schedule disruptions were common, i.e., schedulers and other staff interrupt providers, walk-ins, late cancellations, no-shows, and patients coming late for appointments, knowing they would be in the waiting room for some time before seeing the provider.

**Question 3 What to change to?** Buffer management is used in executing a production schedule or project in TOC, not in the schedule design/modification and not where an appointment schedule is the rope mechanism pulling the patient to the practice at the appropriate time in the appointment schedule only to wait to see the provider. In the healthcare application by Cox and Robinson (2012) and Cox (2020), four buffers were invented to provide feedback for schedule design/modification in this type of scheduling environment. These buffers were never computerized in the medical practice during or after the 2010 implementation, but the schedule and session (later named acute appointment buffer) buffers were informally but actively utilized. Recently, however, in 2023, Wadhwa and Sirias [99] presented their implementation in a large oral surgery clinic and showed the use of these computerized schedule design/modification buffers and buffer management rules in modifying the provider schedule based on changes in patient demand.

The <u>schedule buffer</u> focuses the scheduler's attention on the eminent empty appointments in the next five days in the provider appointment schedule. These five days are considered the active region of the provider schedule, and the scheduler proactively manages this region to ensure high provider utilization (productive time is considered time treating patients and unproductive time is considered idle and paperwork time). The scheduler's highest priority is the red region, the first day (today); the scheduler's objective is to eliminate the empty slots by pulling patients forward from next week's schedule to fill these slots. The scheduler's next priority is filling days 2 and 3's empty slots (the yellow region) by booking patients with health concerns. The green region is days 4 and 5, and the scheduler monitors the schedule for these days. Patients are pulled forward beyond day 5.

The <u>schedule backlog buffer</u> measures the total patient appointment backlog and monitors the size based on the current schedule backlog penetrating a given region. This buffer monitors the schedule backlog to prevent it from becoming "too big." The provider sets the boundaries for the size of the buffer and for each buffer region. Additionally, they determine the appropriate actions to take when one penetrates each region of the buffer, i.e., when the current backlog is in the green region, do nothing, when the buffer is in the yellow region, plan the actions to recover, and when the buffer extends into the red region, implement the recovery plan.

The <u>appointment mix buffer</u> monitors the size of the backlog for each type of appointment and is used to determine if the provider's mix of appointment types offered (supply) matches the patients' need for various types of appointments (demand). The scheduled appointment mix can be modified to accommodate changes in the current patient appointment mix demand. The <u>session buffer</u> (acute appointment buffer) measures the availability and use of acute appointments. The author originally suggested aggregating the acute appointments at the end of the morning and afternoon sessions. This buffer location would allow the provider to start lunch or paperwork early if the number of acute appointments was not fully utilized on a given day. Conversely, suppose more acute appointments are needed than available. In that case, the provider should overbook these later acute slots, thus pushing the session into lunch or paperwork without delaying other patients in the schedule. As part of the appointment mix buffer policies, if more than the allocated number of acute appointments are needed daily for a given number of consecutive days, then an additional slot or slots are added to match the acute patient demand. In the practice, the providers decided to spread the acute slots throughout the day instead of at the end of each session; hence, the name acute appointment buffer is appropriate.

#### **Schedule Execution**

**Question 2 What to change?** The process flow chart of a patient-provider treatment process in Figure 4 is used to illustrate the five focusing steps. We have defined the boundaries of this execution system by the process flow chart. We will first describe the traditional management approach using the chart in Figure 4 a. The flow is from left to right. Patients have appointments (either previously scheduled at the last appointment or by the patient calling the practice) and arrive at the medical practice at the designated time. Upon arrival, the patient goes through check-in, indicating they have arrived for the appointment. They wait in the patient waiting room until a nurse, certified medical assistant, or roomer requests the patient to complete the vitals process, which may include taking the patient's weight, temperature, and blood pressure and questioning the patient about the nature of their visit. This information is entered into a computer template or manually entered into a patient's records. The patient then waits for the provider in the exam room. Many medical practices have three exam rooms for prepped patients awaiting the provider. The provider enters the exam room, reads the patient's information, questions the patient, provides the patient's diagnosis and treatment plan, and exits the room to attend to the next patient. This treatment process is repeated for both appointment sessions.

During the vitals or the MD/PA process, the nurse or provider may require the patient to have a test (strep throat, flu or COVID test or x-ray) to diagnose a suspected illness. Once the patient has been diagnosed and treated, the patient leaves the exam room, completes the check-out process and exits the practice. Hopefully, the sick patient will be on the road to becoming a well-patient.

Notice that throughout this process, several areas might be improved by new technology. One might suggest a new phone system automating the transfer of calls to the appropriate person or department (scheduling, billing, messaging, etc.), automation of paper records to electronic medical records, patient portals to share patient health information, schedule appointments, etc.), new computers or information systems for storing patient information, new lab equipment performing current or new tests, better air conditioning for the waiting room, new clinical AI software to predict no-shows or to transcribe provider notes, new furniture, etc. The list of "local" improvements can continue, but what one or few local improvements will significantly impact achieving the practice's goal. In Figure 4 a, an analyst or business manager looks at each process for possible improvements in the practice. Notice also in Figure 4 b, that statistical fluctuations

exist everywhere, so the analyst has no focus for improve. They focus on everything, which is defined as no focus. This process flow chart is based on a medical practice following the traditional management philosophy that local department improvements translate into global or organizational improvements. In addition, the analyst is using local cost savings as the justification measure instead of directing attention on how to improve to make more money for the practice by increasing constraint capacity.

#### Figure 4. Process flow charts of a patient-provider treatment process. a. Q2. WHAT TO CHANGE? Traditional mgt focuses on local optima everywhere.



Maximization/minimization of a measure of part of a system. Everyone is trying to do their best at their specific job e.g. keeping busy, efficiencies, and cost/piece.

#### b. Traditionally managed line focuses on disruptions everywhere.



Examine Figure 4 b again. Potential long-tailed distributions exist everywhere, and utter chaos to plan and execute in a situation of statistical fluctuations and dependent events. This situation illustrates the underlying characteristic of process lines driving this need for buffer management. In a traditional environment, inventory is everywhere to protect against statistical fluctuations. Note that statistical fluctuations also occur in each stage of the patient-provider treatment process. Notice in a patient provider treatment process, we have a limited number of exam rooms therefore patients accumulate in the waiting room, after check-in and before CMA processing. According to Knight [72-74], a TOC healthcare consultant, the statistical distributions in healthcare are almost always right- or positive-skewed distributions with long tails. For example, a few patients arrive early, some arrive on time, some arrive late, and a few arrive very late for their appointments or do not attend. The same is true of other work center distributions. Each staff multitasks to complete their many duties. Each tries to be as efficient as possible at their tasks. The check-in receptionist helps patients complete forms, checks in and checks out patients, schedules patients for future appointments, responds to telephone calls, etc. The nurse processes patients, responds to calls, updates paperwork, takes patients to and from the lab for lab tests and x-rays, and schedules referrals.

Each staff batches and sequences tasks to make themselves as efficient as possible. The tasks and the individual staff priorities (local optima) cause large statistical fluctuations at each work center (Figure 4b), and the fact that these work centers feed each other cause the statistical fluctuations to accumulate across the process.

Question 3 What to change to? In contrast to the patient-provider treatment process flow chart using the traditional management philosophy, the TOC management philosophy is illustrated in Figure 5. Drum-buffer-rope and the use of buffer management in execution focuses on the strategic leverage point (e.g., the constraint) of the patient-provider treatment process. The supplement to Bacelar-Silva, Cox [22] provides a primer for applying TOC in a medical practice. The dictionary definition of buffer management (Table 1) applies to the execution function, in our case, the appointment schedule execution, the flow of patients through the medical practice. Placing strategic buffers in the patient-provider treatment process can protect the constraint resource, the provider, in our case. Two TOC tools are used to smooth schedule execution: the constraint buffers and the provider interruption report. The constraint buffer (the three exam rooms) and buffer management (the rules for proactively filling and emptying these exam rooms) allow the provider to treat patients seamlessly. The CMA manages the constraint buffer by expediting patients to the exam rooms and prepping them. She also records the causes of delays/interruptions on the daily constraint buffer report. The provider manages the provider interruption report by recording the interruptions during and between treating various patients during each provider session each day. The causes of provider delays and near delays (red region) are recorded and aggregated by cause of disruption for the week. After a few weeks, the provider determines what types of interruptions are emergencies, and they should be interrupted during a consult, the types that can wait till between consults, the types that can wait till after a session, the types that someone else can respond to, and what to ignore. This classification of interruptions becomes the provider's policies related to the receptionist and the CMA triaging interruptions in schedule execution. Weekly buffer management meetings identify and address each provider's biggest disruptions or near disruptions

based on aggregating the daily constraint buffer reports, the cause and actions to eliminate that cause or minimize its effect. Eliminating the causes of disruptions reduces the average treatment times and the standard deviations of all resources (See Figure 5 b), thus creating a smoother flow of patients (and less time to flow through the patient-provider treatment process) to and from the exam rooms. The reduction in the provider average processing times and its standard deviations allows the analyst to increase provider capacity by adding more appointment slots to the schedule about 15 minutes before the red penetrations. This 15-minute offset provides time to process the patient through the work centers before the exam room. The prioritization of addressing problems based on the size of the disruptions causes rapid improvement of provider capacity and flow time. For example, Bacelar [2] added 60% capacity to his schedule in a few weeks, and Cox III and Robinson (2012) added an average of 20% more capacity to four providers' schedules plus reducing the no-show rate from over 20% to 3% plus eliminating a 20% seasonal lull.

The proper application of DBR achieves these improvements, buffer management is an integral part of DBR. Let's first examine the focusing mechanism in performing step 1 of the 5 focusing steps.

<u>Step 1.</u> Identify the system constraint. The strategic constraint in most medical practices should be the provider; however, this is seldom the case. The actual constraint to the patient-provider treatment process can be:

- the schedule (the provider continually finishes appointments ahead of the allocated appointment time; hence, they accumulate a few minutes of unproductive time with each patient);
- the receptionist may have a backlog of patients awaiting check-in and thus delay a specific patient's check-in past the designated appointment time;
- the nurse may be doing one of their many tasks and fail to prep a patient for the provider, thus causing the provider idle time;
- the provider may be missing information, test results, or even gloves, thus creating idle time until found;
- the provider may be interrupted by phone calls or the staff, etc.

So, the analyst, recognizing the provider should be the strategic constraint (the most expensive and scarcest resource in the process) in the patient-provider treatment process, desires to identify the current constraint and determine what actions are needed to move the constraint to the strategic constraint, the provider.

<u>Step 2.</u> Decide how to exploit the constraint. As part of moving the current constraint to the desired location, the analyst must decide how to get the most goal units (productive time) from the provider's available time. Actions to increase the provider's productive time include:

- having all materials, information, and a prepped patient available when the provider enters the exam room (called a full kit),
- triaging all provider interruptions to determine whether the provider should be interrupted,

- having no provider multitasking (the provider focuses only on treating the current patient, then the next, and next), and
- having the provider perform only provider skill-level tasks; lower skill-level tasks are transferred to other staff after proper training.

# Figure 5. PCPP: Schedule execution Q2. WHAT TO CHANGE? Statistical fluctuation and dependent events in process flow.

a Q3. TO WHAT TO CHANGE? TOC mgt focuses on Throughput and cycle time.



b. TOC managed line uses BM to eliminate potential and actual line disruptions.



<u>Step 3</u> Subordinating all else to the constraint is a massive paradigm shift in staff thinking. Workers have always been trained and believe they are required to perform their tasks as efficiently as possible. However, this individual worker efficiency is not the correct view of workers performing tasks in a line or process. The TOC job description for clinical staff is to perform their tasks in support of helping the provider to be more productive. For example, a high-priority task is to have a prepped patient available in an exam room so the provider is never idle waiting for a patient. Recognize that we have changed the job descriptions of the provider (eliminated low-skill level tasks) and support staff (included some traditional provider tasks and new tasks to support patient flow to and from the exam rooms, perform some tasks at session's end, and offload other tasks), the WC processing times are significantly different when compared with the traditionally-managed patient-provider treatment process line. These new job descriptions should promote an effective patient flow from check-in through the treatment process to check-out and to practice exit, and reduce provider treatment times, increase provider utilization (productive time) and increase staff job satisfaction significantly.

<u>Step 4</u> Elevate the constraint. This step should be a conscious decision and only be implemented when the analyst fully uses the constraint resource and desires to improve the system further. In a large medical practice implementing TOC, the following "constraints" were identified in moving the current constraint location to the providers:

- Having one eye chart and several (up to 12 patients) patients queued to use the eye chart each morning (six providers on that floor each scheduled two physicals at 8 AM). Upon identifying this situation, a second eye chart was purchased for \$50, and some providers staggered their physical appointment times.
- Another provider only had two exam rooms and was idled frequently, awaiting a fully prepped patient or test results. Converting a nearby office to an exam room costs \$5,000, paying for itself in 6-8 weeks.
- A third CMA was added to two pods (two providers work in a pod module). This addition of clinical support allowed these providers to add 3 to 5 additional appointment slots each day, which covered the CMAs' annual salaries in the first two months of each year. The additional ten-month throughput generated by these four providers dropped to the organization's profit line.

<u>Step 5</u> warns of inertia setting in. The analyst should always be conscious that the constraint may move from the provider to elsewhere in Step 4 or through external environmental forces. Interestingly, with the new TOC-practice environment (decrease of no-shows from 20+%, virtual elimination of no-appointments-scheduled slots, an increase in the slots in the provider's capacity, and the improved execution of provider schedules), the patient market became the constraint. The practice needed to increase demand for its services. Management reviewed the files of patients not treated by the practice for a couple of years and contacted them about having their annual physicals, most covered by Obama healthcare or insurance. They first identified patients having chronic illnesses and comorbidity and were able to increase patient demand significantly and, at the same time, provide better healthcare to the patients in most need.

# The CQS Applied To A Medical Practice: One Link

A major part of any TOC implementation is getting key stakeholders' opinions on the biggest problem(s) from their perspective. This approach provides the TOC analyst with data for understanding the system and its causalities. It also increases the chance of buy-in and support of the stakeholders in implementing a solution that addresses their biggest problem(s). The CQS process is a major part of a TOC implementation as it frequently surfaces policy constraints that limit practice throughput or other stakeholder needs. Frequently, when implementing the five focusing steps, making a change at a work center doesn't achieve the expected results, and it isn't easy to figure out <u>why</u>. The change question sequence should be used as the new constraint is probably a policy or measure limiting improvement.

Q1 Why change? Q1 applies to the practice owners (the ownership concerns) and represents undesirable <u>organizational</u> effects such as the practice making little or no profit, not providing excellent healthcare, and having unmotivated, uneducated and untrainable workers. These UDEs provide the compelling reason(s) or need for the <u>system</u> change. Q1 also applies to <u>functional</u> levels, e.g., providers, clinical staff and scheduler level (the operations or doer level). Their UDEs might include: patients are always late, patients are no-shows, I work through lunch to catch up on paperwork, I have to track down my nurse, my sessions always run late, I have several daily walkins, etc. Each UDE represents a conflict within the organization and causes the system UDEs.

Q2 What to change? Q2 is answered by examining the UDEs and causalities described by the respondents. For each of these UDEs, an evaporating cloud (See Figure 2 a) can be constructed, and the assumptions surfaced around the conflict shown in the EC. These two levels of UDEs (the partners' answers and the clinical staff's answers to their biggest problems) can be connected causally, with the organization level being the effects and the functional levels being the causes. Also, it is possible to dive deeper into the functional UDEs, thereby identifying causal relationships to determine the organization's core problem. Abductive logic and the categories of legitimate reservation (the rules of logic) are used to connect the UDEs to the core problem in building the current reality tree (see Figure 2 b). ECs can be built from these questionnaire responses and a core problem EC and current reality tree (CRT) built to answer "Q2 What to change?"

Q3 What to change to? The core problem must be identified (by surfacing and challenging the EC assumptions of the core problem) and addressed by identifying primary and secondary injections (actions) to reduce or eliminate the impact of the UDEs. Focus, Goldratt's definition of TOC, plays a major role here. Q2. What to change? Of the thousands of problems in most organizations today, what one or two problems, if solved, would create significant and rapid improvement concerning achieving the organization's goal(s)? The EC and CRT identify the system core problem and its causal relationships to doer and partner problems (UDEs). Again Focus, Q3. To what to change? Of the thousands of proposals to improve the organization, what one or two proposals would cause significant and rapid improvement in achieving the organization's goal(s)? The EC, with its injections (Figure 3 a) and future reality tree (Figure 3 b) build a comprehensive solution for the organization.

Q4. How to cause the change? This question is answered by socratically involving the providers, clinical staff, schedulers and other key stakeholders in education and training workshops and having them actively involved in answering each question in this change question sequence. They should also have significant and active involvement in building the implementation plan for this change. The prerequisite tree is the thinking processes tool for building this project plan. If anyone knows why an action is wrong or cannot be carried out, it is the employees. They face that problem each day. They are also the individuals who can overcome any obstacle they face when given the opportunities and incentives.

Q5 How to measure and sustain the change? Q5 is answered by replacing local optima measures with global measures and creating new TOC job descriptions. New employees are trained using the process flow chart and the appropriate job description using the five focusing steps to explain why a particular action is taken. The employee then works with an experienced employee for a few days. Finally, the clinical supervisor and clinical staff monitor the new employee for 3-4 days. Recall that we built the new job descriptions based on the new roles of the clinical staff and the schedulers in supporting the provider instead of doing their best at their jobs.

An example of a change in measures is the scheduler's measure of booking the provider as far into the future as possible (the measure of a full schedule) to ensure high provider utilization. This measure should be changed to <u>schedule fulfillment</u> (the scheduler proactively manages patients and providers to achieve schedule fulfillment (patients attend their appointments). Additionally, several scheduling policies were changed. The practice notified all patients of the changes:

- patients should call the practice immediately if they need a same-day acute appointment,
- all acute patients are seen the same day as they call for an appointment;
- concerned patients are given appointments in the next two to five days and instructed to call the practice to change to an acute appointment if their concern becomes acute;
- patients unable to attend an appointment are instructed to call immediately to cancel their appointment so that someone needing an appointment can book the slot;
- do not walk in, call the practice immediately to reserve an acute appointment. Walking in unannounced disrupts the provider's schedule and increases patients' waiting times.
- Each no-show patient is called that day to determine the cause of no-showing and to develop a plan so that no-showing will not happen again.

# The CQS Applied To The Community Healthcare Supply Chain

Up to this point, the discussion has been about improving one link, the primary care provider, in the healthcare supply chain (HCSC). The initial link was the large primary care practice case study [14, 20]. Based on a search for improving this solution, several hundred articles were examined, and it was found that most practices face the same UDEs as the primary care practice. Given the commonality of problems across different types of practices and healthcare systems, the author(s) used the thinking processes and change question sequence to provide generalized guidelines for improving schedule design/scheduling [16] and schedule execution [13]. Most outpatient scheduling medical practices (medical and surgical specialty medical practices) can use these scheduling and execution guidelines to build a better scheduling system with slight modifications

to fit their (and specialty) practice. These generic guidelines are a major piece to solving the HCSC wicked problem by having each link in a TOC HCSC implement same-day acute and concerned (next few days) appointments and encourage patients to use them. However, even if each practice in a community has acute and concerned slots, one must connect and synchronize treatment across these individual links. This requires close communication among practices in the community. Figure 6 shows the current and TOC situations of scheduling appointments with a primary or specialty care provider.

# Figure 6. Process flow chart of the HCSC with patient-external wait times.



Source: Merritt Hawkins (2017). 2017 Survey of physician appointment wait times. Dallas, TX, Merritt Hawkins.

b. TOC appointment times.



For example, suppose one calls a primary care physician practice to establish a relationship. In that case, a physical is the preferred first visit so the provider can get a baseline history of the patient's health. According to Hawkins [50] (Figure 6 a), the average time from the patient calling to the

assigned appointment time is 54 days (if one can find a primary care provider accepting patients); based on the results of the physical examination, suppose that the provider refers the patient to a specialist such as a cardiologist, the appointment time can be an additional 32 days. Note for the various specialists the average patient direct wait times. If one already has a cardiologist and calls that practice, the next available appointment can also be weeks away (based on personal and others' experience). Scheduling and executing a schedule based on the traditional management philosophy is the rule, not the exception, in today's healthcare environment.

In contrast, suppose the outpatient medical practices in a community implemented the TOC link and HCSC model in Figure 6 b. A new or established patient can call their provider to schedule an acute appointment and suppose their provider refers the patient to a specialist by scheduling a same-day acute appointment referral; then the patient could either see both providers on the same day or two consecutive days starting today. If the patient is an existing patient with the specialty medical practice, then they can call that practice directly for a same-day appointment.

## The Journey Of Exploration And Its Milestones

Figure 7 provides a high-level view of my thirteen-plus-year journey of exploration. The figure doesn't match the text and Table 3 exactly but highlights the use of various concepts and researchers in my discoveries along the way. The figure shows the research topic of interest that sparked a change in goals over time. In contrast, Table 3 presents the dates, milestones, goals, results, and whether it was achieved roughly chronologically.

Its innermost rectangle represents the 2010 implementation and the size of the system under study. Within this system analysis/synthesis framework, we recognized the separate but interacting nature of schedule design/scheduling, execution and system frames. For example, we examined the scheduling function to identify and solve problems and then implemented solutions both on paper and in reality. We checked reality as it related to scheduling, execution and the practice. In this manner, we recognized that scheduling problems could significantly impact executing the schedule and vice versa. I then wanted validation that the model was appropriate and to identify how to improve the model by TOC experts, healthcare professionals, and healthcare academics. We presented the research at the TOCICO annual conference (2012) and published articles in practitioners' healthcare organizations. I then spent a couple of years examining the academic literature to find that this was a wasted effort; very few models were implemented, very few authors provided actual results, and none were generalizable, therefore, this research is of no value to practitioners. The value of this effort to me was significant. It allowed me to identify 14 generic problems that seemed to exist in various healthcare environments. I used these UDEs to conduct a thinking process analysis to develop generic guidelines for schedule design/scheduling and schedule execution.

The remaining explanation of the diagram is left to the reader. Continue to read from the innermost part of the diagram, noticing that the system and environment have expanded in size and scope from 2010 to the present and from the inner workings of scheduling and execution to solving the global healthcare crisis.





The action research, my healthcare research journey, started in August 2010 at our annual family beach vacation. My daughter (a part-time provider raising three children) and son-in-law (a new partner and provider) had worked as providers (MDs) in a large family practice clinic located in a rural community for seven years. My son-in-law was one of three full-time physicians who had recently bought into the practice as partners, only to find that the practice was not doing well financially. As a result, they feared they might lose their investment. They asked if I thought TOC could be applied to healthcare, specifically their medical practice. They described the practice, partners, providers' problems, and the environment, and I facilitated their understanding of the theory of constraints. I met with two practice partners for a three-hour luncheon meeting to discuss the use of the TOC and the implementation plan for their practice. We started a holistic TOC implementation in September 2010. The results (Cox and Robinson, 2012) were exceptional (56% improvement in net ordinary income) and immediate (within a few months). Let me elaborate on the 56% increase in net ordinary income. If the practice had a 12% net ordinary income before the implementation, then after the implementation, the net ordinary
income was 68%! The primary tools used were the three processes of ongoing improvement (five focusing steps, buffer management, and change question sequence. Other TOC tools were used and discussed in the TOCICO video presentations and Health Systems below.

Being well aware of and having encountered the rigor-versus-relevance chronic conflict in academia, I wanted to document my work for truth (the UDEs exist in current reality) and validity (the causal relationships are logically sound.). The rules for using the various thinking processes and the categories of legitimate reservation [19, 25, 81, 90, 91] provide rigor to a logical analysis.

Let's now continue my exploration of the outpatient scheduling and execution problem. Recall we started the implementation in September 2010. We had essentially completed the implementation in December.

<b>Dates</b> 2010 09 2010 12	<ul> <li>Milestones, goals, explanations, and results achieved.</li> <li>M1: Our goal was to save PCPP.</li> <li>M1 achieved. Results were excellent but it was not holistic. Why? Satisficing partners.</li> </ul>
2011	M2: Our goal was to improve/validate the TOC model with TOC and healthcare professionals
2012	<b>M2 achieved.</b> The TOCICO conference presentation [20] was well received by TOC healthcare and other TOC consultants
2014, 2015	Publications in healthcare professional journals [21] and [9, 22] (Family Practice Management and Industrial Engineer). AISE has a large healthcare special interest group.
2011-2015	M3: Our goal was to review academic literature to improve/validate the TOC model. M3 not achieved. No academic research provided any improvement to the TOC model. Presentations were made at the TOCICO 2015 [8] and 2016 [15] conferences discussing my disappointment in academia's contribution despite hundreds of articles to solving this problem and the core conflict being rigor vs. relevance conflict. We offered some potential solutions to strengthen the rigor of qualitative research.
2011-20	<ul> <li>M4: Our goal was to develop generic TOC scheduling and execution guidelines.</li> <li>During the TOC implementation (2010), we recognized two core problems: poor scheduling and execution policies. In the academic literature review, the problems studied also fell into these two inherent classifications. We then worked on guidelines for each function.</li> <li>M4 achieved. Articles were published in Health Systems on generic scheduling guidelines [16] and generic execution guidelines [13] for appointment environments.</li> </ul>
2015	<b>M5:</b> Our goal was to audit the primary care practice to determine its sustainability. In October 2015, several key employees (two owners/providers, two other providers, the nurse supervisor, a senior nurse, the operations supervisor, and the scheduling supervisor) were interviewed. The results were excellent, but again, the implementation was not holistic. Everyone wanted more TOC training, but no one followed up. The hypothesized cause was that the partners were satisficers. The partners were satisfied with the practice's profitability, requiring additional work hours to complete paperwork, but didn't want to change.

Table 3. My journey of exploration in healthcare

M5 achieved. The longitudinal case [12] was published in 2021.

- 2018 M6: Our goal was to solve the healthcare wicked problem. In the summer, a TOC academic requested that I speak to his Engineering Management graduate Special Topics class on my TOC healthcare research. I asked to speak in December as during my research journey, I read about healthcare being a wicked, ill-structured, ill-defined, and messy problem, and I wanted to investigate the possibility of solving the healthcare wicked problem. M6 achieved. I presented my solution process to the class, which was well received.
- 2019 M7: Our goal was to construct a general process for solving wicked problems. The TOC academic mentioned in M6 was on the TOCICO BODs. He discussed my presentation with the board, and the program committee asked that I make a keynote presentation on a general process for solving wicked problems. I worked another six months to convert a specific solution for healthcare to a solution that could solve similar hierarchical structured wicked problems.

**M7 achieved.** I presented a 45-minute keynote at the 2019 conference [10]. Upon request, I presented a detailed webinar (2+ hours) on the topic [11].

- 2018-present
   M8: Our goal was to solve the global healthcare supply chain wicked problem. Since 2010, I have followed the healthcare work of Alex Knight, a British TOC consultant with thirty years of experience in implementing TOC in large and varied healthcare organizations in the UK and other countries. I thought I could develop a model for linking his work to our work. Alex shared his knowledge generously through TOCICO presentations and webinars and even wrote a novel, Pride and Joy, outlining TOC's use in hospitals. His work sparked the idea of synchronizing the outpatient medical practice links in an outpatient medical practice environment.
   M8 achieved. In 2018, a manuscript was submitted to Health Systems for review. It is now under its third review.
- 2023 M9: Our goal was to provide an implementation plan for M8 globally. Responding to the reviewers' comments on M8, we learned about community operational research projects. We studied that literature and developed a framework for implementing M8 globally.
  M9 work-in-progress. This solution was presented at the TOCICO 2023 conference [18] in October. We prepared a file containing documents on implementing TOC in healthcare for TOC experts to use in their communities. I am presenting this paper, a TOC basics workshop, and a TOC in healthcare workshop at SE DSI to encourage academics to learn TOC and implement it in healthcare organizations in their communities. We are also scheduling a TOCICO webinar in the April/May timeframe.

Other Milestones. Along my journey of exploration, two opportunities presented themselves.

**Johan Groop.** In 2014, I was asked to be the opponent of Johan Groop in his dissertation defense. Johan's dissertation was on the use of TOC in analyzing home healthcare in Finland. My role was to analyze his dissertation research and question and critique his work before an audience of about 300 faculty, scholars, and students. Johan had devised and implemented a TOC solution. As a result of the investigation, the studied home care unit reduced its use of leased labor significantly, the savings of which are estimated at  $\in 0.5$ M annually. Johan's work is a major piece in solving the global healthcare crisis as it may allow many elderlies to remain in their homes for a few more years with daily support and monitoring. The dissertation and its abstract and a journal article abstract can be accessed through academic databases.

**Bacelar Milestone**. In 2016, Gustavo Bacelar, a Portuguese and Brazilian MD and Ph.D. student in Clinical and Health Services Research at the Faculty of Medicine, University of Porto, in Porto, Portugal, contacted me about being a co-supervisor on his dissertation. He wanted to study the use of TOC in healthcare. Gustavo and I communicated weekly on Skype from 2016 till 2023. He was an exceptional student. He needed three articles published on TOC in healthcare to complete his dissertation. As part of this research, he devised an implementation plan for a large obstetrics/gynecology department in a large hospital in Porto. He started the implementation, and two weeks later, the hospital stopped all outpatient appointments to the department because of the COVID-19 epidemic. Treating outpatients was suspended for two years; therefore, outpatient appointment scheduling and execution were suspended. The department showed excellent results based on the two-week results. Meanwhile, Gustavo completed three articles and one proceeding presentation to meet his dissertation requirements. The dissertation (the dissertation includes a section detailing the obstetrics/gynecology department partial implementation) and its abstract and a journal article abstract can be accessed through academic databases.

# SUMMARY AND DISCUSSION

# Summary

This paper outlines a process based on applying the Theory of Constraints to outpatient medical practices and linking the practices together in a given community to provide more, cheaper, better, and faster healthcare delivery to a community with existing resources or with little additional expenditures. To achieve this goal, we identified, defined, described, and illustrated the major TOC tools needed to improve the HCSC, described the milestones on my journey of exploration, starting with the implementation of TOC in a large primary care practice, next identifying and validating the elements of a system solution, and now with the development of a direction for a solution to the healthcare supply chain wicked problem, and proposes an approach to implementing the HCSC solution in your local communities. In reviewing this paper, two questions should come to mind:

- Why is the outpatient appointment scheduling problem so important?
- Why use the TOC instead of the traditional management philosophy?

Let me briefly respond to these questions.

Why is the outpatient appointment scheduling problem so important? Two primary entry points exist today for the HCSC: the primary care provider clinic (and specialty care provider clinics) and the hospital emergency department. Hospitals are overcrowded and significantly more expensive than outpatient clinics. Therefore, if these outpatient clinics implemented TOC (reducing no-show, late cancellation, and no-appointment scheduled rates, increased capacity by eliminating the execution chaos, and encouraged same-day acute and 2-5 day concerned

appointments to patients then a major part of the 2/3 of ED patients could schedule timely appointments and eliminate the need for an ED visit. This alternative could reduce healthcare costs significantly.

Solving the outpatient appointment scheduling and execution problem has been the subject of academic research since the Lindley [76] and Bailey [3] queuing theory articles were published in the early 1950s. Hundreds of articles [7, 24, 102] have been published, but few have been implemented, and none have provided generic guidelines for appointment scheduling. All are based on local-optima measures. Most researchers assume that the more complicated the problem, the more sophisticated the solution, BUT two points should be obvious. First, to apply sophisticated mathematical models, the multidimensional aspects (multiple stakeholders with multiple and conflicting objectives and measures) must be addressed, not just one aspect of the problem, no-shows. Most researchers assume these dimensions away (the wickedness of the problem) to simplify the wicked problem and thus create a nonsolution. Second, the solution must be implemented. Sophistication blocks implementation.

Academic research in appointment scheduling is an excellent example of observational bias, e.g., where the researcher only investigates a topic where it is convenient to get data. This type of bias, a.k.a. the streetlight effect or the drunkard's search principle (Streetlight effect. n.d. In Wikipedia. <u>https://en.wikipedia.org/wiki/Streetlight\_effect</u>), is described by a well-known joke:

"A policeman sees a drunk man searching for something under a streetlight and asks what the drunk has lost. He says he lost his keys and they both look under the streetlight together. After a few minutes, the policeman asks if he is sure he lost them here, and the drunk replies, no, and that he lost them in the park. The policeman asks why he is searching here, and the drunk replies, "this is where the light is".

The researcher doesn't investigate the obvious causes of the no-show, i.e.,

- the patient's contact information is incorrect,
- the patient was calling for an acute or concerned appointment and was given an appointment beyond the patient tolerance time (the time a customer is willing to wait),
- the patient's condition worsened, causing the patient to seek immediate treatment, etc.

While the appropriate action is for the practice to work with its patients to eliminate these causes (to look where the keys were lost), it is more convenient (and rewarding given the need and current measures for academic tenure and promotion) to use highly sophisticated modeling for predicting the no-show (to look where the light is shining). The issue here is that we have created an academic measurement system with the top researchers in the world focusing on solving nonproblems instead of focusing their efforts on addressing global wicked problems to improve humanity.

In contrast, Goldratt [44 pp. 9-10] believed: "The admiration of sophistication is totally wrong... The key to thinking like a true scientist is the acceptance of any real-life situation, no matter how complex it initially looks, once understood, is embarrassingly simple." Goldratt suggested that the scientist should use this inherent simplicity concept to identify and map the system's causal relationships from UDEs to the core problem by continually asking the question why an effect occurs, surfacing the cause, validating the causality and cause existence and supporting assumptions then asking why again (and again). The structure of a current reality tree makes it clear that relatively few causes at lower levels in the tree result in many effects higher in the tree. I used this causalities mapping process in my exploratory healthcare journey. When I started this journey, the destination was not to solve the global healthcare supply chain wicked problem (I would have thought myself crazy) but to conduct action research to help one primary care provider practice. As T. S. Eliott's quote at the beginning of this paper (We shall not cease from exploration and the end of all our exploring will be to arrive where we started and know the place for the first time) as I completed my journey of what I thought was the destination, I reflected on that destination and realized that it was but one milestone on a further journey. I am now close to the journey's destination and wonder why no one has stated this simple and obvious solution.

Why use the TOC instead of the traditional management philosophy? TOC is a holistic management philosophy that should replace the traditional management approach. Taylorism started in the early 1880s to 1890s and was viewed by many as scientific management. Taylorism is built on local efficiencies, everyone doing their best at their job in isolation. Goldratt recognized that the sum of these local efficiencies does not provide a global optimum. Therefore, local efficiencies should be replaced by identifying the organization's strategic constraint or leverage point and making this resource as efficient and effective as possible. Other resources should restructure their job descriptions, task priorities and measures to support this resource.

Additionally, TOC provides a systems framework for logically structuring (Q1 and Q2), and solving a complex problem (Q3) and implementing its solution (Q4 and Q5). As we applied this framework on this journey, we expanded the scope of our analysis to arrive at how to address the global HCSC problem with a simple win-win solution.

This research does not provide a complete TOC solution to the healthcare wicked problem. Other TOC healthcare consultants and academics provide significant contributions to solving this problem. Alex Knight, a TOC consultant in the UK, studied healthcare and social care in large hospital complexes and community hospitals for over thirty years. His novel, Pride and Joy [64] describes the hospital environment's problems and the solution's direction based on over 30 TOC implementations worldwide. Knight [57-63, 65-67] and coauthored with others [68-71] presented at the annual TOCICO conferences, providing solutions to various links in the HCSC. For example, Knight and West [72-74] provided three workshops socratically introducing many TOC-related solutions. Others [52-54, 85-89, 93, 94] have authored books or provided presentations on applying TOC in hospital environments, including surgeries, emergency departments, wards, etc. Their applications include hospital complexes, elective surgeries, using their materials to see further on this journey. I am grateful.

Recognizing and implementing an effective outpatient HCSC would significantly reduce the demand placed on these hospital resources at a significantly reduced cost. Additionally, Groop's solution [47] of an effective home healthcare system as an alternative to the elderly care nursing home overcrowding problem allows the elderly to remain independent for more years at a significantly reduced expenditure. Wadhwa and others [56, 96-99] have successfully implemented

TOC in Oral and Maxillofacial Surgery in various environments (for profit, for purpose, government, standalone, within a hospital and medical school complex). Bacelar et al [2] report the results of many of these implementations in a systematic literature review of TOC healthcare implementations. These research efforts of TOC implementations represent the links in the healthcare supply chain. One must connect these links to create a local community healthcare supply chain.

Returning to the solution to the healthcare supply chain wicked problem suggested in Figure 6 b, I suggest that you, an academic, team with a TOC consultant in your community or other academics and study TOC and its healthcare applications. Once comfortable with the TOC applications, approach your primary (or specialty) care provider practice with an offer to implement TOC in their practice. If successful, then use that practice as a model to approach the half-dozen specialty practices that it refers patients to and implement TOC in those medical practices, then link the practices together using acute and concerned appointment patient + referrals. Lastly, report your research (including problems encountered) so that we can improve this TOC HCSC model.

#### APPENDIX

This appendix provides instructions on how to access various hard to get references. The Taylor and Francis "TOC in Healthcare" article collection ((one can also enter this title) is available for free downloading of the citation, article, supplements, appendices at:

https://www.tandfonline.com/journals/thss20/collections/theory-constraints-healthcare

A dozen of the TOCICO "TOC in Healthcare" (one can also enter this this title in Google) are available for free viewing of presentation videos, abstract and presentation slide PDF. The TOCICO annotated bibliography of all healthcare conference presentations and webinars is available on the TOCICO healthcare portal at:

https://www.tocico.org/general/custom.asp?page=healthcare\_portal

The reader can become a guest member to determine if an academic or student membership is warranted. I encourage all readers to view the free portals and determine whether membership is warranted to assist you in your research, teaching and service academic responsibilities.

contains over 1,200 presentations with presentation slides. Guest and academic memberships are available. However, a regular membership is required to view all videos.

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#### A MODEL OF HEALTHCARE IT AND MANAGERIAL SOPHISTICATION

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# ABSTRACT

Sophisticated Information Technology (IT) allows organizations to deal with complex issues, compete effectively, and support customer needs. It includes managing information by understanding that managing and using technology are two related but separate managerial skill sets. A model that integrates IT and managerial sophistication to predict business performance must be able to acquire, manage, and use information technology that aligns IT strategy with business strategy. The model distinguishes between internal and external IT support management with the equally vital requirement to govern IT effectively by selecting appropriate structure, processes, and relational mechanisms.

#### **INTRODUCTION**

Sophisticated Information Technology (IT) allows organizations to deal with complex issues, compete effectively, and support customer needs. It includes managing information by understanding that managing and using technology are two related but separate managerial skill sets. In particular, Enterprise Resource Planning (ERP) systems require managers to manage ERP systems' internal and external support. They also consider the appropriate internal structures, processes, and relational mechanisms needed to align the IT strategy with the organizational business strategy. Every business activity within an organizational setting uses some technology, and technological change can affect competition through its impact on virtually any activity [29]. However, there may be mismatches or gaps between an organization's technologies and those of customers, clients, and patients.

For example, a critical security issue in healthcare is the impact of Ransomware and Phishing attacks [67] and the subsequent effects on organizational operations and patient relationships [68]. Healthcare organizations impacted by a ransomware attack may be unable to share critical healthcare information with patients and business partners, potentially altering business operations during and after a security breach, infuriating customer relationships because the technology level does not meet the security threat's level of Sophistication [42] further impacting business performance [8]. A negative relationship between patients and organizations occurs when patients exhibit technological capabilities exceeding the organization's status. Thus, patients may ask why a security breach occurred or why healthcare services became restricted. Each of these groups may potentially exhibit a higher or lower level (the gap) of technological sophistication based on their information technology (IT) level compared to some subjective state-of-the-art standards.

Alexander and Wakefield (2009) define IT sophistication as the diversity in technology tools and software used to support patient care, clinical support, and administration [5]. A recent KPMG study (2022) found that healthcare organizations spend less on technology than organizations in other business sectors [64]. While 60% of healthcare organizations make artificial Intelligence

(AI) a key investment area focused on patient outcomes, these IT investments do not focus on patient relationships or IT security, despite the relative percentage of Healthcare AI spending exceeding other business sectors. While senior healthcare executives recognize the dangers of cyberattacks, such as Ransomware and Phishing, they realize that with continued security breaches, consumer trust in protecting their data will decrease and will impact where patients do business. Thus, there seems to be a lack of management sophistication in understanding or collaborating with IT to align IT with business strategy.

Aligning IT Sophistication with business strategy is not a new idea. Still, as threat actors' Sophistication increases, IT's complexity and integration across the business enterprise increase and diversify, and non\_IT managers increasingly become distanced from how sophisticated Information Systems integrate Internal and external actors, aligning IT with Business Strategy becomes more difficult. We believe understanding the difference between IT Sophistication and IT Management Sophistication is essential in leveraging the potential of more sophistication in achieving the goals of the modern healthcare organization. While IT sophistication concerns technology tools, IT Management Sophistication suggests an evolution of a company's IT management practices, such as information systems (IS) expenditure, IT use experience, IS function, and so forth [28, 31]. IT Management Sophistication reflects the extent to which IS strategy aligns with Business Strategy, supporting overall company goals such that the Sophistication of IT tools progressively aligns with other business strategies as the company matures [63]. Thus, this research seeks to present a model that integrates IT Sophistication and IT Management Sophistication to make a theoretical contribution that clarifies the distinction between these concepts and provides a practical understanding showing the importance of combining these concepts to combat Security Breaches and improve operational performance.

We begin by reviewing the IT Sophistication and IT Management Sophistication literature trending toward a healthcare perspective. We then present models for understanding the importance of IT Sophistication and Managerial IT Sophistication, followed by conclusions and future research directions.

# LITERATURE REVIEW

Information Technology (IT) is the acquisition, processing, storage, and dissemination of vocal, pictorial, textual, and numeric information by a microelectronics-based combination of computing and telecommunication (Fletcher, 1991). It includes all hardware, software, communications, telephone, and facsimile facilities (Weill, 1992). IT is used extensively throughout organizations in some form or other [19]. Information Systems (IS) and Information Technology (IT) are used interchangeably with the understanding that IS includes a broad range of individual technologies to support business operations. The Chinese automobile industry defines sophistication by evaluating a horizontal comparison of technological complexity or total factory productivity using international panel data [16]. Some researchers explained sophistication in terms of understandability. The idea is that straightforward systems that did many things and were cost-effective were sophisticated [14].

Information System (IS) researchers view IS sophistication and underlying technologies as critical firm resources [39, 70]. For instance, Enterprise Resource Planning (ERP) is a software system that helps organizations run the entire business, supporting automation and business processes in finance, accounting, human resources, manufacturing, supply chain, procurement,

and more https://www.sap.com/products/erp/what-is-erp.html. However, a wide range of technologies may support aspects of the ERP System with varying degrees of sophistication. Functionally, IS sophistication includes hardware, operating systems, applications, network and telecommunications technologies, e-mail, universal file access, networking technologies, databases, and a variety of shared services, such as Electronic Health Records (EHRs), which may be part of the broader Enterprise Resource Planning (ERP) system.

#### **IS SOPHISTICATION**

IS sophistication refers to the extent, intensity, and integration to which an organization has diffused key IS into its base organizational structure for supporting business processes/activities [50]. While Saunder and Keller (1983) refer to IS sophistication as a mix of applications provided by the IS organization, de Bu'rca et al. (2005) thought business organizations needed to address several different categories of different technologies and applications [19, 60]. De Burca (2006) defined IT sophistication as the degree to which an organization's processes, equipment, and personnel compare favorably or unfavorably with its competitors [19]. Raymond and Pare' (1992) define IT sophistication as a multidimensional construct that refers to the nature, complexity, and interdependence of IT usage and management practice in an organization [56]. Researchers typically consider three dimensions that comprise IS sophistication: the extent of IS use, the intensity of IS use, and IS integration with business processes [10, 69].

IS sophistication determines IT success and moderates business practice and performance [50]. Understanding technology as the physical, human, knowledge, and social components with technoware, humanware, infoware, and orgaware may be helpful. Technoware is the physical tools component of technology. Humanware is the person-embodied aet-of-doing-type skills technologies. It is what people do with the technology that matters. Infoware is the record embodied know-what-why-how-type facts technologies. It imbraces tool-based tasks, profession-specific guidelines, codified knowledge, and human creativity. Good infoware enables quicker skills development and results in savings in terms of time and resources utilized for any organized endeavor. Orgaware is the institutional embodied work procedural methods like operational steps and procedures and includes practical strategies of value networking and stakeholder cooperation [29].

IT Sophistication embraces a broad landscape and has important implications for the management of organizations. As such, the basis of our theoretical argument rests on the assumption that the relationship between service practice and performance is contingent upon the extent of IT managerial sophistication. In attempting to define IT sophistication, we define technological sophistication. Khandwall (1976, pp. 27-8) argued that a technologically sophisticated firm is the products and processes utilized and involved with very sophisticated and complex operations technologies with a lot of research and development involved, while a relatively technologically unsophisticated environment implies the opposite. De Bu'rca et al. (2005) suggested that a firm needs to face up to many challenges to become technologically sophisticated: firstly, the business requires a solid scientific-technical base; secondly, new technology can quickly make existing technologies obsolete; and thirdly, as new technologies come on stream, their applications create or revolutionize markets and demands. Porter (1980, p. 679) contended that technological sophistication is related to firm performance, with higher

profits in emerging industries characterized by significant technical uncertainties than in more mature industries with minimal technological change. Likewise, Fynes et al. (2001) have argued that small firms' viability mainly depends on their technical sophistication.

#### **IT ASSIMILATION**

Business organizations constantly seek, update, and implement new technologies to compete successfully. Vendors, customers, and employees must assimilate these technologies within the scope of their roles and update procedures and policies over time. IT assimilation refers to firms' success in utilizing specific IT capabilities to enhance their business performance. It also refers to how IT infuses particular business activities with varying degrees of sophistication and how effectively IT enables the conduct of these activities relative to other organizations [7]. Rich interactions between technical and managerial personnel increase IT innovativeness [44]. IS sophistication refers to how a firm has diffused or assimilated key information technologies into its foundation for supporting business applications [7]. Sophisticated IT enhances organizational freedom by improving inter-organizational connectivity across inter-departmental units and extra-organizational connectivity with external business partners, allowing better responsiveness to competitive pressures [23]. In general, sophisticated IT leads to higher levels of technical knowledge, which leads to more innovation and the assimilation of increased levels of IT. Evidence shows that sophisticated IT enhances the managerial ability and willingness to shape innovative IT applications [59]. IT sophistication might be measured by how essential technologies diffuse into an enterprise's IT infrastructure [7]. Early IT sophistication studies found that a senior manager's IT knowledge did not significantly affect the assimilation of IT, nor did increased interaction between a CIO and other senior management team members or organizational size impact IT assimilation [7]. However, more recent research suggests that boards, senior leadership, and IT leadership are experiencing a disconnect [47].

#### **IT MATURITY**

Sophistication means different things to different people. One way is to characterize sophistication as levels or stages of growth. Nolan (1979) used the "Stages of Electronic Data Interchange (EDI) growth" model, the precursor of ERP Systems, to explain the relationship between a stage and a prior or following stage [33, 49]. Other models, Crosby's Grid and the Capability Maturity Model (CMM), similarly defined levels of IT sophistication. Saunders and Keller (1983) referred to IT maturity as the sophistication of the mix of technology and applications available in the organization [61]. More recently, Raymond and Pare' (1992) defined IT sophistication as technological support, hardware, and systems [56, 57]. In these models, the evolution of organizational IS identified different stages of IS growth [41]. IS maturity is the ultimate stage of computing growth, where information resources and computer-based systems are fully developed and integrated [17, 27]. Cheney and Dickson, (1982) characterized IS sophistication into three main criteria: (1) "technological sophistication," reflecting the hardware and software system and nature of the application; (2) "organizational sophistication," reflecting the information resources for management activities; and (3) system performance.

Understanding the external capabilities of technologies linked to an organization is closely associated with listening capability [25]. Listening organizations know customers and service providers by creating the technical ability to satisfy those customers [43] [54]. To manage the

service exchange process between the organization and its customers, the service component of the organization must develop market intelligence: in other words, to employ sophisticated listening practices. These comprehensive information-laden practices not only endeavor to understand the needs of the external customer but also examine the internal customer's needs and their relationship to the external customer's needs [26]. Managers should look at these relationships regarding people/equipment focus, customer contact time, degree of customization, and degree of employee discretion [62]. The above implications for managers are that they must carefully consider their service context and supporting technologies before embracing an IT strategy to improve their performance.

A user's drive to use technology, the need for technology support, and the group's cultural orientation toward collaboration indicate levels of sophistication in the service context [66]. The lack of complexity in using service technology might be due to insufficient support for complex organizational tasks [21]. Nevertheless, looking deeper, given the growing ubiquity of the internet, the availability of suitable collaborative technology applications is not an issue. Instead, the low levels of use or sophistication of use of IT result in the loss of valuable potential benefits from the technology, including significant increases in white-collar productivity and the quality of group decisions [66]. In these situations, it may not make sense to classify an entire application as sophisticated. Instead, rate the activity performed using the application or infrastructure as high or low on sophistication [21].

We might think of organizational IT maturity as IT professionalism, which refers to the level of professionalism exhibited by the organization regarding technical competence and business understanding of IT. High levels of awareness and knowledge about the latest information technologies amongst employees, the presence of powerful IT champions who actively encourage the use of IT and the existence and prevalence of innovative IT applications and solutions developed by organization members, and a high degree of comfort using IT might characterize an organization demonstrating high IT maturity [66]. The gap between IT professionalism and IT Technology is understanding the context of technology fit to understand the factors that influence the sophistication of use, including the need for technology support, cultural orientation, and technology drive. There is a drive to increase IT sophistication and a lesser driver for technology support. Cultural orientation towards collaboration possibly acts as a catalyst, further enhancing the sophistication of technology use [66].

Businesses require a robust technical infrastructure that allows new technology to make existing technologies obsolete quickly and create applications that revolutionize markets and demand for products and services. Technology is the enabler of the IS strategy that supports the business strategy. Managers decide which technologies to invest in and which best support the customers' needs. Sophisticated organizations manage the service exchange process to develop market intelligence (de Bu'rca et al., 2006). This characterization suggests that IS sophistication has essential implications for the management of organizations. Porter (1980) provided strong evidence that technological sophistication is related to firm performance; however, many studies cast doubt on IT complexity's direct effect on performance. Most likely, the management of IT professionalism moderates the relationship between service practices and service performance. Raymond et al. (1995) found that IT management is positively related to structural sophistication, and IS sophistication is positively associated with performance. Mulligan and

Gordon (2002) found that the relationship between customers and suppliers in the financial services industry showed that IS sophistication forced organizations to address relationships with customers and suppliers [48, 50].

#### MANAGEMENT OF IT SOPHISTICATION

There is a difference between IT Sophistication and IT professionalism, which we now call IT management of sophistication. IT Management of Sophistication represents how IT management practices have evolved and formalized the planning, control, organization, and integration of IT activities within an enterprise. IT management sophistication suggests an ongoing evolution of an organization's IT management practices, such as information systems (IS) expenditure, IT use experience, IS function, and so forth [28]. A recent study of business executives from 109 firms found that perceived IT importance predicted IT management sophistication, particularly the control aspect, which is relevant for strategic alignment needed to obtain and maintain competitive advantage. The same study further showed that IT management sophistication mediated effective IT/business relationships, which can incentivize building more comprehensive, agile, and strategy-oriented IT systems for collecting and analyzing market information [72]. Many IS researchers focused on linking IS investment and organizational performance with understanding IS sophistication (i.e., diversity and complexity in using IS) and how corporate performance interacts to bring about competitive advantage [50]. However, given the ubiquity of IT across their organizations, senior managers still fail to properly understand the strengths and limitations of their information systems and the need to manage IT across the entire IT infrastructure, applications, and people.

In a study of 600 board members, despite investments of time and money, 65% believe their organizations are at risk of a cyberattack within the next 12 months, and almost half believe they are unprepared to cope with a targeted attack [47]. Just 69% of responding board members see eye-to-eye with their Chief Information Security officers (CISOs). Fewer than half (47%) of members serve on boards that interact with their CISOs regularly, and almost a third only see their CISOs at board presentations. These results suggest meaningful and effective conversations about cybersecurity and IT sophistication are not occurring [47]. The higher the importation of IT sophistication within an organization's IT Steering Committee, the greater the Management IT sophistication of the firm [6, 38].

# A MANAGEMENT IT SOPHISTICATION MODEL

Raymond et al. (1995) found that IT management is positively related to structural sophistication, and IS sophistication is positively associated with performance. Mulligan and Gordon (2002) found that the relationship between customers and suppliers in the financial services industry showed that IS sophistication forced organizations to address relationships with customers and suppliers [48, 50]. As shown in Figure 1, Noor et al. (2009), in a study of strategic accounting information systems of small and medium-sized enterprises (SMEs), found that IT sophistication is a determinant of Management Accounting Information (MAI), which in turn is a determinant of Computer-Based Information Systems (CBISs). Sophisticated IT increases the availability of quality information, leading to improved performance and the success of CBISs [51]. CBIS success includes overall perspectives of the individual, system, and organization [20] [51]. IT sophistication also directly affects the amount of information provided; for example, as

IT sophistication increases, managers have increased access to information, assisting them in making better business decisions [24].

#### FIGURE 1 CONCEPTUAL FRAMEWORK (NOOR 2009)



Figure One hypothesizes that IT sophistication is a determinant of the management of IT, which in turn is a determinant of CBIS Success. The management of IT plays a mediated role in the relationship between IT Sophistication and CBIS Success. However, the hypothesized relationship concerns the structure of the relationship and how a service organization classifies or positions itself in the context of provider service. Management must understand the link between IT sophistication and company performance. Burca et al. (2005) advocated that to call a firm technologically sophisticated, a company should possess a robust scientific-technical base; new technologies should quickly make existing technologies obsolete, and new IT applications should create new demand or revolutionize markets and needs. Bu'rca et al. (2006) investigated the relationship between service practices, business performance, and IT sophistication. They showed that an IT competitive advantage existed when IT sophistication moderated the services practice-service performance relationship (Figure 1). Moderation occurs when the relationship between two variables depends on a third variable. Service encounters are more socially interactive and information-dependent than the information needed in manufacturing and require greater awareness or listening to customers' needs.

Ratnaningsih and Suaryana (2014) revealed that the sophistication of information technology, management participation, and accounting knowledge manager positively and significantly influence the effectiveness of accounting information systems. Ratnaningsih and Suaryana (2014) also provide evidence that private universities with advanced information technology, management participation, and high manager knowledge can improve the effectiveness of corporate information systems. Based on the above analyses, there appears to be a positive relationship between the manager's role, knowledge manager, and information technology sophistication with the effectiveness of the information system. Some research on the implementation of previous information systems that some researchers have done found a positive and significant relationship between the influence of information technology sophistication on the alignment or conformity of information technology with business strategy [32].

Sophistication is challenging to define. In a study of product cost accounting systems, 16 different definitions of sophistication suggested that descriptions of IT sophistication are too broad and that researchers should concentrate on narrowly defined issues [14]. Brierley (2010) explained sophistication by whether the parent company determines the software used by the operating unit, the power of the software chosen by the functional team, the effect of the parent company specifying the importance of product costs in decision-making on management's demand for product cost information; the lack of funds available to invest in product costing

systems; the lack of time for data collection and operating the product costing system; and the effect of having solely customized sales on the level of manufacturing technology, and the number of different materials and labor included in the product[13]. There is mixed support for the direct effects of IT sophistication on service performance [19].

FIGURE 2 (Conceptual Framework, deBurca et al. 2006)



Similarly, Okumus (2003) illustrated how two large hotel companies had to rely on external IT companies to develop and implement their specific projects since both groups lacked IT sophistication [9, 53, 52]. Cragg (2013) provided additional support for this relationship by proposing a model for the influence of internal and external IT support on IT sophistication; see Figure 2 [18]. As shown in Figure 1, Noor (2009) found that management information moderated the relationship between IT Management Sophistication and IT Success. It is essential to recognize that managing the IT function and managing the organization's strategy are related but not the same. Organizations need to address both the implementation of IT and the alignment of IT to business strategy to drive business performance successfully.





The models in Figures 1 and 2 suggest that IT management skills are important when developing and implementing IT decisions. Managerial and organizational capabilities influence how technology develops, deploys, and is used [65, 73]. According to Mata et al. (1995), managerial skills include management's ability to conceive of, develop, and exploit IT applications to support and enhance other business functions [45]. IT management skills include the ability of IT managers to understand and appreciate the business needs of different functional managers, suppliers, and customers, the ability to work with these operational managers, suppliers, and customers to develop appropriate IT applications, the ability to coordinate IT activities in ways that support other functional managers, suppliers, and customers, the ability to anticipate the future IT needs of operational managers, suppliers, and customers [45]. Harguem (2021) theorized that the determinants of IT Management sophistication required IT governance

effectiveness. IT governance comprises the leadership, organizational structure, and processes needed to sustain and support an organization's business strategy [31].



#### FIGURE 4: Harguem (2021)

Figure 4 represents a synthesis of three streams of IS research in a decision-making structure needed to encourage the successful specification of decision rights and accountabilities desirable for IT-related behaviors leading to IT strategic alignment with business strategy. Who makes the decisions, who implements the findings, and how is the performance of the IT measured to demonstrate IT strategic alignment with the business strategy [31]? IT Sophistication and IT Management Sophistication plays a role in achieving IT Strategic alignment with Business strategy. Figure Five, the IT Sophistication and Management Inclusive Model, theorizes determinants and moderators of IT Sophistication and IT Management sophistication leading to effective business performance.

At the center of Figure Five, IT sophistication determines IT Strategic alignment. IT Management Sophistication determines IT sophistication and IT Strategic alignment [50, 51]. Harguem (2021) provides substantial theoretical and qualitative support for IT governance to determine IT management sophistication. IT management Sophistication determines IT strategic alignment, which impacts Business performance [31]. Noor (2009) suggests that IT management sophistication defines IT sophistication. The relationship between IT management and IT sophistication becomes crucial as we separate business strategy from the IT strategy. Figure Five suggests that internal IT support, external IT support, and IT governance determine IT management sophistication. As Cragg (2013) presents in Figure 3, Internal and External IT support also influence IT Service Performance. Lastly, IT Sophistication moderated the relationship between Service Practices and IT Service performance. The distinction is that sophisticated IT by itself cannot drive business strategy. Technologies require maintenance and upgrade resources to support the organization and its strategic aims. However, the choice of technology and how the technology is applied requires a different set of management skills.

#### Figure 5: (THE IT MANAGEMENT SOPHISTICATION AND IT SOPHISTICATION INCLUSIVE MODEL)



Compared to technical skills, managerial IT skills require a longer development time. IT Managerial skills are not innate skills, they are teachable. For example, management's understanding of IT projects and their potential contribution to the company's performance was crucial for American Airlines to develop the SABRE system, the first airline reservation that gave them a considerable competitive advantage. Integrating resources is another critical area in developing and implementing IT projects. The foundation of resource integration points out the maximization of a firm's competitive advantage through combining and utilizing valuable resources. Managing IT security requires funding, which may not lead to a competitive advantage but will avoid losing customers after a security breach, given government accountability and reporting responsibilities. Firms attempt to find a performance advantage by establishing optimal resource boundaries with available IT resources. The resource-based "strategic necessity hypothesis" claims that IT creates an advantage by leveraging or exploiting existing human and business resources.

Interestingly, sophisticated IT users do not outperform less sophisticated users; however, those who combine IT with critical complementary human and business resources gain performance advantages (Powell and Dent-Micallef, 1997). Sigala et al. (2004) revealed that hotels with more sophisticated technologies combined with their other resources achieved higher productivity

scores than those using technologies for automation only. Additionally, IT projects must be integrated with other projects and systems to ensure they are user-friendly, reliable, secure, responsive, flexible, easy to maintain, accurate, and measurable [9]. To effectively address IT security in healthcare, IT sophistication, and IT Management Sophistication must be in place.

#### IT SOPHISTICATION IN HEALTHCARE

It is misleading to compare healthcare providers on only one technology dimension. For instance, do they have an Electronic Healthcare Record (EHR) System? It would be more appropriate to evaluate the entire array and implementation of technologies, as suggested in Figure 5. For example, a classic cost-effectiveness trade-off occurs when a patient/consumer compares an inexpensive, good-outcome treatment with a high-cost, potentially better-outcome therapy. The patient might value the overall experience over one single outcome measure. Outcomes are typically a function of many factors whose interactions are challenging to measure.

The cost and quality of a procedure depends on the facility, the physician, and other staff. Consider the case of a sophisticated medical device or new therapy that is available only at a hospital with poor quality rankings. How will the consumer be presented with this information? How clearly can such a decision-theoretic choice be presented? The technological connection between the patient and the medical outcome is the EHR. EHRs store patient records such as medical examinations and hospital admissions, the patient's demographics, immunization history, and other aspects of a patient's medical history. A critical feature of EHRs is that standards ensure that records are interoperable, i.e., anyone with the appropriate permission can view the information, thus allowing the consumer to move quickly between service providers. Historically, moving an HER within and across professional networks creates boundary issues when deciding who should pay and who would reap the financial rewards, let alone security issues in protecting patient records.

To maintain a competitive advantage, healthcare organizations must increasingly become more sophisticated, suggesting it would be necessary to innovate computer security in a more sophisticated way to sustain competitive advantage [29]. The rise in complexity and sophistication of the IT capability in hospitals also increases the importance of IT governance in these organizations [12]. Hence, an organization's IT governance mechanisms often indicate the sophistication of its management (both IT and business) capability [11]. For example, some corporations and government agencies began implementing IT governance mechanisms to achieve a fusion between IT and business to obtain needed IT involvement from top management. As a result, getting value from IT is an organizational competency that companies and IT executives are responsible for developing.

Healthcare organizations are facing increasingly sophisticated cyber attacks and fraud. Interestingly, the degree to which IT management sophistication contributes to a company's success is contingent upon its adaptive innovated behavior [34]. Technology sophistication, management skills, and integration of resources are key issues when implementing IT decisions [9]. However, there are times when IT management sophistication differs with the need for innovation and to be less aggressive and more grounded. Consequently, conflicts may exist between intended and realized IT management sophistication, leading to poor strategic alignment [34]. Deroche (2022) conducted a psychometric test of a nursing home (NH) health information technology (HIT) sophistication with a survey format from a prior study representing NHs with low (20%), medium (60%), and high (20%) HIT scores [22]. D The survey contains 50 questions related to three IT sophistication dimensions (IT capabilities, extent of IT use, and degree of internal and external IT integration) and three domains of care (resident care, clinical support, and administrative activities). Deroche looked at 429 NHs that completed at least two annual surveys over four (Alexander, Deroche, & Powell, 2020) based on self-reports by administrators. Findings revealed that resident access to technology was a significant predictor of the nursing home IT sophistication (P<.001). Including covariates—nursing home location, bed size, and ownership-with their interactions produced a nonsignificant effect. Residents or their representatives' use of electronic health records and personal health records were both significant predictors of overall IT sophistication (P<.001) [40]. Studies of nursing home IT in the US found differences in IT sophistication (an analogous measure to IT maturity) relative to LTC home characteristics (i.e., ownership, location, and size). A spectrum of IT maturity may exist across the LTC sector in Ontario, the setting of the proposed survey, and it will be helpful to identify inter-facility differences that may contribute to different levels of IT adoption [30]. IT sophistication is valid and reliable for assessing changing trends in key IT dimensions and associated quality and safety measures.

Previous studies related to nursing homes defined IT sophistication as the diversity of technology and software used to support resident care, clinical support, and administrative processes [3, 4, 36]. IT Sophistication has three domains: functional, technological, and integrated sophistication. Operational sophistication identifies the kinds of computerization used; technical sophistication specifies the extent of use of the technology; and integrated sophistication reflects the amount of internal and external integration of technology used in each healthcare domain[3, 4, 36]. In our prior studies, IT sophistication requires three IT dimensions (IT capabilities, extent of IT use, and degree of internal/external IT integration) within three healthcare domains (resident care, clinical support (laboratory, pharmacy, radiology), and administrative activities). Previous studies identified resident care management, clinical support, and managerial processes as three domains of IT sophistication. Further studies are needed to assess the relationship between IT implementation and resident outcomes to evaluate the value added to quality care [3, 36].

In a national Delphi study evaluating the IT maturing of nursing homes, Alexander et al. (2020) used an IT maturity model containing seven stages to rank IT technologies, with the majority of technologies (40%) ranking at level four. Only 11% were at the highest level [1]. Results. In another Delphi study of IT sophistication in New South Wales, Australia, Alexander et al. (2020) found that participating aging care facilities were similar to other NSW facilities in residential places and remoteness but different in organizational type. IT sophistication was highest in IT capabilities and integration in resident care. IT sophistication was lowest in clinical support. Respondents had a mean of 1.2 years of IT experience. IT sophistication varied among aged care facilities. A linear relationship (P < 0.05) existed between the proportion of high-care residents and total IT sophistication. Routine reports of IT sophistication in aged care are not available. If data were available, determining the influence of IT sophistication on the quality of care for residential aged care would be possible [2].

# CONCLUSION

It is essential to understand how increasing IT sophistication can be leveraged to create opportunities to engage residents in their care. IT management is concerned with a firm's capabilities for building and deploying new capabilities. Hence, a firm with durable IT infrastructure and superior IT management can effectively arrange a new application, modify or redesign enterprise systems with structural sophistication, and solve maintenance hurdles [35]. We can conclude that the role of managers, knowledge, and complexity of information technology can affect the organization's performance. The manager's role and technological sophistication significantly influence the effectiveness of information systems, while managers' detailed knowledge of IT has no significant effect [32].

Under the Patient Protection and Affordable Care Act (2009), the Health Information Technology for Economic and Clinical Health (HITECH's) incentive program laid the foundation for healthcare delivery reform by having organizations demonstrate meaningful use for a host of qualifying applications of IT Healthcare [15]. The key goals were to restructure healthcare delivery and achieve higher healthcare quality, reduce IT costs, and increase access through better storing, analyzing, and sharing health information [15]. The concept is conceptionally the same as Nolan's IT maturity model.

It is reasonable to expect that the level of clinical IT sophistication drives the needs of those in the external environment. Clinical IT sophistication could result from organizational responses to problems emerging in the external environment, such as treating the increasingly heterogeneous acutely ill patient population, and serve as one vehicle for enhancing the attractiveness of the hospital to physicians as a place to treat patients. These points could help direct hospital administrators in making their efforts to improve hospitals' clinical IT capability. Particularly, administrators need to identify the key stakeholders of the organization and their significant needs and configure the clinical IT structure accordingly to accommodate the emerging demands of the environment. With stakeholders' demands at heart in planning clinical IT configuration, the clinical IT practice could be cost-effective and pertinent to address the most urgent and vital issues [71].

The increased sophistication of artificial intelligence outpaces the regulatory and review capacity of most agencies charged with protecting public health and providing oversight of technologies applied to health and well-being [55]. Employee performance improves with increased information technology (IT), sophistication, and quality (Sayudha, 2020; Sulistyawati & Bahruni, 2021Managerial IT sophistication alludes to the instruments utilized to plan, control, and assess present and future applications [46]. Thong (2001) suggested evaluating culture in technology, management, function, and information among the numerous facets of IT Managerial Sophistication. Information is a new dimension of complexity. Furthermore, IT and Managerial sophistication may be viewed as less pertinent because most organizations in developing countries do not isolate information technology's capacities.

The need for research that advances an understanding of how to manage the security of IT resources effectively is timely. There is a growing frequency and sophistication of IT security breaches and significant direct and indirect costs incurred by the affected firms and their stakeholders [37]. The security of IT resources is a core competence and differentiator, as many business processes are now embedded or are dependent on IT resources. Management sophistication is required to address IT security issues—leadership and management problems concerning the downward trend of IT security. However, there are differences in the level of

innovative IT-based formal communication processes that may be due to cultural, structural, resistance to change, government involvement, and lack of incentives, despite stakeholders being aware of IT and its applications [58].

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#### EXAMINING A DISTANCE DECAY EFFECT FOR ED UTILIZATION AMONG GERIATRIC POPULATION IN MARYLAND, 2017-2019 SEDS DATA

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#### ABSTRACT

Based on the Anderson's Model of Health Services Use framework commonly used to study health utilization in Emergency Departments (EDs), peoples' behaviors and outcome are determined by factors specific to the individual as well as the context in which healthcare is sought. Individual factors are classified into three categories: need, predisposing and enabling factors. Healthcare access is a critical enabling factor and can be measured by distance. Several studies examining the utilization of medical services have found geographic proximity as one of the influencing factors driving the utilization of medical services in EDs. A 'distance decay' effect is present when the patient's distance from the ED correlates negatively with the decision to use the ED, specifically for non-urgent medical conditions. Using the 2017-2019 State Emergency Department Databases (SEDD) of Maryland, we propose to examine and quantify the distance decay effect for different types of ED care (emergent, non-emergent, behavioral and injuries) among geriatric patients after controlling for covariates. Types of ED care were identified using the New-York University-John Hopkins University Emergency Department Algorithm (NYU-JHU-EDA). With the help of linear regression models, we find preliminary evidence pointing out to the presence of a distance decay for non-emergent care, i.e. older adults living further away from the EDs, had a lower probability associated with the use of the ED for non-emergent care. But the opposite effect was seen for emergent care. The findings of this study will be critical to policy-makers in understanding the relationship between ED locations and its use for non-emergent and emergent ED care. Additionally, it will be valuable in identifying programs and interventions to reduce ED use for non-emergent care.

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#### THE IMPACT OF NURSE STAFFING RATIOS ON PATIENT EXPERIENCE AS MEASURED BY HCAHPS

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# ABSTRACT

#### **Objective:**

To assess the impact of nurse staffing ratios on overall inpatient hospital experience as measured by HCAHPS.

#### Methods:

Correlation between RN nurse staffing ratios in medical-surgical units of 47 New Jersey hospitals and the final hospital HCAHPS score for each of the years 2013-2019.

#### **Results:**

Data indicates that RN nursing ratios in a hospital's medical-surgical unit explain approximately 12 percent of the HCAHPS score a hospital receives.

#### Introduction

The relationship between nursing and patient care is multifaceted. To provide high quality nursing care, several structural and process factors are at play. These factors include patient acuity, the nurse's skill, education, and training, the facility and its supplies and equipment, ongoing training, and the use of documented best practices. Additionally, the interpersonal relationships that exist within the care-giving team as well as nurse engagement, and satisfaction with their job.

A 2023 survey of more than 11,000 Ohio nurses paints a startling picture, one that nurses across the country know all too well, nursing is in a staffing crisis. Some key findings of this survey include [1]:

- 58.05% of nurses who left the bedside did so because of patient care load.
- 70.09% of direct care nurses are currently considering leaving the bedside because of patient care load.

There have been dozens, if not hundreds of studies done, which offer reasonable to substantial evidence that patient outcomes are more favorable in hospitals with better nurse staffing. In one

famous study conducted by Harvard University, researchers found that hospitals with high RN staffing levels, resulted in a 3 to 6 percent shorter length of stay for patients and reduced costs for the hospital [2].

But the relationship between nurse staffing levels and patient experiences of care is less clear. One drawback of the existing literature that examines nurse staffing levels and their impact on the patient experience is how the variable "patient experience" is defined and measured. In the United States, the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey provides a standardized approach to defining and measuring the concept of patient experience.

Additionally, nurse staffing ratios vary considerably between hospitals and within hospital units. There are no federal rules or regulations that require healthcare facilities to measure or report nurse staffing levels, let alone meet minimum nurse staffing ratio thresholds. Only two states, California, and Massachusetts, have legislation regarding necessary minimum nurse staffing levels. A handful of other states have implemented various laws and regulations that require hospitals to report nurse staffing ratios. Among these states, considerable variation exists in how nurse staffing ratios are defined, measured, and reported. Additionally, this variation extends to the degree of accessibility of the reported nurse staffing ratios to the public.

This study investigates how the patient experience of care, as measured by HCAHPS scores, is affected by the staff-to-patient ratios of different types of nursing personnel in medical-surgical units. We collected data from 46 New Jersey hospitals on their staff-to-patient ratios of registered nurses, licensed practical nurses, and unlicensed assistive personnel, as well as their HCAHPS scores, for the years 2013-2019. No correlation of significance was found between LPN nurse staffing ratios and HCAHPS or unlicensed assistive personnel staffing ratios and HCAHPS. The relationship between RN nurse staffing ratios and HCAHPS scores was mixed.

Overall, for the years 2013-2019, a significant negative correlation was found between RN staffing ratios and HCAHPS scores, indicating fewer patients per nurse yields improved HCAHPS scores. The data indicate that RN nurse staffing ratios in the medical-surgical unit explain approximately 12 percent of the variance in the HCAHPS score a hospital obtains. But when the data is examined year by year, the story changes. Of the seven years analyzed, only three years showed a significant correlation between RN nursing rations and HCAHPS scores obtained.

#### Literature Review

#### -Nurse Staffing Ratios

Nurse staffing ratios communicate the number of patients each nurse is required to care for at one time, as patients are added to a nurse's assignment, the ratio increases [3]. Considerable variation in defining and measuring nurse ratios exists. At the federal level there is no law or regulation that mandates nurse staffing levels or even the measurement and/or reporting of existing nurse staffing levels.

At the state level there are sixteen states that address nurse staffing in hospitals either through law or regulation. Nine states mandate that nurse-led staffing committees create staffing plans based on patient acuity (American Nurses Association, 2022) (Davidson, 2023). These nine states are California, Illinois, Nevada, New York, Ohio, Oregon, Texas, Washington, and Minnesota (Davidson, 2023). California and Massachusetts are the only states that currently have legislated mandated nurse-to-patient ratios. Massachusetts requires RN-to-patient ratios specifically in intensive care units while California more broadly requires minimum unit specific RN-to-patient ratios for acute care, acute psychiatric, and specialty hospitals [4] [5].

The five states of Illinois, New York, New Jersey, Rhode Island, and Vermont mandate the disclosure and/or reporting of nursing ratios [4]. The measurement, the frequency, the reporting mechanism, and the availability of the data to the public varies considerably among each of these states [6]. New Jersey is the only state that measures the numbers of patients per RN staff by hospital unit. New Jersey hospitals are required to report RN staffing ratios by hospital unit on a quarterly basis to the State of New Jersey Department of Health, which makes this data available to the public.

# -HCAHPS

The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey is a 29-item survey instrument and data collection methodology for measuring patients' perceptions of their hospital experience [7]. All acute care hospitals that provide care to Medicare patients are required to administer the HCAHPS survey as part of the Inpatient Prospective Payment System. Additionally, the Hospital Value-Based Purchasing (VBP) program ties a percentage of Medicare reimbursement to the results of the HCAHPS survey. VBP is designed to incentive hospitals to improve performance in patient quality, safety, and experiences. VBP is a budget neutral program that is funded by a 2 percent reduction in Medicare reimbursement. These reductions in reimbursements are then used to make incentive payments to top performing hospitals. In other words, the reduction in reimbursement to poor performing hospitals is reallocated to the top performing hospitals, creating clear winners and losers.

HCAHPS is known as the *person and community engagement* domain of the VBP system. HCAHPS accounts for 25 percent of a hospitals VBP score. Hospitals are evaluated, compared, and compensated based on their patient experiences of care as measured by the HCAHPS survey. CMS estimates that the 2024 VBP total incentive payments will equate to \$1.7 billion [8]. With approximately 3,000 hospitals participating in the VBP program, each hospital has approximately a half a million dollars at stake. Although the VBP program is a federal program, value-based payment models are increasingly being adopted by all payers of healthcare services [9].

# -Nurse Staffing Levels and Patient Experiences of Care

The existing research makes a strong argument that fewer patients per nurse translates into improved patient experiences both in the United States and around the world. Table 1 outlines the principal findings of numerous international and domestic studies. Several of the U.S. studies utilize HCAHPS as the primary measure of patient satisfaction but unfortunately there is considerable variation in defining and measuring nurse staffing levels. For example, Oppel and Young measured nurse staffing as the ratio of RN nurse FTE per 1,000 patient days [10]. While Delhy and colleagues measures nurse staffing as the number of RN staff hours per adjusted patient day [11].

Author	Findings				
[11] (Delhy, Dor, &	Found that patient experience scores would generally improve with				
Pittman, 2021)	increases in registered nurse and nursing assistant hours.				
[12] (Hong & Cho, 2021)	Found that improved nurse staffing was correlated with improved patient experience.				
[13] (Lasater, et al., 2021)	Examined existing nurse ratios in relation to both nurses and patients' recommendations of hospitals. They found that favorable nurse ratios are associated with better hospital ratings from both nurses and patients.				
[14] (Winter, Dietermann, Schneider, & Schreyogg, 2021)	Found that lower nursing staff levels are associated with reduced patient-perceived quality of nursing care and patient loyalty to the hospital (measure of patient experience)				
[15] (Marcoux, 2020)	Specifically examined patient experience measures in emergency departments and compared California mandated nurse staffing ratio hospitals to comparison hospitals with no mandated staffing levels. Did not determine a direct correlation between government mandated nursing ratios and patient experience.				
[16] (Aiken, et al., 2018)	Nurse staffing levels were positively associated with better patient perceptions of hospital care.				
<ul><li>[17] (International Council of Nurses, 2018)</li></ul>	This is a position statement from the International Council of Nurses which states the optimal nurse staffing leads to better patient outcomes, better patient satisfaction, and better employee morale.				
[18] (Mazurenko, Collum, Ferdinand, & Menachemi, 2017)	Higher nursing ratio was found to be positively associated with to patient satisfaction (experience).				
[10] (Oppel & Young, 2017)	Staffing Flexibility (having part-time nursing staff) was found to be the most import variable related to patient experiences.				
[19] (Bruyneel, et al., 2015)	Patient care experience is better in hospitals with better nurse staffing and a more favorable work environment.				
[20] (Aiken, et al., 2012)	Found that improved nurse staffing ratios and nursing work environments were associated with increased patient outcomes and increased patient experience.				
[21] (Witkoski- Stimpfel, Sloane, & Aiken, 2012)	As the number of hours in a nurse work-shift increase, patient satisfaction decreases, and nursing burnout increases.				
[22] (Zhu, et al., 2012)	Increases in nurses was positively associated with patient outcomes and patient experiences.				

Table 1Nurse Staffing Ratios and Patient Experience

[23] (Kutney-Lee, et al., 2009)	Patient-to-nurse workloads were significantly associated with patients' ratings and recommendation of the hospital to others.
[24] (Jha, Orav, Zheng, & Epstein, 2008)	Hospitals with high nursing staffing ratios (fewer patients per nurse) had better HCAHPS performance.
[25] (Potter, Barr, McSweeney, & Sledge, 2003)	Found a positive correlation between RN hours and patients' perception of satisfaction (more nursing hours, increased patient satisfaction) as well as a negative correlation between nursing hours and patient pain management (more nursing hours, less patient pain).

#### Methodology

The official Person and Community Engagement (HCAHPS) domain score, as provided by CMS for a particular year is determined by using data from both a "baseline" and a "performance" time-period. This research specifically focuses on the "performance" time-period. HCAHPS data was obtained from the Centers for Medicare and Medicaid Services *Hospitals Archived Data* Snapshots data archive website [26].

Nursing ratio data was obtained through the New Jersey State Department of Health. Ratios for the following nursing categories were obtained: (1) registered professional nurses (RN), (2) licensed practical nurses (LPN), and (3) unlicensed assistive personnel. This data was obtained for the medical-surgical unit of 47 New Jersey hospitals for the years 2013 through 2019. Medical-surgical beds represented approximately 80 percent of all hospital beds in the sampled hospitals. Additional characteristic information of the sampled hospitals can be found in Table 2. The hospitals in this sample reported such little use of licensed practical nurses that the category was dropped from our analysis. New Jersey law requires hospitals to report the number of nursing hours worked, the number of nursing staff, and the number of patients, every 8 hours. This is done for each hospital unit and each category of nursing staff. The number of hours worked is divided by the number of staff and the ratio of 1 nursing staff to *X* patients is calculated. Hospitals are required to submit monthly averages of this data to the New jersey Department of Health and Senior Services [27].

<b>Descriptive Category</b>	Number of Hospitals		
Type of Control			
Proprietary, Corporation	5		
Proprietary, Partnership	1		
Voluntary Nonprofit, Church	6		
Voluntary Nonprofit, Other	35		
Teaching Status			
Teaching (COTH member)	18		
Teaching (Non-COTH)	19		

# Table 2 Characteristics of Sampled Hospitals

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No Reported Teaching	10
Number of General Medical/Surgical Beds	
Less than 50	0
51 to 100	5
101 to 250	26
251 to 500	14
More than 500	2

#### Results

Table 3 contains the descriptive statistics for the three variables of interest (Patient to Registered Nurse ratios, Patient to Unlicensed Nursing staff ratios and HCAHPS scores). An Analysis of Variance (ANOVA) revealed no mean differences in patient to RN ratios across the years studied. For patient to unlicensed staff ratios, there were mean differences for the overall ANOVA test across years (F = 2.57, p = .02,  $\eta^2 = .05$ ), but no mean differences between any two years. In the patient experience category, as measured by HCAHPS scores, there was a mean difference for the overall ANOVA test across years (F = 2.21, p = .04,  $\eta^2 = .04$ ), and a mean difference in HCAHPS scores only between the years 2013 and 2019 (M<sub>2013</sub> = 29.20, M<sub>2019</sub> = 21.60). These data indicate that patient experience (HCAHPS) is on an overall downward trajectory.

Table 4 contains the Pearson correlations among the three measured variables across years. Before breaking the data down by year, an overall correlation was run between HCAHPS and nursing ratios across all seven years. The correlation between patient to registered nurse ratios (RN ratio) was the only one statistically significant at p < .05 (r = -.34), indicating that approximately 12 percent of the variance in patient experience (HCAHPS) scores can be explained by patient to registered nurse ratios. In 2013, 2014, and 2016, the correlation between RN ratios is significant with approximately 10 percent of the variance in patient experience (HCAHPS) scores being explained by RN ratios. As the number of patients per RN increases, the HCAHPS scores decrease. In the years where there was not a significant relationship between these two variables, the HCAHPS scores tended to be lower with RN ratios remaining relatively stable.

Descriptive Statistics by Year for Nursing Ratios and IICAHPS Scores							
Year	Variable	Mean	St Dev	Min	Max	Skewness	Kurtosis
						(Error)	(Error)
2013	RN Ratio	5.22	.73	3.55	7.55	.62 (.35)	1.49 (.69)
2013	Unlicense Ratio	11.59	3.83	6.50	25.73	1.70 (.35)	3.62 (.69)
2013	Patient Exp	29.20	13.56	13.00	74.00	1.41 (.35)	2.07 (.69)
2014	RN Ratio	5.16	.76	3.13	7.45	.29 (.35)	1.33 (.69)
2014	Unlicense Ratio	11.38	3.81	4.15	23.55	1.30 (.29)	2.83 (.69)
2014	Patient Exp	24.59	12.16	10.00	72.00	1.62 (.35)	3.92 (.69)
2015	RN Ratio	5.05	.73	3.58	7.63	.92 (.35)	2.09 (.69)
2015	Unlicense Ratio	10.39	2.58	3.85	17.88	.24 (.35)	.81 (.69)
2015	Patient Exp	23.23	10.46	8.00	49.00	.58 (.35)	52 (.69)

#### Descriptive Statistics by Year for Nursing Ratios and HCAHPS Scores

Table 3
2016	RN Ratio	5.01	.68	3.58	7.55	.88 (.35)	3.13 (.69)
2016	Unlicense Ratio	10.52	2.60	3.88	17.48	.20 (.35)	.65 (.69)
2016	Patient Exp	24.67	12.05	6.00	54.00	.81 (.35)	04 (.69)
2017	RN Ratio	5.01	.73	3.27	7.40	.37 (.35)	1.91 (.69)
2017	Unlicense Ratio	10.22	2.49	3.77	15.37	.21 (.35)	.26 (.69)
2017	Patient Exp	26.53	12.34	10.00	63.00	1.28 (.35)	1.41 (.69)
2018	RN Ratio	4.94	.68	3.35	6.83	.72 (.35)	1.61 (.69)
2018	Unlicense Ratio	9.93	2.40	15.03	9.93	.08 (.35)	.83 (.69)
2018	Patient Exp	23.02	10.68	9.00	52.00	.78 (.35)	.09 (.69)
2019	RN Ratio	4.87	.67	3.08	6.33	25 (.35)	.86 (.69)
2019	Unlicense Ratio	9.79	2.26	3.20	14.95	22 (.35)	1.11 (.69)
2019	Patient Exp	21.60	8.51	10.00	45.00	.92 (.35)	.45 (.69)

Note: RN ratio is an indicator of how many patients each registered nurse is assigned (higher numbers indicate more patients per RN and/or fewer staff); unlicense ratio is an indicator of how many patients each unlicensed nursing care person is assigned (higher numbers indicate more patients and/or fewer staff); Patient Exp is measured by the HCAHPS portion of government ratings (higher numbers indicate higher patient experience).

Year	RN and Unlicensed Ratios (significance level)	RN ratio and HCAHPS	Unlicensed ratio and HCAHPS
2013 (N = 46)	.19 ( <i>p</i> > .05)	34 ( <i>p</i> < .05)	26 ( <i>p</i> > .05)
2014 (N = 46)	.21 ( <i>p</i> > .05)	34 ( <i>p</i> < .05)	27 ( <i>p</i> > .05)
2015 (N = 46)	.07 ( <i>p</i> > .05)	26 ( <i>p</i> > .05)	11 ( <i>p</i> > .05)
2016 (N = 43)	.07 ( <i>p</i> > .05)	30 ( <i>p</i> < .05)	.08 ( <i>p</i> > .05)
2017 (N = 45)	.19 ( <i>p</i> > .05)	21 ( <i>p</i> > .05)	.13 ( <i>p</i> > .05)
2018 (N = 45)	.25 (p > .05)	10 ( <i>p</i> > .05)	01 ( <i>p</i> > .05)
2019 (N = 46)	.26 ( <i>p</i> > .05)	14 ( <i>p</i> > .05)	06 ( <i>p</i> > .05)

# Table 4 Correlations among Measured Variables per Year

Note: Positive correlations between RN and Unlicensed ratios indicate both are taking care of more patients; Negative correlations between RN or Unlicensed and HCAHPS indicate that patient experience is higher when staffing ratios are lower.

# Discussion

The data indicates that approximately 12 percent of the variance in HCAHPS scores can be explained by patient to registered nurse ratios in the medical surgical unit of the New Jersey hospitals studied. Interestingly, when the data is examined by year, only three of the seven years show significant correlation between RN nursing ratios and HCAHPS. These results can best be described as mixed. The argument that fewer patients per nurse will result in improved patient experiences makes intuitive sense but is not strongly supported by this data. Additional research is need to better clarify the complicated relationship between nurse staffing levels and patient experiences of care.

While HCAHPS is a standardized measure of the patient experience for hospitals in the United States, there is considerable variation in the measurement and reporting of nurse staffing ratios. A more holistic understanding of nurse-to-patient staffing ratios and their impact on patient outcomes and experiences of care cannot be assessed without consistent measurement and reporting of nurse staffing ratios across the United States. Currently no federal rule or regulation exists requiring the measurement or reporting of nurse staffing in the United States and only a limited number of states have attempted to tackle this problem on their own.

Tremendous progress has been made in the United States in terms of defining and measuring variables surrounding hospital care. It is a positive step in the right direction, but it is only a step in a long journey. The utter lack of data surrounding nurse to patient staffing levels needs to change. Clearly defined and agreed upon measures of nurse staffing ratios must occur for a meaningful understanding of the role of nursing in patient outcomes and patient experiences.

# Limitations and Strengths

This research seeks to better understand the role the nursing profession has in relation to the experiences of the patients they care for. As previously mentioned, data on nurse staffing levels in American hospitals is very sparse. Due to data availability, this research was limited to 47 hospitals in the state of New Jersey. Clearly numerous factors are at play when considering the experience a patient has with their hospital encounter. All research may suffer from omitted variable bias and this research is no different. Investigators are forced to do what they can with what they have. Thus, the results may be valid only for the units under investigation, and not necessarily be generalizable.

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# IMPACT OF ELECTRONIC HEALTH RECORD SYSTEM ON INTEROPERABILITY OF LOW-RESOURCED PROVIDERS

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# ABSTRACT

Though progress has been made across the last couple of decades, the electronic exchange of information between systems, interoperability, is still not consistently used by providers nationwide. The 2022 American Hospital Association's Annual Survey on Information Technology revealed the Electronic Health Record's (EHR) used by smaller, independent, rural, and critical access hospitals are characteristically not certified by the Office of the National Coordinator for Health IT (ONC) and these providers are less likely to engage in public health related exchange than their counterparts. Since most patients see multiple providers within their lifetime (within and across medical systems), the ability of providers' systems to exchange health information is now more important than ever so patients can be treated wholistically. Recently, the ONC issued the Trusted Exchange Framework and Common Agreement (TEFCA) as the standard regarding infrastructure and governance to support network connection, and data exchange to become a Qualified Health Information Network (QHIN). Additionally, some of the large EHR vendors have either joined or announced their plans to join TEFCA, giving their customers access. The number of EHR vendors is vast and varies across providers and systems. This study seeks to understand the extent to which a lower-resourced provider's Electronic Health Record (EHR) system impacts interoperability across the following dimensions: size, ownership, location, critical access, and system affiliation. It will also explore challenges and opportunities associated with EHR adoption. The initial phase of the research is focused on model development, instrument development, identification of sample characteristics and parameters, and data gathering techniques. The second phase of the study will focus on data collection and analysis, and the documentation of findings. Because some of the more popular EHR costs more, system inequality may be a contributing factor to lowerresourced providers access to EHR and in essence impact interoperability.

# ASSESSING OPTIMAL CARE PLAN CLASSIFICATION USING CALL BELL FREQUENCY ANALYSIS

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#### ABSTRACT

Background: Accurate classification of care plan levels is crucial for ensuring the optimal delivery of care in assisted living facilities. This study aimed to investigate the relationship between call bell frequency and care plan levels, with the ultimate goal of developing a more effective method for classifying care needs.

Methods: Data encompassing call bell usage and care plan levels for a 12-month period (March 2022-2023) was analyzed to identify any patterns or correlations. Time series graphs were employed to visualize call bell frequency trends throughout the day, while statistical analyses were conducted to assess the relationship between call bell frequency and care plan levels.

Findings: Seasonal patterns were evident in call bell usage, with higher volumes observed during mealtimes and shift changes. Upon closer examination of individual. The findings suggest that call bell frequency alone may not be a reliable indicator for determining care plan levels. Individual resident analysis, considering factors such as cognitive decline, functional limitations, and psychological well-being, provides a more comprehensive understanding of care needs.

Implications: The developed tool for analyzing individual resident data can be utilized to inform staffing decisions, treatment approaches, and communication with families, ultimately contributing to improved quality of care. This approach has the potential to enhance the continuum of care for all stakeholders involved.

Conclusion: This study highlights the importance of individualized care assessments in determining appropriate care plan levels in assisted living settings. By incorporating a holistic approach that considers both quantitative and qualitative data, facilities can provide personalized care that addresses the unique needs of each resident.

Recommendations: Future research should focus on expanding the dataset to include a broader range of assisted living facilities and residents, allowing for a more generalizable understanding of the relationship between call bell frequency and care needs. Additionally, exploring the impact of interventions aimed at reducing call bell response times could provide valuable insights into improving resident satisfaction and quality of care.

#### TANF PROGRAM: ADMINISTRATIVE REFORM & TRANSPARENCY

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#### ABSTRACT

This paper intends to raise awareness of an ethical conundrum involving the Temporary Assistance for Needy Families Program (TANF): improper use of public funds. This composition also offers suggestions to improve public administration and monetary management to combat nationwide child hunger via TANF. Even so, the preface and ten statistical and theoretical works that highlight the issue with the TANF funds policy and clarify the efficacy of governmental food security initiatives in the U.S. are included in the introduction and literature review. The research methodology will clarify the exploratory approach concerning national hunger and TANF recipients not receiving enough funds. Moreover, the recommendation section will address biases and other perspectives regarding food security, what can spur innovative change regarding the

government program, and attempts to justify the research about public administration.

KEYWORDS: child, food security, policy implementation, CARES Act, poverty, TANF,

#### ABSTRACT

This paper intends to raise awareness of an ethical conundrum involving the Temporary Assistance for Needy Families Program (TANF): improper use of public funds. This composition also offers suggestions to improve public administration and monetary management to combat nationwide child hunger via TANF. Even so, the preface and ten statistical and theoretical works that highlight the issue with the TANF funds policy and clarify the efficacy of governmental food security initiatives in the U.S. are included in the introduction and literature review. The research methodology will clarify the exploratory approach concerning national hunger and TANF recipients not receiving enough funds. Moreover, the recommendation section will address biases and other perspectives regarding food security, what can spur innovative change regarding the government program, and attempts to justify the research about public administration.

**<u>KEYWORDS</u>**: child, food security, policy implementation, CARES Act, poverty, TANF, maltreatment

#### Introduction

Concern for food security has been discussed amongst public administrators nationwide, especially during unimaginable inflation and an impending recession in the United States. Amongst the total population in the U.S., 37.9 million Americans are currently experiencing poverty and economic insecurity alongside the "abundance" the U.S. has to offer [1]. During current inflation, mass layoffs, and no wage adjustment to match the actual cost of living (estimated at \$24.16 per hour in an eight-hour workday) reveals an unequal distribution of resources, which leaves children in a vulnerable state of hunger due to lack of affordability [2].

The approach to combat nationwide hunger, especially child maltreatment, has encouraged the government and appointed health professionals to formulate strategies aiming to mitigate widespread child maltreatment; hence, the Coronavirus Aid, Relief, and Economic Security (CARES) Act, established in March 2020 in tandem with the National School Breakfast Program, the National School Lunch Program, and the Summer Food Service Program [3]. Another popular government program is the Temporary Assistance for Needy Families (TANF) – an economic support program established in 1996 for low-income families. Its goal is to help families provide their child(ren) with basic survival needs [4]. Nonetheless, this composition will discuss how the world's richest nation (in terms of GDP) attempts to mitigate an economic and humanitarian crisis-food insecurity, through policymaking. Additionally, this paper will put forth the effort to offer other innovative solution(s): appropriating TANF funds to interrupt the cyclical issue of unequal fund distribution and food insecurity.

#### **Literature Review and Identified Dilemma**

Upon the ubiquitous COVID-19 lockdown, school nutrition programs in the United States continued operation to reduce food insecurity and ensure that children maintained a healthy diet beyond the limitations of a classroom(s) [3]. The consequences of the pandemic influenced the implementation and improvement of program(s) assessing its efficacy and capacity to withstand [3]. Although the National School Lunch Program began in 1946, decades later COVID-19 yielded opportunities for potential innovative change in the program despite it being a preeminent food assistance program in the U.S. [3]; child poverty has an estimated cost of \$1 trillion although 11.88% (for domestic) or \$665 billion of the U.S.'s federal budget is allocated toward economic security programs today [3].

Hendrix (2016) defines "*acute*" food insecurity as a temporary gap in access to food that comes from a variety of factors ranging from inflation to disruptions in delivery systems, recessions, natural disasters, and the like [5]. Meanwhile, the author defines *protracted crises* as

environments vulnerable to death, disease, and disruption of livelihood over a prolonged period, hence the results of the pandemic [5]. Despite the nuances in the author's perspective of food poverty and the debate of semantics, the fact is that food insecurity/poverty is measured based on calculations dating from 1959 to the mid-1960s [1] These outdated and pre-pandemic measurements are still applied to lay out the qualifications for eligibility. However, what is not at all considered is the rhetorical situation of the early 2020s and the lethality of COVID-19. In March 2020, President Trump signed the USDA-funded CARES Act, which provides an estimated \$24.8 billion in funding for food assistance due to the pandemic, and Child Nutrition Programs received \$8.8 billion in additional emergency funds [6]. It is, according to the contributing authors, "the third series of increasingly larger legislative responses as a result of COVID-19," [7]. Unfortunately, after a three-year course, some CARES Act provisions expire in 2023; some finance and housing provisions expire as early as 2021 (e.g., Advance Child Tax Credit and eviction moratorium) [8].

However, there is still TANF, but how the funds are released is not equal amongst all states in the U.S. According to CBPP, "in 2020, for every 100 families living in poverty, only 21 received TANF..." [9]. Furthermore, out of the \$94 billion TANF budget in 2020, only \$2.6 billion was spent on child welfare services between forty-two states totaling 8% of the budget; twelve states spent approximately 20% while only TWO states spent over 50% [9]. Much of the budget (\$6.8 billion) was spent on Pre-K/HeadStart and other areas [9]. Many states still have unspent TANF funds since the policy does not require states to dissipate all the TANF funds annually [9]. In fact, since 2021, the state of Tennessee has been sitting on more than \$800 million in unspent TANF funds, according to McCaffrey and Safawi [9]. The program is underperforming since states barely disperse their portion of TANF funds, defeating the TANF program's objective.

#### Methods

In response to the social phenomenon of increasing maltreatment in successful and developed countries, the exploratory research design attempts to provide a theoretical and practical approach to encourage the proper distribution of TANF funds at the administrative level. The collection of data consists of qualitative research gathered from secondary sources including existing literature and other web sources about TANF recipients.

#### **Conclusion & Recommendations**

Bad administration of funds as it pertains to the TANF program plays an integral role in food insecurity among kids. The program intends to provide cash for impoverished families so their kids can access resources, but most importantly, food. Food maltreatment is a nationwide issue, hence, this paper spells out two simple solutions to combat food insecurity through TANF. It is no one-size-fits-all solution, but if applied, it may provide some effectiveness of governmental food security strategies in the U.S. Theoretically, there needs to be some level of transparency within institutions and in the public which, in part, will promote accountability of those involved in running government programs. Transparency will disclose pertinent and reliable information to stakeholders. Ortega-Rodruguez et al. claim, "Reducing corruption and promoting transparency [are priority] to achieve social sustainability [10].

Policy regarding fund allocation and limited cash reserve should be in place for every state to prevent high accumulation. Not only that but there should be inflation-adjusted wages. But to not get on a tangent, first, the process of how to apply Design Thinking starts at the root—the overall design of the policy. Mintrom and Luetjens suggest that Design Thinking, "has the potential to improve problem definition and mechanism design in policymaking processes," [11]. It is a component of policy development and the applicability of policy action [11]. They insist

that design thinking will allow public managers to know what citizens want and understand how those individuals experience government services; the aim is to enhance public value and for policy design to be more responsive to public expectations [11]. This way, states can intentionally avoid creating opportunity risks to provide for families since it increasingly perpetuates a cyclical problem. The TANF program budget needs to be disbursed, by management, to citizens as it is supposed to be.

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# ADDRESSING HEALTHCARE GAPS FOR THE INTELLECTUALLY DISABLED: A JOURNEY OF SOCIAL ENTERPRISE AT INNISFREE VILLAGE

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#### ABSTRACT

According to the CDC, intellectual disability (ID) is the most prevalent developmental disability in America, affecting nearly 6.5 million individuals. Individuals with ID often encounter challenges when seeking care from qualified and willing healthcare providers, creating a noticeable gap in healthcare delivery. This gap substantially burdens organizations and parents responsible for the lifelong care of individuals with ID. Compounding these challenges, many individuals with ID struggle to secure and maintain employment long-term. A recent study indicates that ID individuals are fifty percent more likely to be unemployed compared to their non-ID peers. Approximately one-third of working-age adults with ID have never obtained employment in industry. Consequently, these individuals grapple with healthcare challenges and significant barriers to employment in society. This paper thoroughly examines the successful methods employed by Innisfree Village, a non-profit social enterprise with over 50 years of experience, in addressing these complex challenges. A comprehensive analysis is provided regarding the village's social enterprise operations, funding mechanisms, and supportive life-work-share environment, particularly during economically challenging times. The authors investigate the difficulties faced by the organization from a fundraising, caregiving, healthcare, and community needs perspective. Insights are offered into the innovative efforts of Innisfree Village to enhance the wellness and health outcomes for the ID community members while expanding their organization's entrepreneurial endeavors. The paper explores the village's ongoing strategic initiatives to bridge healthcare and employment gaps while meeting the unique needs of its community members with intellectual disabilities. Regarding social enterprises such as this, substantial challenges exist in health care management, not only from personnel and employee maintenance perspective, but also from the cognitive and physical disability perspective for ID individuals. Organizations who fail to balance both health care personnel management issues with ID individual health and work-balance needs will struggle. The results indicate that Innisfree Village establishes an effective model to work from.

Keywords: Social enterprise, social entrepreneurship, non-profit, intellectually disabled, ID, health care management, ID community, developmentally disabled, special needs, healthcare delivery, fundraising, healthcare gap

# HEALTHCARE DISPARITY IN WISCONSIN: EXPLORING ITS CURRENT STATE

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# ABSTRACT

Healthcare disparities have long existed in the United States despite the advancement in medicine, technology, and society. This study reviews existing health related data from the Center for Disease Control (CDC) and the Wisconsin Department of Health Services to determine the inequalities that exist between different ethnic groups in the state of Wisconsin. Our findings indicate that American Indian/Alaskan Natives and African American communities have lower life expectancies and are at higher risk for many conditions that should be preventable. Raising awareness of these inequalities is the first step to bridging the gap between ethnic groups.

# INTRODUCTION

Healthcare disparities do exist in the United States as several studies have indicated. These disparities are based on various factors including races [15], gender [2], and education [18]. It is always the goal of the government, including the state government of Wisconsin, to create equitable health outcomes for their citizens.

In this paper, we are going to explore the current state of health disparities in the state of Wisconsin based on the available data and reports from trusted sources such as the CDC, Federal government, state government and other reliable entities. We believe this paper can provide a glance of the various existing disparities in Wisconsin as well as provide potential initial steps to address them.

This paper will be structured as follows: The next section will cover the literature reviews related to health disparities, followed by a brief description on how the data was collected. Then, we will present the findings of our research on Wisconsin health disparities, followed by discussion and conclusion.

# LITERATURE REVIEWS

Healthcare is one of the never-ending issues in US politics. In fact, on health expenditure in the year 2020, data indicated that the United States spends the highest in terms of Dollars per capita compared to other developed countries in the amount of \$10,687 [7]. The second highest was Germany with \$6,524. At the same time, compared to other industrial countries, the United States held undesirable records, including the lowest life expectancy at birth, the highest death rates for avoidable or treatable conditions, the highest maternal and infant mortality, and having one of the highest suicide rates [7].

Wisconsin is not different from the other states in terms of their goal to achieve health equity for all its residences. The state has a relatively low number of uninsured with around 5.4% of its around 5.8 million residents [12]. The governor has established a Health Equity Council in 2019 tasked with developing a comprehensive plan to improve all determinants of health and addressing health disparities based on various factors including race, economic status, educational level, history of incarceration and geographic location by 2030 [16]. They defined health equity as "...[a system where] everyone has a fair and just opportunity to be as healthy as possible" [16, p. 3]. They recognized that someone's residence, income and wealth, and racial or ethnic background play an important role in creating disparity. Therefore, their recommendations focus on the economic, social, and physical environments [16, p. 3].

Existing studies on health disparities have explored a number of factors. Race is always one of the important factors in creating disparities. In its report about minority health, the Wisconsin Department of Health Services [15] highlighted the fact that, for example, the death rates of a pregnant African American mother are 5 times higher compared to white mothers, while the infant death rates are 2.7 times higher. Moreover, in terms of Covid-19 hospitalization, African American Wisconsinites were 1.8 times more likely to be hospitalized compared to Caucasians. For Native Americans, it was 1.6 times higher, while Hispanics were 1.2 times more likely to be hospitalized. These numbers indicate that minority groups are still at a disadvantage.

Another report on health disparities by the Wisconsin Collaborative for Healthcare Quality and the University of Wisconsin Health Innovation Program [14] found several disparities across races. Their findings reported that American Indian/Alaskan communities had lower childhood vaccination rates in children, while adults had much lower breast cancer screening. African American adults were less likely to attain recommended weight and blood pressure control. The issue with attaining recommended weight applied to Hispanic/Latino adults as well, while those with diabetes in this group had much lower blood sugar control. The weight issue also applied to Caucasian adults. In this report [14], they looked at disparities due to health insurance coverage, e.g., those with Medicaid or uninsured had lower childhood vaccinations and were more likely to screen positive for depression. Individuals living in rural and urban areas also experience disparities due to economic factors, access to healthcare and its utilization, cost, and distribution of providers and services. In fact, ten counties in Wisconsin are designated as Health Professional Shortage Area (HPSA) for Primary Care [10], and most of them have rural status.

A study by Cameron et al [2] shows that women had fewer economic resources to utilize health facilities such as physician visits and hospital stays than men with similar demographic and health profiles. This indicated that gender does play a role in health disparities as well. In their paper, Zajacova and Lawrence [18] listed several previous studies linked education and health including lower education level associated with worse general health, and more chronic conditions among others.

In summary, there are a number of factors that can contribute to health disparities. Addressing those factors as well as other inhibiting aspects as mentioned in the Health Equity Council report are important to achieve the goal of a fair and just opportunity to be as healthy as possible for everyone. However, in this study we are focusing on races as factor for disparities.

# METHODOLOGY

Data related to existing health disparities were collected from various trusted sources from federal and state government sites as well as well-known entities related to public health. Data from federal government is available through a number of websites including:

- Wonder database (<u>https://wonder.cdc.gov/</u>) from the Centers for Disease Control and Prevention (CDC) this database can provide various data including births, underlying causes of death, and cancer statistics.
- HDPulse Data Portal (<u>https://hdpulse.nimhd.nih.gov/data-portal/home</u>) from National Institute for Minority Health and Health Disparities this database provides resources related to efforts to reduce disparities and improve minority health.
- Wisconsin Department of Human Services (<u>https://www.dhs.wisconsin.gov/</u>) this website provide data related to various health aspects of Wisconsin residents including health insurance coverage, deaths, cancers, and others.
- KFF (<u>https://www.kff.org/</u>) is an independent organization serving as nonpartisan source of health-related information.

In collecting our data from those databases, we filter the results based on state (i.e., Wisconsin), and set races, and gender as parameters to be displayed. We limit the search to the year 2020, for no particular reasons. We are planning to explore data from a longer time period in the follow-up research.

# RESULTS

Health disparity has started with birth as life expectancy varies across races. Life expectancy is one of the indicators of health disparity across different races. Based on the data from 2020, the life expectancy for Wisconsin is 77.7 years, with females at 80.3 years and males at 75.2 years. However, racial disparities in life expectancy persisted. For the US as of 2021, the American Indian/Alaska Natives have the lowest life expectancy at 65.2 years, while Asians have the highest at 83.5 years [11]. Based on the mortality data per age group, AIAN and African Americans have the higher percentage in the age group below 85+. The following table show the top three age-group of the **mortality percentage** for each of the race groups [5]:

ΔΙΔΝ	Asian	Black / African	White
	Asian	American	White
65-74 years	85+ years	65-74 years	85+ years
(22.2%)	(22.6%)	(21.7%)	(36.5%)
75-84 years	75-84 years	55-64 years	75-84 years
(21.5%)	(21.8%)	(20.2%)	(24.9%)
55-64 years	65-74 years	75-84 years	65-74 years
(19.1%)	(18.9%)	(15.8%)	(18.7%)

As we can see the mortality data for Wisconsin shows that the largest percentage of the passing happened in the age group of 65-74 years for AIAN, 85+ years for Asians, 65-74 years for African American, and 85+ for Caucasians. From these statistics we could conclude that the **life expectancy of AIAN and African American** are the lowest among the four races.

Birth by age group can also indicate disparities among races. As report by the Wisconsin Department of Health Services [15], the risks of pregnancy for African Americans are five times higher compared to their Caucasian counterparts. Disparities can also be shown by the number of teen pregnancies across races in Wisconsin. The table below shows the percentage of births by race/ethnicity of mother's age in the state for 2020 [5]:

Age of Mother	AIAN (percent)	Asian (percent)	Black / African American (percent)	White (percent)
< 15	0	0.04	0.3	0
15 – 17	2.4	0.37	2.4	0.3
18 - 19	4.6	1.04	7.2	1.6

 TABLE 2: PERCENTAGE OF BIRTHS BY RACE/ETHNICITY OF MOTHER'S AGE

\*) Pct of all birth in each race group

As we can see, there is significant disparity among teen pregnancies with African Americans. Based on the Health Compass Milwaukee [9], the teen birth rate for 15 – 19 occurs in Milwaukee area with Socioeconomic Status (SES), which refers to an index of ZIP code-based income and education levels, wherein individual ZIP codes are placed into 5 groups based on index value quintiles (Q1 to Q5,) categorized as low. That area includes several ZIP codes including 53206, which was labeled by Milwaukee Journal Sentinel as Wisconsin's most incarcerated ZIP code [3]. Babies born from teen moms face higher risks of low birth weight, preterm birth and severe neonatal condition [17]. Low birth weight, for example, can have long term impact into adolescence including mild problems in cognition, attention, and neuromotor functioning [8]. Hack et al [8] indicated that having social and environmental disadvantages would amplify those conditions negatively. We can probably predict that most of the African Americans are most likely to be exposed to those situations. This in turn would create even bigger disparities, not only in health but also others.

Exploring data related to the cause of deaths based on races gives insight into unique different illnesses prevalent within a race group. We use mortality data of 2020 retrieved from CDC's Wonder database [6]. As the data was covering the time of Covid-19, that pandemic was the leading cause of deaths in all race groups. However, in this study we omitted the Covid-19 statistics, although it should be mentioned here that there is equality in terms of Covid-19 deaths across the race groups. The following table shows the identified top four leading causes for each race group [6]:

Race group	Cause of Death	Percentage
	Atherosclerotic heart disease	4.62%
	Bronchus or lung, unspecified - Malignant neoplasms	4.44%
AIAN	Accidental poisoning by and exposure to other and unspecified drugs, medicaments and biological substances	4.1%
	Alcoholic cirrhosis of liver	3.93%
	Atherosclerotic heart disease	3.37%
Acien	Bronchus or lung, unspecified - Malignant neoplasms	3.04%
Asiali	Acute myocardial infarction, unspecified	2.88%
	Stroke, not specified as haemorrhage or infarction	2.72%
Plack / African	Atherosclerotic heart disease	4.92%
American	Bronchus or lung, unspecified - Malignant neoplasms	4.75%

TABLE 3: PERCENTAGE OF THE CAUSES OF THE DEATHS BY RACE

	Atherosclerotic cardiovascular disease, so described	4.03%
	Accidental poisoning by and exposure to narcotics and psychodysleptics [hallucinogens], not elsewhere classified	3.92%
	Atherosclerotic heart disease	5.20%
	Unspecified dementia	4.73%
White	Bronchus or lung, unspecified - Malignant neoplasms	4.40%
	Alzheimer disease, unspecified	4.33%

As we can see from this table, Atherosclerotic heart disease was the leading cause in all race groups. Another cause that can be found in all four race groups was Bronchus or lung, unspecified - Malignant neoplasms. This so-called lung cancer is caused mostly by smoking [1]. The other two causes in each race group are relatively unique to each race group in terms of their high percentage. Substance abuse and alcoholic cirrhosis were prevalent among AIAN. Among African Americans, another type of substance abuse caused a high percentage of deaths. For Asians, stroke and Acute myocardial infarction were the other two leading causes of deaths.

If we look into gender disparities in each race group, we can identify some causes that are much higher in one gender than in another. For African Americans, for example, heart related diseases are much higher in male than females, while brain related causes such as dementia and Alzheimer were higher in females than male. Several causes for African Americans are listed in the following table [6]:

Causes in Black / African Americans	Gender	Crude rate per 100,000
Pronchus or lung unspecified Malignant peoplesms	Female	29.6
Bronchus of lung, unspecifieu - Manghant neoplashis	Male	40.7
Agute muccardial inferction unspecified	Female	13.6
Acute myocarulai marcuon, unspecineu	Male	21.1
Atherocaleratic cardiovaceular disease so described	Female	24.1
Auteroscierouc carulovascular uisease, so described	Male	35.6
Atheneoglaphic heart diagons	Female	30.6
Atheroscierouc heart disease	Male	42.3
Unanacified domentia	Female	32.1
onspecified dementia	Male	18.6
Alphoimer diagona unergailiad	Female	19.6
Aizhenner uisease, unspecified	Male	14.4
Chronic obstructive pulmonary disease, unspecified	Female	24.1

TABLE 4: PERCENTAGE OF THE CA	AUSES OF THE DEATHS AMON	G AFRICAN AMERICA	ns by Gender

	Male	15.5
Account by other and unanacified firearm discharge	Female	10.5
Assault by other and unspecified in earlie discharge	Male	46.4
Accidental poisoning by and exposure to narcotics and	Female	16.6
psychodysleptics [hallucinogens], not elsewhere	Male	41.8
classified		
Accidental poisoning by and exposure to other and	Female	13.6
unspecified drugs, medicaments and biological	Male	33.5
substances		

For Caucasian race groups, there were several disparities across gender as shown in the table below. We still see some heart related diseases are higher in males, while some others are higher in females such as stroke, and Atrial fibrillation [6]:

Causes in White	Gender	Crude rate per 100,000
Occophague unepocified Malignant pooplasme	Female	2.5
oesophagus, unspecifieu - Manghant neoplashis	Male	10.1
Liver cell carcinema - Malignant neoplasms	Female	1.3
Liver cell carcinollia - Malignant neoplashis	Male	6.0
Non-insulin-dependent diabetes mellitus, with	Female	1.3
multiple complications	Male	6.8
Unanacified domentia	Female	69.7
onspecified dementia	Male	32.0
Parkinson disease	Female	11.4
r ai kiiisoii uisease	Male	19.2
Alphaiman diagona unanggifiad	Female	64.6
Alzhenner disease, unspechied	Male	28.6
Agute muccordial inferration unapositied	Female	24.9
Acute myocarulai iniai cuon, unspecineu	Male	44.3
Atheneoglevetic condicusces landiceses as described	Female	18.0
Atheroscierotic cardiovascular disease, so described	Male	29.5
Athorocaloratic heart diagons	Female	43.7
Atteroscierotic near t disease	Male	68.4
Atrial fibrillation and flutton	Female	14.8
	Male	9.7
Strate not englished as been explaned or inferentian	Female	23.8
Subke, not specified as naemorrhage or infarction	Male	15.4
Alcoholic cirrhogic of liver	Female	4.4
	Male	10.2
Intentional colf harm by handgyn diacharga	Female	1.0
intentional sen-narin by nanugun discharge	Male	9.4

 TABLE 5: PERCENTAGE OF THE CAUSES OF THE DEATHS AMONG CAUCASIANS BY GENDER

# DISCUSSION

The result of our exploring study shows that health disparities still exist in Wisconsin across various race groups as well as between gender. Some of the causes of the death are higher in males, while some others are higher in females. Some of the leading causes of the death, especially among minority groups, were related to substance abuse or alcohol abuse. To bring those causes down, concerted efforts by stakeholders are needed. The recommendations by the Governor's Health Equity Council to focus on the economic, social, and physical environment to achieve health equity are great steps in the right direction [16]. This direction should also help with addressing the reduction of teen pregnancies that are the highest among African Americans. All efforts should be made to close the gap of life expectancy between race groups, especially improving those of AIAN and African Americans.

As heart disease is one of the leading factors of deaths across all genders, the state government and other stakeholders should make an effort to prevent that disease starting from the young age by raising awareness as well as creating other strategies or initiatives to address them. This includes addressing other medical conditions that increase the risk of heart disease such as diabetes, obesity, unhealthy diet, physical inactivity, and excessive alcohol use [4].

# CONCLUSION

In the recent report called 2021 Wisconsin Population Health and Equity Report Card by The University of Wisconsin Population Health Institute [13], the state scored poorly in overall health grade (receiving a 'C') for the health of the state population based on measures of length and quality of life. However, if the score is adjusted for racial / ethnic disparities, the score drops to a 'D'. And even worse if it is adjusted for educational disparities. The score dropped to an 'F'. At the same time, the report provided a list of possible actions to address the disparities. Those possible actions include: (i) ensuring access to quality health care; (ii) housing initiatives to enable safe and affordable housing; (iii) providing more economic resources for children and families among others. We agree with all their assessments and their recommendations.

At the same time, policy makers who are going to implement those possible actions can apply several principles of operations management to create a level of efficiency in their actions such as balancing costs and maximizing impact. They should be able to review existing resources and technology and then utilize them in an efficient way. For any obstacles encountered in this undertaking, they should look at the underlying problem to be removed. They should adjust operations when needed. This study has a number of limitations including: (i) literature based only and relying on existing data; and (ii) do not review all possible disparities such as rural vs urban or across education; (iii) data is only for one year, i.e., 2020. Future studies will expand the disparity variables to include more factors such as rural vs urban, as well as looking data from multiple years.

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# THE ROLE OF STRICT INVENTORY CYCLE TIME REQUIREMENTS IN COVID-19 VACCINE DISTRIBUTION: A CASE STUDY FROM NEW YORK STATE

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#### ABSTRACT

We present a case study in regional COVID-19 vaccine distribution in the US, demonstrating both the relevance of standard inventory models in this unique endeavor, and the particular need to update such models continuously in the context of an emergency. Use of a mixed integer program in modeling the vaccine ordering problem of a single agent participating in a decentralized vaccination network demonstrates how one requirement governing that problem penalizes the combined capacity of the network. These findings were used to argue the updating of that requirement by the governing body, who relaxed that constraint in April 2021. The study shows how a steady-state business model can be highly applicable to an emergency situation, yet still falter if the user does not recognize that the model and associated policies will require continual revision, a condition less familiar in a standard business context.

**Keywords:** COVID-19, vaccine distribution, periodic review models, agent-based systems, adhocracy

# The Role of Strict Inventory Cycle Time Requirements in COVID-19 Vaccine Distribution: A Case Study from New York State

#### 1. Introduction

In this paper, we describe New York State's COVID-19 vaccination network as it operated in early 2021, and demonstrate how one feature of a policy that governed its vaccine usage inadvertently cost the system a portion of its capacity to vaccinate. This feature, a cycle time requirement that all vaccine be consumed within seven days of receipt, was not a binding constraint at the outset, when vaccine production lagged well below the system's capacity to vaccinate. As vaccine production increased, however, the bottleneck in the vaccination effort shifted from vaccine supply to vaccination capacity, at which point the results of this study were conveyed to the governing body in a proposal to relax the cycle time requirement, freeing more capacity. The governing body relaxed the requirement in late April 2021.

The research problem here requires evaluation of one policy constraint, the cycle time requirement, in the context of a complex system. System complexity is driven by the decentralized decision-making of organizations volunteering capacity to the delivery system, as well as the dynamism of that system's operating environment. The outcome of interest is *capacity loss*, defined as the portion of each participant's vaccination capacity left unutilized as a result of the group's governing policy. The arguments in this case are made through formulation of a mixed integer program representing the COVID-19 vaccine ordering problem as solved by a single agent participating in the decentralized network. The resulting model is used in numerical experiments to estimate capacity loss under various policy settings, demonstrating how the current cycle time requirement penalizes the combined capacity of the vaccination delivery network.

While study results support revision of rules governing a particular mass vaccination effort at a particular time, the theoretical implications of this research are broader. First, this study strongly suggests that well-known concepts and tools from stationary business conditions can be surprisingly relevant and useful in an emergency. Simultaneously, this case highlights how these same tools can nonetheless falter and fail during an emergency if their application is *maintained* 

as if under stable conditions. Indeed, this study suggests the most important difference between inventory policy in emergency versus non-emergency conditions is not necessarily the decision model chosen, but rather the expected 'shelf life' of that choice, as the emergency policy will likely require multiple modifications throughout its use, to reflect the rapidly changing environment in which it operates. Finally, as COVID-19 overwhelmed the capacity of any single organization to coordinate a response, it highlighted our growing dependency on multiple organizations to work autonomously toward a common goal in times of disaster. When organizations form successful agent-based adhocracies, they do so in part by defining the best set of rules for each agent to steer by, and this study demonstrates how an intuitive and yet suboptimal rule can result in dramatically compounded loss to the combined capability of a group. Given that this newer agent-based organizational form is here to stay, it is imperative we better understand both its strengths and vulnerabilities.

In the next section, we briefly review related literature in inventory theory, organizational theory and mass vaccination operations, as each area supports an important dimension of the case study at hand. Section 3 of this paper then describes early COVID-19 vaccine distribution in New York State, including an agent-based network of vaccinators, its governing protocol for ordering vaccine, and the environmental factors changing throughout the early months of 2021. This third section brings us to a point in spring of 2021, when conditions were improving around that group, and yet vaccination was not accelerating as expected, despite very high demand. In Section 4, we develop a mixed integer program to represent the decisions confronting each contributor to that network, and describe the test bed used to demonstrate which policy feature requires modification to address the productivity paradox. Numerical results are shared in Section 5, discussion and extensions of the results in Section 6, and conclusions in Section 7.

#### 2. Related Literature

This investigation draws on the intersection of three distinct bodies of literature, each informing an important dimension of the problem at hand. The first of these is the extant inventory theory that best describes the underlying inventory management problem in this case, as described next.

#### 2.1 Related Inventory Theory

In early 2021, New York State established a distribution system for COVID-19 vaccine stock, one which required participating organizations to place vaccine orders with the state government at regular intervals. While the details of this ordering system are provided in the next section, its overall structure is rooted in long-standing inventory theory. Ordering decisions faced by participants here are fixed order period problems (Hopp and Spearman, 2001), as the vaccinators operate within a fixed-interval order system or periodic review system (APICS, 1995). Furthermore, the delicate nature of COVID-19 vaccine stock places this fixed order period problem squarely in the domain of perishable inventory management (Dai and Song, 2021). Interestingly, many early seminal studies in perishable inventory are likewise grounded in healthcare, specifically blood bank management (Nahmias, 1982). Nahmias (1982) provides a research framework that characterizes the problem presented in this paper as one of 'fixed life perishability' for a single product, as stock held in inventory beyond a certain amount of time will then expire in some sense. Fixed life perishability inventory models are offered in seminal works such as Jennings (1973), Nahmias and Pierskalla (1973), and Fries (1975).

Although COVID-19 vaccine stock is distinctly perishable in a tangible sense, fixed life perishability in this investigation does not refer to a physical property of the vaccine. In contrast, perishability here results from the policy governing participation in the vaccination effort, which levies heavy financial penalties to holding vaccine at a particular location beyond a fixed interval of time. In general, integrating the location of stock with inventory policy design is a well-established area in supply chain literature (for example, see the review of Farahani et al., 2015), including a substantial stream of work focused on perishable products in particular (for a fixed life example, see Firoozi et al., 2013). However, neither network design nor vaccine stock location in the network are centrally determined in this study. Instead, vaccine is administered through multiple organizations volunteering capacity, and thus potential stock location is largely emergent from the size and location of those volunteers, as well as their local ordering decisions. The result represents an important transition away from the assumption of a designed inventory network, introducing a somewhat newer model of underlying organizational form, discussed next.

#### 2.2 Related Organizational Theory

In this study, COVID-19 vaccination is accomplished through a hybridized system featuring centralized elements of control and decentralized decision making by multiple participating organizations. This endeavor is best described as an adhocracy (Mitzenberg, 1980) or an agent-based system (Macal & North, 2006), consisting of largely autonomous agents aligning their efforts through common operating policy, to work independently in the creation of a common outcome. Adhocracies are rare in the business world, as they are usually temporary endeavors; should demand for an adhocracy's outcome sustain indefinitely, a more efficient, centralized, high-control system would likely be constructed to replace it.

The adhocracy is a particular instance of the agent-based approach, which is recognized as central to the successful formation of complex, adaptive systems (Anderson, 1999). While the idea of effective organization through agency was initially greeted with skepticism by some organizational scholars (Eisenhardt, 1989), the advantages of this approach are becoming increasingly apparent, as it enables faster launch and scaling when compared to traditional, higher control frameworks, and is often more resilient in the face of uncertainty, disruption or loss of any of its parts (Siggelkow and Rivkin, 2005). Interestingly, supply chains are among those systems that have come into sharper focus under an agent-based lens, in analyzing problems including supplier selection (for example, Valluri and Croson, 2005; Ghadimi et al., 2018) and port operation (Gehring, 2010). Furthermore, agent-based modeling features an important distinction between the objectives local to the participating agents and the global objectives of the system (Krokhmal and Jeffcoat, 2010), a dynamic particularly familiar to humanitarian logistics. By definition, a disaster poses requires response beyond the capacity of any single organization, and thus the relief chains to address them are typically composed of multiple actors aligning through some coordination mechanism (Balcik et al. 2010), a process long recognized as one of the greatest challenges in humanitarian logistics (Kovacs and Spens, 2009). Not surprisingly, these challenges are addressed in a growing body of agent-based studies in humanitarian logistics, such as Das and Hanaoka (2014), Krejci (2015), and Wang and Zhang (2019).

#### 2.3 Related Modeling of Mass Vaccination Operations

A third body of literature that informs this case study examines its end-product, the service of mass vaccination. Modeling and analysis of mass vaccination operations can be divided into research emerging before the pandemic, versus research informed by COVID-19 vaccination specifically.

2.3.1 Extant Literature, Pre-Pandemic. Scholarly research supporting vaccine logistics as an emergency response predates the emergence of COVID-19. In a survey of 644 decision models published for use in emergency response operations, 4% of those models addressed mass vaccination (Minas et al, 2020). Math programming dominates these vaccine-related studies, particularly mixed-integer applications. Prior to COVID-19, related research often addressed response to other health threats, such as modeling the distribution of medication required to counter anthrax attacks (Lee et al, 2009; Chen et al, 2016), or the optimal capacity and location of points-of-dispensing for same (Ramirez-Nafarrate et al, 2015). Decision models of mass vaccination typically assume a central decision maker deploying resources in response to a threat. Studies range from strategic modeling, such as the design of regional mutual aid policies in Arora et al. (2010), to tactical applications such as response to bioterrorism attack on a particular airport (Berman et al., 2012). In these studies, the challenge before the decision maker often includes allocation of a vaccine stockpile across multiple sites, and recent studies have integrated the progression of the disease through those locations as well. Examples of this include the two part modeling of the spread and response to smallpox in Daskalis et al. (2017) and the spread and vaccination response through a compartmentalized landscape in the case of Ebola in Büyüktahtakın et al. (2018).

2.3.2 Emerging Studies in the Context of COVID-19. The COVID-19 pandemic has renewed attention to the vaccine distribution problem, and presented new challenges as well. Kim and Yuan (2021) provide a timeline of issues observed in the first six months of the US rollout, and note its heavy focus on the physical distribution of the vaccine, while many of its problems can be traced to the flow of information. Dai and Song (2021) highlight multiple operations research

problems embedded the COVID-19 vaccination rollout, made in apparent in part by uneven success rates in converting available vaccine stock into vaccinations during the initial US rollout. Finkenstadt and Handfield (2021) sound a similar call to action, framed through application of the Supply Chain Operating Reference (SCOR) model to the vaccination rollout problem. Among their recommendations, the authors note a need for better understanding of the role of agency theory (Eisenhardt, 1989) in the formation of the COVID-19 vaccine supply chain. Another feature particular to the COVID-19 pandemic is the two-dose structure of many of its vaccines, creating a new need for models to optimize allocation of limited stock between them. As an example, Hill and Keeling (2021) employ math programming to demonstrate the efficacy of prioritizing limited vaccine for use as first doses, modeling the objective as maximization of averted deaths. The onset of COVID-19 may also be the first time researchers interested in vaccine distribution have confronted the problem of sustaining simultaneous responses, such Rastegar et al. (2021) mixed integer model representing the difficulties of equitable distribution of limited stocks of influenza vaccine in the context of the COVID-19 pandemic. Of the three emergent research problems, the case study in this paper reflects the importance of the first one, agency theory, as highlighted by Finkenstadt and Handfield (2021). How agency theory relates to the particulars of the COVID-19 vaccination rollout in New York State is described next.

#### 3. Inventory Policy in Early COVID-19 Vaccine Distribution: A Case Study from New York State

In late 2020, the United States established a plan for the mass vaccination of its population against COVID-19, assigning the federal government the role of approving and procuring vaccines. While the federal government then divided the vaccine stock among its states and territories by population size, the management of all remaining distribution and vaccination activity was assigned to each state (Ivory et al, 2020; Dai and Song 2021), a relationship illustrated in Figure 1. This figure and the following section outlines one state-level solution, the design of vaccine distribution within New York State. In the context of early 2021, the New York State distribution system is best understood in two parts: the collection of organizations providing vaccination services, known from this point forward as *enrolled providers*, and the state-

mandated inventory ordering protocol that guided their combined efforts. Both are pictured in Figure 1, the former explicitly illustrated as a node in the lower portion of the diagram, and the latter reflected in the curvilinear arc of communication originating from the left of that node, which represents vaccine requests placed weekly with New York State.





# 3.1. Enrolled (Vaccination) Providers.

New York State enrolled providers include both commercial and non-profit organizations of various sizes; examples include public health departments, hospitals, health clinics, medical practices and both independent and chain-operated pharmacies. These organizations are then loosely grouped by economic region, dividing the state into ten district zones of activity (NYSDOH, 2021a). These districts operated as adhocracies, or agent-based vaccination systems under the guidance of the state. While the success of an adhocracy does not depend on direct control of

its participants, it is wholly defined by its coordination mechanisms, which enable each participant to collaborate with the whole (Mitzenberg, 1980). The agent-based nature of the group illustrated at the bottom of Figure 1 is underscored by term 'enrolled providers', as this label refers to health care providers having applied and been accepted into NYSIIS, a web-based vaccine ordering platform which served as the definitive coordination mechanism between the state and all the various vaccinators.

# 3.2 Vaccine Ordering Protocol.

New York State's vaccine ordering protocol provided the governance mechanism to coordinate the otherwise autonomous enrolled providers. Throughout the time period in this case, enrolled providers placed orders for vaccine at the beginning of the interval designated Week X in Figure 2. In the presence of vaccine scarcity, these orders were more accurately called planning requests, as the state determined which enrolled providers did receive vaccine when all orders could not be filled from the federal allotment released that week.



Figure 2. Milestone Dates in Weekly COVID-19 Vaccine Ordering Cycle for New York State Enrolled Providers

While the state then places the potentially revised vaccine requests with its federal sources, the vaccine itself is drop shipped from manufacturer or federal (CDC) distribution center directly to each enrolled provider (NYSDOH, 2021b), as pictured in Figure 1. This is an important feature:

while operating protocol is structured around consolidation of local requests for a central vaccine stock, this state-level operation does not fit the description of a consolidated system in the sense of humanitarian logistics (for examples, see Vaillancourt 2016). Rather, the New York State vaccination network functions as an agent-based system with a governing intermediary between the agents and the supply, guiding the combined effort through an common inventory policy that included the following constraints:

- COVID-19 vaccine was ordered and delivered in lots, and the minimum order size (one lot) varied with the manufacturer.
- Vaccination was to be conducted by scheduled appointments only, verifying the eligibility of patient. Throughout the early months of vaccination, the condition of eligibility evolved in a series of expansion 'phases' announced by the state.
- Vaccine redistribution among providers was discouraged, and could not be conducted without prior permission from the state for each instance.
- Vaccine was to be used within seven days of receipt, and enrolled providers could expect severe financial penalties for failing to meet that target.

The first constraint in the above list is driven by the three manufacturers and the requirements of shipping vaccine to drop sites, while the second prioritizes recipients by vulnerability. The third bullet point reflects an intention to strengthen accountability for vaccine stock, as well as to mitigate complexity in a dynamic environment. The constraint described in the last bullet point is intended to assure expedient use of this life-saving and initially scarce commodity, and is also the policy feature under evaluation in this study. Within the first weeks of operation, New York State bolstered this policy through executive orders, establishing harsh fines and other penalties for non-conformance (NYS Executive Chamber, 2021a; Passy, 2020).

# 3.3 Dynamics of the Environment

While previous sections describe who provides vaccination service and what rules govern vaccine inventory, the case description is not complete without describing what factors in the surrounding environment changed throughout the first half of 2021. These exogenous factors

can be summarized as vaccine supply, the reliability of vaccine demand, and the enrolled provider mix.

*3.3.1 Vaccine Supply.* The availability of COVID-19 vaccine to fill planning requests from the enrolled providers changed dramatically during the first three months of 2021. Figure 3 shows the amount of vaccine allocated by the CDC to New York State, inclusive of New York City, by manufacturer (CDC, 2021a; CDC, 2021b; CDC, 2021c). This amount is revealed to the state at the first milestone in the timeline of Figure 2, at which point the state determines how to fill the waiting requests.



Figure 3. COVID-19 Vaccine Available for Weekly Distribution to New York Providers (Federal Allocation to NYS), December 2020 – May 2021. (Source: CDC, 2021a, CDC, 2021b and CDC, 2021c)

Vaccine availability is limited at the beginning of the Figure 3 time series (Fitzsimmons et al, 2021), with an exception in Week 2 created by Moderna's approval for emergency use, when all stock accumulated in anticipation of that approval was shipped. In the early weeks of the series, manufacturers Pfizer and Moderna worked on raising vaccine batch size from 5 liters during trails

to a reliable 2,000 liters for steady-state production, while simultaneously reducing cycle time (Fritz – Edward, 2021, Weise and Weintraub, 2021). As a result of these changes, vaccine supply starts improving in February. Some irregularities are created by the sporadic availability of the Janssen vaccine later the timeline, but total combined weekly availability of vaccine essentially doubles over the first four months of 2021.

3.3.2 The Reliability of Vaccine Demand. Vaccine demand is subject to two uncertain factors, the actual demand for appointments and the number of no-shows for appointments taken. In the early days of the vaccination effort, actual demand was quite high, but filtered by eligibility. In the case of New York State, this created complex waves of demand, as the state expanded eligibility dynamically in a series of detailed 'phases'. Appointment no-shows were also a source of uncertainty from the beginning, leaving providers with unexpected unused doses, a condition exacerbated by vaccine packaging in multi-dose vials that cannot be returned to storage after the first dose is drawn (Goldstein, 2021). No-shows typically result from vaccination seekers gaming a scarce vaccine supply by making multiple appointments, without cancelling those they choose not to use. Where no-shows were a major source of appointment demand uncertainty at the outset of the timeline, appointment demand changed in a few months, as younger individuals became eligible. At this point, uncertainty concerning actual appointment demand became another factor in the provider's environment.

Figure 4 provides a visual example of the dynamism in vaccine interest during the case study period, including two waves of demand stemming from announcements of expanded eligibility. This figure illustrates a two-week time series of web site traffic for one regional vaccine appointment aggregator, *Vaccine Hound*, which collects and posts links to websites of enrolled providers throughout Western New York. With 60,000 people in Western New York consulting the appointment aggregator during this interval, Figure 4 shows how that activity is arranged in a fluctuating pattern, with peaks created by shifting eligibility visible in the first two peaks.
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Figure 4. Appointment Seeking Traffic on Appointment Aggregator vaccinehound.org, March 31, 2021 to April 16, 2021

On April 16, 2021, the end of the Figure 4 timeline, the CDC website reported 80% of the US population 65+ years old had received at least one dose of the vaccine. At this milestone, the bulk of the vaccination work outstanding has shifted to a demographic less affected by the virus, and thus less motivated to seek out appointments.

*3.3.3 The Enrolled Provider Mix.* On December 15, 2020, nursing director Sandra Lindsay received the first dose of the Week 1 allocation pictured in Figure 3, only hours after its arrival at nearby Kennedy (JFK) airport, and this initial vaccination is believed to be the first non-trial use of a COVID-19 vaccine in the United States (Fitzsimmons et al, 2020). The hospital setting surrounding this event was typical of the state's enrolled provider network at the outset of vaccine distribution, as vaccine shipped primarily to hospitals, for the vaccination of front-line health care workers. By April 2021, however, the delivery network had grown dramatically more complex as the state phased in more providers, while increasing the diversity among organizations granted vaccine. Whereas the inventory policy began in a hospital-based operating environment, most New York hospitals had retired from the mass vaccination effort by April 2021, replaced with a mix of local health departments, state and federally operated mass vaccination sites, independent and chain pharmacies, neighborhood health clinics, specialty clinics such as dialysis and addiction centers, and medical practices.

# 3.4 Underlying Inventory Theory and the Problem Under Study

One interesting feature of this particular case of COVID-19 vaccine distribution is the number of 'normal' business concepts that are readily recognizable in the structure and governance of the agent-based vaccination network. For example:

- Independent demand. While the vaccine itself is the result of a complex process requiring multiple inputs, the finished vaccine becomes an independent demand item upon its release to the state.
- Agent-based activity. Vaccine is ordered for use by an enrolled provider, one of a heterogeneous pool of providers. Each provider decides how much vaccination activity to attempt each week, under the guidance of the governing inventory policy.
- Order interval. Driven by release of vaccine inventory at the federal level, the state establishes a system allowing its enrolled providers to order vaccine every seven days, an unvarying order interval.
- Lot size. All three vaccine manufacturers enforced a minimum shipment size that also served as a multiplier in determining feasible vaccine order sizes.
- Order policy. Both the state and each enrolled provider contribute to the decision of how much vaccine is ordered for use the following week, effectively creating an order policy between them.
- Order cycle time. While the definition of the phrase 'cycle time' can vary with its context, the term is being cited here as the amount of time required to consume an order upon delivery. At the time of this case, the order interval and the order cycle time were anchored by the governing policy at the same value of seven days.

The vaccine distribution system operates as a fixed reorder cycle inventory model, but the fixing of the order cycle time to the same length as the order interval itself forbids the carry-over of any vaccine doses from one order interval into the next interval. One striking feature of this operating policy is how it incorporates elements of centralized continuous replenishment as a supply chain coordination mechanism, bundled together with features expected of collaborative

procurement, a distinctly decentralized approach (Balcik et al. 2010). This centralized fixed order interval system with decentralized local ordering decisions operated without incident at the outset of vaccination in mid-December 2020. By March 2021, demand for vaccination was extremely strong, vaccine supply was increasing dramatically and the capacity of the vaccination network was expanding through entry of additional enrolled providers. However, the resulting productivity of the vaccination effort did not rise as quickly as expected, given the favorable nature of these changes to the environment, and anecdotal evidence suggested a subset of enrolled providers were experiencing considerable stress. At this point, an investigation is launched to demonstrate how these counter-intuitive complications can be linked to one feature of the governing inventory policy, signaling a need to update it. Establishing this relationship requires the abstract modeling of the vaccination system and its operating policy, outlined in the next section.

#### 4. Modeling the Cost of an Order Cycle Time Limit

To demonstrate how a fixed order cycle time requirement can potentially suppress the capacity of a heterogeneous agent-based vaccination network, we model the decisions faced locally, at the enrolled provider level. This section develops a formulation with the enrolled provider as the unit of analysis, and weekly order intervals as the granularity of a multi-period inventory planning mixed integer program. This section concludes with a description of a test bed of numerical experiments to be used to estimate capacity loss.

#### 4.1 General Formulation of the Enrolled Provider's Problem

We begin with an assumption that the enrolled provider will operate seven days a week. The problem facing the provider is choosing how many lots of vaccine to order each week, to maximize vaccination. To state these decisions symbolically, we define two sets of decision variables:

#### $\lambda_t$ = number of lots ordered for arrival in week t

#### P<sub>t</sub> = number of doses administered during week t

In addition, we establish the following parameters:

Q = minimum lot size (doses)

*T* = planning horizon, in weeks

 $BI_t$  = vaccine inventory in stock when order arrives in week t (excluding the arriving order)  $\Theta$  = maximum number of days allowed to consume arriving order without substantial penalty f(k,t) = maximum vaccinations feasible, given they take place in the interval of k days after the arrival of vaccine order in week t

The enrolled provider's decision program can then be approximated as:

$$Max \ \sum_{t=1}^{T} \boldsymbol{P}_{t} \tag{1}$$

s.t.

$$\lambda_t Q \leq f(\theta, t)$$
 for  $\forall t$  (2)  
 $\lambda_t Q + BI_t \geq P_t$  for  $\forall t$  (3)

$$\boldsymbol{P_t} \le f(7, t) \qquad \qquad \text{for } \forall t \qquad (4)$$

$$BI_{t} = BI_{t-1} + \lambda_{t-1}Q - P_{t-1} \qquad \text{for } t = 2, ..., T \qquad (5)$$

$$BI_t \le f(\theta - 7, t) \qquad \text{for } t = 2, \dots, T \qquad (6)$$

 $P_t, \lambda_t \geq 0; \ \lambda_t = Integer; BI_1 = 0; BI_t \geq 0$ 

The objective stated by expression (1) is to vaccinate as much as possible across the *T* weeks of the planning horizon. Expression (2) fixes the allowable cycle time after vaccine delivery, a requirement that the vaccine arriving in week *t* can be consumed within  $\Theta$  days of arrival. Expressions (3) and (4) limit week *t* vaccination to the minimum of either doses available or the maximum capacity to vaccinate within that week. Expression (5) is the inventory balancing logic that determines how much vaccine from the prior week is still present when the week *t* shipment arrives, and expression (6) assures that this amount can be consumed in the time remaining with respect to the order cycle time limit.

As discussed previously, New York State's original value for  $\Theta$  was 7; an enrolled provider had 7 days to administer all doses in an arriving shipment, or face harsh penalties. This forbids carrying vaccine inventory into the following week through expression (6), which reduces the program considerably. The issue of what vaccination capacity is available is modeled within the general function f(k, t), as multiple factors might influence this value, discussed in further detail in section 4.3.

# 4.2 Deterministic Exploration of Capacity Loss from Fixed Cycle Time Policy

To demonstrate the cost of the cycle time requirement to the vaccination network, we transform f(k,t) into a linear function with three assumptions. First, assume that demand is sufficient to fill any vaccination appointment made available, an assumption consistent with conditions at the time of the outset of this study. Next, assume an enrolled provider's capacity to vaccinate can be stated as a fixed rate:

v = maximum daily vaccination rate feasible, in doses

Third, assume that the enrolled provider will operate seven days a week. Expressions (2), (4) and (6) can then be replaced with expressions (7), (8) and (9), respectively.

$$\lambda_t Q \leq \theta v \qquad \qquad \text{for } \forall t \qquad (7)$$

$$P_t \le 7v$$
 for  $\forall t$  (8)

$$BI_t \le (\theta - 7)v \qquad \qquad \text{for } t = 2, ..., T \qquad (9)$$

This revised formulation is used to robustly estimate the impact at various levels of  $\Theta$  on an enrolled provider's ability to vaccinate. Abstraction away from the variable nature of f(k, t) is not costly to the development of an argument for increasing  $\Theta$ , as discussed next.

#### 4.3 Modeling Uncertainty

Within the original program introduced in section 4.1, environmental uncertainty would be reflected in the variability of the function f(k, t). Described as the maximum feasible vaccinations that can be delivered in k days upon the arrival of week t's shipment, the result of this function can vary with a wide variety factors over the course of those days, as most providers

were existing organizations with other service obligations to meet simultaneously. Furthermore, these factors determining any instance of f(k, t) are not confined to capacity issues. To deliver vaccine, a provider must have an available appointment (free capacity) and a patient for that appointment (demand). As discussed earlier in section 3.3.2, daily demand for vaccine was subject to uncertainty from the start of vaccination in mid-December 2020, initially due to appointment no-shows. In the event of no-shows, providers kept waiting lists and developed other contingency plans to prevent vaccine wastage, but these activities required further time. Such circumstances incentivize providers to under-order relative to their ability to vaccinate, creating "safety time" at the end of each week for contingency efforts addressing no-shows. Even in the linear, deterministic program developed in section 4.2, this response to all possible uncertainties embodied in f(k, t) is readily represented, by modeling safety time in doses. To do so, let:

E(v) = the expected maximum daily vaccination rate feasible, in doses

 $\sigma_v$  = the standard deviation in the maximum daily vaccination rate feasible, in doses

Here we are generalizing the issue of uncertainty around both capacity and demand by restating their combined result as an average daily vaccination rate and some degree of variation observed around that average. Invoking the central limit theorem, the distribution of f(k, t) can be assumed can be approximated with a normal distribution with mean kE(v) and a standard deviation of  $\sqrt{k}\sigma_v$ . Assuming that the enrolled provider will tolerate a less than 0.1% chance of violating the fixed cycle time policy, the safety time penalty (in doses) can be described as  $3\sqrt{k}\sigma_v$ . Expression (7) can then be replaced with:

$$\lambda_t Q \leq \theta E(v) - 3\sqrt{\theta}\sigma_v \qquad \qquad \text{for } \forall t \qquad (10)$$

For completeness, expressions (8) and (9) can also be restated as:

 $\boldsymbol{P}_t \le 7\boldsymbol{E}(\boldsymbol{v}) \qquad \qquad \text{for } \forall t \qquad (11)$ 

 $BI_t \le (\theta - 7)E(v)$  for t = 2, ..., T (12)

The assumption of normally distributed demand across the order cycle is compatible with assumptions of other distributions for daily demand uncertainty, via the central limit theorem, and is a common representation of error (Law, 2015). This assumption is also consistent with a large body of inventory models typically featured in business texts (see, for example, Heizer and Render, 2011; Stevenson, 2015). Indeed, parallels can be drawn between expression (10) and a traditional reorder point model, where the reorder point is determined with respect to a target level of stock out risk. Here, however, each enrolled provider sets a point so that stocking out across  $\theta$  days of demand is virtually *quaranteed*, to avoid punishment under the policy guidelines. In this program, the enrolled provider does not set a reorder point, but instead confines the size of the arriving order to three standard deviations less than average uncertainty over appointment yield during  $\theta$  days. Transforming expression (7) into (10) through the introduction of  $-3\sqrt{\theta}\sigma_{\nu}$ introduces a safety margin the enrolled provider maintains by withholding appointment capacity at the end of the order cycle, allowing time to pursue contingency planning and rebooking in the event of no-show patients. Unlike a traditional reorder point policy, the provision in expression (10) allows the introduction of varying degrees of hesitancy on behalf of the enrolled provider within the experiment design, but does not explicitly map to related concepts such as safety stock and service level.

#### 4.4 Methodology and Test Bed

To demonstrate the cost of cycle time requirement  $\theta$  in the operation of the vaccination network, we use the previous formulation to find the optimal ordering pattern for a range of providers that vary in weekly capacity. Specifically, we solve objective function (1), subject to constraints (3) and (5) from section 4.1, and revised constraints (10), (11) and (12) from section 4.3. This program reflects the assumption that the provider is operating 7 days a week, and demand uncertainty can be broadly characterized as demand reliability, the potential variation in capacity consumed due to as "no shows" requiring more time to convert to appointments.

To generate the test bed results, we solve each scenario with Frontline's *Solver* in Microsoft *Excel*, using a planning horizon of T = 25 weeks. To explore the impact of varying levels of  $\theta$ , we vary the following parameters to generate test bed instances:

- **30 levels of provider weekly capability:** 7E(v) = 10, ..., 300 doses, tested at intervals of 10. The lower end of that range is typical of medical practices, the midrange is more typical of pharmacies participating at various levels of resource commitment, and the upper limit suggests a smaller mass vaccination site, such as a neighborhood clinic staffed by a local health department. In each test instance, E(v) is determined by dividing this factor level by seven.
- 6 levels of cycle time restriction: θ = {7, 8, 9, 10, 11, 12} days. θ = 7 represents the operating policy at the outset of the case study.
- **3** levels of variation in the conversion of daily vaccination appointments to patients:  $CV = \sigma_v/E(v) = \text{coefficient}$  of variation of the experiment = {0.0, 0.1, and 0.2}. We state this uncertainty factor as CV to keep the overall degree of variation proportional to the size of the provider at any level. In each test instance,  $\sigma_v = CV^*E(v)$ . This factor codetermines the maximum appointments the enrolled provider takes, to be assured that all doses can be consumed within the cycle time, even in the presence of "no-show" appointments requiring re-booking for consumption. Levels are relatively low to reflect that demand for vaccination appointments is otherwise quite high at this point in the case study, although no-show appointments can be problematic.
- 2 levels of vaccine lot size: Q = {50, 100} doses. Testing outcomes at Q=100 simulates the conditions of ordering the Moderna or Janssen vaccines, while testing again at half that amount explores the sensitivity of capacity loss to this requirement.

The factors described above combine to form 30 x 6 x 3 x 2 = 1,080 test instances in which the optimal pattern of integer lot size multipliers  $\lambda$  are found to maximize weekly vaccination levels P across the 25 weeks. P will be maximized with a repeating pattern of multipliers  $\lambda$  enabling the best fit of weekly vaccination to weekly capability, although a few solutions suffer a minor end-of-horizon effect, where vaccination near the finite horizon T=25 is inflated to maximize expression (1) by exhausting what would be carry-over inventory during steady-state operation. To best assess impact on the steady-state, making all instances more comparable to each other, the solution from Week 6 through Week 20 is evaluated for the purpose of reporting capacity unused or average weekly vaccination.

# 5. Results

# 5.1 Overall Results

Table 1 provides an overview of capacity loss across the testbed, representing the mean vaccination capacity loss associated with the two different lot sizes combining with the various levels of  $\theta$ , the length of cycle time set by the governing policy:

Table	1.	Mean percent	t vaccination	capacity	loss,	over	all	demand	and	capacity	condition	S
(n=90 )	exp	eriments per o	ell).									

	Fixed Or	der Cycle	Length $ heta$			
Fixed Lot Size	7 days	8 days	9 days	10 days	11 days	12 days
Q=50	26%	15%	7%	3%	2%	2%
Q=100	35%	26%	17%	11%	8%	6%

Table 1 indicates that current conditions at the time of the case would create a loss of 35% of vaccination capacity in a group of enrolled providers equally distributed across the range of capacities tested here, with perceived demand variability equally distributed among the three levels tested here. This aggregate loss drops to 26% if the governing policy of fixed order cycle  $\theta$  is relaxed by one day, with continued but diminishing improvement as the policy is relaxed further. To move away from Table 1's summary assumption of a uniform distribution of size among enrolled providers, the interaction of capacity available and variability of demand must be considered in detail. Of the 1,080 total test bed instances, we designate the 180 experiments using the factor level *CV=0* (deterministic demand) and *Q=100* (existing order size) the base case scenarios, and examine these next.

5.1.1 Base Case Deterministic Results. Figure 5 provides a heat map of percent capacity loss and the corresponding average weekly vaccinations for different sizes of providers combined with differing cycle time policies, across the base case scenarios. Loss is created by the ratio of the cycle time policy to the minimum order size policy of the manufacturer; the top bands of the table include all facilities precluded from participation due to that ratio falling below 1.0, while

Cycle Time Policy ( $\Theta$ )

the remainder of the tables show a pattern of loss which is maximized as vaccination capability nears but does exceed a round number of vaccine lots.

	7 days	8 days	9 days	10 days	11 days	12 days		
10	100%	100%	100%	100%	100%	100%	10	
20	100%	100%	100%	100%	100%	100%	20	
30	100%	100%	100%	100%	100%	100%	30	
40	100%	100%	100%	100%	100%	100%	40	
50	100%	100%	100%	100%	100%	100%	50	
60	100%	100%	100%	100%	100%	18%	60	
70	100%	100%	100%	30%	30%	30%	70	
80	100%	100%	40%	40%	17%	17%	80	
90	100%	47%	26%	18%	9%	4%	90	
100	0%	0%	0%	0%	0%	0%	100	
110	9%	9%	9%	9%	9%	9%	110	
120	17%	17%	17%	17%	17%	0%	120	
130	23%	23%	23%	23%	4%	0%	130	
140	29%	29%	29%	5%	0%	0%	140	
150	33%	33%	33%	0%	0%	0%	150	
160	38%	38%	7%	7%	0%	0%	160	
170	41%	41%	13%	2%	0%	0%	170	
180	44%	18%	7%	3%	0%	0%	180	
190	47%	12%	4%	1%	0%	0%	190	
200	0%	0%	0%	0%	0%	0%	200	
210	5%	5%	5%	0%	0%	0%	210	
220	9%	9%	9%	0%	0%	0%	220	
230	13%	13%	13%	0%	0%	0%	230	
240	17%	17%	3%	0%	0%	0%	240	
250	20%	20%	0%	0%	0%	0%	250	
260	23%	23%	4%	0%	0%	0%	260	
270	26%	8%	1%	0%	0%	0%	270	
280	29%	5%	0%	0%	0%	0%	280	
290	31%	3%	0%	0%	0%	0%	290	
300	0%	0%	0%	0%	0%	0%	300	

7E(v): Provider's Weekly Vaccination Capability (in Doses)

	Cycle Time Policy ( $oldsymbol{ heta}$ )							
	7 days	8 days	9 days	10 days	11 days	12 days		
10	0	0	0	0	0	0		
20	0	0	0	0	0	0		
30	0	0	0	0	0	0		
40	0	0	0	0	0	0		
50	0	0	0	0	0	0		
60	0	0	0	0	0	49		
70	0	0	0	49	49	49		
80	0	0	48	48	66	66		
90	0	47	67	73	82	86		
00	100	100	100	100	100	100		
10	100	100	100	100	100	100		
20	100	100	100	100	100	120		
30	100	100	100	100	125	130		
40	100	100	100	133	140	140		
50	100	100	100	150	150	150		
60	100	100	149	149	160	160		
70	100	100	149	167	170	170		
80	100	148	167	175	180	180		
90	100	167	182	189	190	190		
00	200	200	200	200	200	200		
10	200	200	200	210	210	210		
20	200	200	200	220	220	220		
30	200	200	200	230	230	230		
40	200	200	233	240	240	240		
50	200	200	250	250	250	250		
60	200	200	249	260	260	260		
70	200	249	267	270	270	270		
80	200	267	280	280	280	280		
90	200	280	289	290	290	290		
00	300	300	300	300	300	300		

Figure 5. Percent Vaccination Capacity Loss (left) and Average Weekly Vaccination (Right) Under Varying Levels of Cycle Time Requirements of Base Case Scenarios

Increasing the allowable cycle time reduces this effect across, in many cases because the provider is able to create an alternating pattern of larger and smaller orders to keep working steadily week

by week. As an example, consider a pharmacy that can vaccinate at a rate of 20 doses a day, 7 days a week, for a maximum weekly vaccination feasible of 140 doses. Under the current policy in the left-hand columns of each table, this pharmacy can only order 100 doses a week, enough for five days of activity upon arrival, and thus 2/7 = 29% of its potential goes unused. If allowed 10 days to finish a delivery of vaccine, this same pharmacy could order 200 doses one week followed by two consecutive weeks of 100 dose orders, averaging 133 vaccinations a week. This relaxation of the cycle time creates the difference between 300 doses administered in a three weeks time (the current policy) and 400 doses administered (proposed policy), a 33% increase in production from the same provider.

5.1.2 Results under Uncertainty. Figure 6 provides the results of test instances of fixed lot size Q=100 under demand variability CV=0.1 and CV=0.2. Uncertainty around the exact number of vaccinations that can be achieved across the critical interval  $\theta$  manifests as a reduction of the effective capacity of a provider as it reserves  $3\sqrt{\theta}\sigma_v$  doses of safety time each week to alleviate the risk of incurring penalties. As a result, both heat maps in Figure 6 are "warmer" with capacity loss than their counterpart in Figure 5. Furthermore, the maximum degree of capacity loss for certain providers under the current policy ( $\theta = 7$ ) is higher. As an example, a provider who expects to complete at most 250 vaccinations a week leaves only 20% of capability unused in the cases of no and lower variability, but the loss jumps to 60% in the case of CV = 0.2.

As discussed at the outset, the purpose of gathering these results is to gauge the cost of a current policy of  $\theta = 7$  and to inform a recommendation for increasing  $\theta$ . One interesting feature of introducing uncertainty is that, while capacity loss is generally greater in an aggregate sense, small increases to  $\theta$  are somewhat *less* influential. This can be seen here by looking across the rows of the Figures 5 and 6 heat maps, and noting where that loss actually drops. For example, a one day increase of the cycle time policy  $\theta$  from 7 to 8 days produces immediate improvement in capacity loss in six test instances in Figure 5, but only four test instances in the right-hand table of Figure 6. This is because capacity loss created by the provider's capability being a non-integer multiple of the vaccine lot size also serves as safety time where needed, which is also why capacity loss is not universally lower when comparing the Figure 6 results with Figure 5. Nonetheless, the combined results demonstrate how some amount of capacity contained within

many providers is structurally blocked from use in vaccination under the current policy of  $\theta = 7$ , and extending that requirement by a few days frees that capacity for use in most cases.

		Cycle Time Policy ( $oldsymbol{ heta}$ )					
		7 days	8 days	9 days	10 days	11 days	12 days
	10	100%	100%	100%	100%	100%	100%
	20	100%	100%	100%	100%	100%	100%
	30	100%	100%	100%	100%	100%	100%
	40	100%	100%	100%	100%	100%	100%
	50	100%	100%	100%	100%	100%	100%
	60	100%	100%	100%	100%	100%	100%
	70	100%	100%	100%	100%	30%	30%
	80	100%	100%	100%	40%	17%	17%
7E( <i>v</i> ):	90	100%	100%	26%	18%	9%	6%
Provider's	100	100%	0%	0%	0%	0%	0%
Weekly	110	100%	9%	9%	9%	9%	9%
Vaccination	120	17%	17%	17%	17%	17%	17%
Capability	130	23%	23%	23%	23%	23%	0%
(in Doses)	140	29%	29%	29%	29%	0%	0%
	150	33%	33%	33%	33%	0%	0%
	160	38%	38%	38%	7%	0%	0%
	170	41%	41%	41%	2%	0%	0%
	180	44%	44%	7%	3%	0%	0%
	190	47%	47%	4%	1%	0%	0%
	200	50%	0%	0%	0%	0%	0%
	210	52%	5%	5%	5%	0%	0%
	220	55%	9%	9%	9%	0%	0%
	230	13%	13%	13%	13%	0%	0%
	240	17%	17%	17%	0%	0%	0%
	250	20%	20%	20%	0%	0%	0%
	260	23%	23%	4%	0%	0%	0%
	270	26%	26%	1%	0%	0%	0%
	280	29%	29%	0%	0%	0%	0%
	290	31%	31%	0%	0%	0%	0%
	300	33%	0%	0%	0%	0%	0%

	Cycle Time Policy ( $oldsymbol{ heta}$ )							
	7 days	8 days	9 days	10 days	11 days	12 days		
10	100%	100%	100%	100%	100%	100%		
20	100%	100%	100%	100%	100%	100%		
30	100%	100%	100%	100%	100%	100%		
40	100%	100%	100%	100%	100%	100%		
50	100%	100%	100%	100%	100%	100%		
60	100%	100%	100%	100%	100%	100%		
70	100%	100%	100%	100%	100%	100%		
80	100%	100%	100%	100%	17%	17%		
90	100%	100%	100%	18%	9%	6%		
100	100%	100%	0%	0%	0%	0%		
110	100%	100%	9%	9%	9%	9%		
120	100%	17%	17%	17%	17%	17%		
130	23%	23%	23%	23%	23%	23%		
140	29%	29%	29%	29%	29%	29%		
150	33%	33%	33%	33%	33%	0%		
160	38%	38%	38%	38%	0%	0%		
170	41%	41%	41%	41%	0%	0%		
180	44%	44%	44%	3%	0%	0%		
190	47%	47%	47%	1%	0%	0%		
200	50%	50%	0%	0%	0%	0%		
210	52%	52%	5%	5%	5%	5%		
220	55%	55%	9%	9%	9%	0%		
230	57%	13%	13%	13%	13%	0%		
240	58%	17%	17%	17%	0%	0%		
250	60%	20%	20%	20%	0%	0%		
260	23%	23%	23%	0%	0%	0%		
270	26%	26%	26%	0%	0%	0%		
280	29%	29%	29%	0%	0%	0%		
290	31%	31%	31%	0%	0%	0%		
300	33%	33%	0%	0%	0%	0%		

Figure 6. Percent Vaccination Capacity Loss under Coefficient of Variation Levels 0.1 (Left) and 0.2 (Right)

5.1.3 Reduced Lot Size Results. Table 1 established the general impact of reducing lot size Q, showing the overall vaccination capacity loss under Table 1's assumption drops from 35% to 26% under the current policy of  $\theta = 7$  days, when Q is reduced from 100 down to 50 doses. Figure 7

shows the distribution of that benefit across all experiments, illustrating the percent of vaccination capacity regained when the base case value of *Q* is cut in half:

CV = 0.0										
Cycle Time Policy ( $\Theta$ )										
	ays ays days days									
	7 d 9 d 11									
10	0%	0%	0%	0%	0%	0%				
20	0%	0%	0%	0%	0%	0%				
30	0%	0%	0%	0%	0%	84%				
40	0%	0%	64%	64%	84%	84%				
50	100%	100%	100%	100%	100%	100%				
60	83%	83%	83%	83%	83%	18%				
70	71%	71%	71%	26%	30%	30%				
80	63%	63%	34%	34%	17%	17%				
90	56%	31%	19%	15%	9%	4%				
100	0%	0%	0%	0%	0%	0%	1			
110	0%	0%	0%	9%	9%	9%	1			
120	0%	0%	14%	17%	17%	0%	1			
130	0%	0%	19%	23%	4%	0%	1			
140	0%	24%	29%	5%	0%	0%	1			
150	33%	33%	33%	0%	0%	0%	1			
160	31%	31%	7%	7%	0%	0%	1			
170	29%	29%	13%	2%	0%	0%	1			
180	28%	15%	7%	3%	0%	0%	1			
190	26%	9%	4%	1%	0%	0%	1			
200	0%	0%	0%	0%	0%	0%	2			
210	0%	0%	5%	0%	0%	0%	2			
220	0%	8%	9%	0%	0%	0%	2			
230	0%	11%	13%	0%	0%	0%	2			
240	0%	15%	3%	0%	0%	0%	2			
250	20%	20%	0%	0%	0%	0%	2			
260	19%	19%	4%	0%	0%	0%	2			
270	19%	7%	1%	0%	0%	0%	2			
280	18%	5%	0%	0%	0%	0%	2			
290	17%	3%	0%	0%	0%	0%	2			
300	0%	0%	0%	0%	0%	0%	3			

7E(v):

Provider's Weekly

Vaccination Feasible

(in Doses)

	CV = 0.1						
		Cycle <sup>-</sup>	Time P	olicy (	9)		
	¥,	Å.	\$Å	ays	ays	ays	
	g	g	qa	p 0	19	2 7	
10	0%		0%	-0%	-0%	-0%	
10	0%	0%	0%	0%	0%	0%	
20	0%	0%	0%	0%	0%	0%	
30	0%	0%	0%	6 40/	0.40/	0.40/	
40	0%	100%	100%	100%	84%	84%	
50	0.70	0.00%	0.00%	0.0070	0.00%	0.00%	
70	83% 710/	83% 710/	8370 710/	83% 710/	83% 20%	83% 20%	
/0	6.20/	6.20/	6.20/	249/	30%	30%	
00	0370 E C 0/	0370 E C 0/	10%	150/	1770	£0/	
100	50%	00%	19%	15%	9%	0%	
110	3U%	0%	0%	0%	0%	0%	
110	45%	0%	0%	1.70/	970 170/	970	
120	0%	0%	10%	229/	229/	1/70	
140	0%	0%	20%	23%	23%	0%	
140	0%	2.2%	2370	2970	0%	0%	
150	0%	3370	3370 210/	33%	0%	0%	
170	20%	31%	200%	20/	0%	0%	
100	2370	2270	2570	270	0%	0%	
100	28%	28%	/70	370 10/	0%	0%	
200	20%	20%	470	170	0%	0%	
200	2.370	0%	0%	5%	0%	0%	
210	24/0	0%	0%	0%	0%	0%	
220	2370	0%	12%	12%	0%	0%	
230	0%	0%	17%	1370	0%	0%	
240	0%	20%	20%	0%	0%	0%	
250	0%	10%	2070	0%	0%	0%	
200	0%	19%	4/0	0%	0%	0%	
210	0%	19%	0%	0%	0%	0%	
200	17%	17%	0%	0%	0%	0%	
250	17%	0%	0%	0%	0%	0%	
300	1770	0/0	0/0	0/0	0/0	070	

	CV = 0.2							
	Cycle Time Policy (0)							
	sáe	sáe	sáe	lays	lays	lays		
	7 ¢	8	р 6	10	11	12		
10	0%	0%	0%	0%	0%	0%		
20	0%	0%	0%	0%	0%	0%		
30	0%	0%	0%	0%	0%	0%		
40	0%	0%	0%	0%	84%	84%		
50	0%	0%	100%	100%	100%	100%		
60	0%	83%	83%	83%	83%	83%		
70	71%	71%	71%	71%	71%	71%		
80	63%	63%	63%	63%	17%	17%		
90	56%	56%	56%	15%	9%	6%		
100	50%	50%	0%	0%	0%	0%		
110	45%	45%	0%	0%	0%	9%		
120	42%	0%	0%	0%	17%	17%		
130	0%	0%	0%	23%	23%	23%		
140	0%	0%	0%	29%	29%	29%		
150	0%	0%	33%	33%	33%	0%		
160	0%	0%	31%	31%	0%	0%		
170	0%	29%	29%	29%	0%	0%		
180	0%	28%	28%	3%	0%	0%		
190	0%	26%	26%	1%	0%	0%		
200	25%	25%	0%	0%	0%	0%		
210	24%	24%	0%	0%	5%	5%		
220	23%	23%	0%	9%	9%	0%		
230	22%	0%	0%	13%	13%	0%		
240	21%	0%	0%	17%	0%	0%		
250	20%	0%	20%	20%	0%	0%		
260	0%	0%	19%	0%	0%	0%		
270	0%	0%	19%	0%	0%	0%		
280	0%	18%	18%	0%	0%	0%		
290	0%	17%	17%	0%	0%	0%		
300	0%	17%	0%	0%	0%	0%		

Figure 7. Percent Vaccination Capacity Gained by Reducing Lot Size Q from 100 to 50, at all Levels of Fixed Cycle Time ( $\theta$ ), Enrolled Provider Capacity ( $7^*E(v)$ ) and Demand Variability (*CV*).

As Figure 7 shows, the benefit of the smaller lot size is consistent across the test bed, restoring vaccination capacity in those bands of experimental instances where the enrolled provider's size is not close to a multiple of the larger lot size. The greatest gains are among the smallest providers near the top of the tables, who were previously excluded by virtue of the minimum lot size and the fixed order cycle requirement. It should be noted that shipment lot sizes are

determined by the vaccine manufacturers, and thus are not a governing policy 'lever' the state might adjust. However, this result remains relevant as there are more local means of reducing lot size if other aspects of the governing policy are revisited, discussed in the next section.

# 6. Discussion

# 6.1 Interpreting the Results

The need for a fast start and rapid scaling makes New York State's regional adhocracy model a good fit for vaccination during the early months of 2021, but it is the underlying organizational structure's sensitivity to its own rules of coordination that create the context of this investigation. Figure 8 illustrates how the experimental results reflect the influence of two rules and three exogenous factors on the outcome of interest. That outcome, the overall combined utilization of the vaccination adhocracy, is pictured at the center of Figure 8, with the rules on the right and the exogenous factors on the left.



Figure 8. Entity/relationship diagram of constraints on utilization of enrolled provider vaccination capacity.

Figure 8 clarifies how a cycle time limit of seven days, intended to assure expediency in protecting people from a life-threatening condition, could nonetheless emerge abruptly as a factor working against that same mission. To begin, one entity in Figure 8, vaccine supply, is among the few with

direct influence on capacity utilization, and is also the only entity not modeled explicitly in the Section 4 math program. At the start of this case study, vaccine supply was a binding constraint on vaccination, a very visible limitation that drew media coverage (see, for example, the *Washington Post* article of Fritz – Edward, 2021). This, however, is the time period in which the parameters of the governing inventory policy were set, but rendered non-binding by these conditions. Supply is not an explicit parameter or variable in this study because Section 4 models a single vaccinator's point of view when determining a weekly planning request for vaccine, as discussed Sections 3.2 and 4.1. As illustrated earlier in Figure 1, it is New York State that combines these requests with information on inbound vaccine stock, solving a separate weekly allocation problem to determine which enrolled providers do receive their on-line requests, if all such requests cannot be met by vaccine available. Only when the expanding vaccine supply exceeded the combined volume of vaccine requests did other Figure 8 entities gain influence over the outcome of interest. This shift in conditions was signaled by enrolled providers not requesting all vaccine they appeared capable of using, even when supply was available and vaccine demand was extremely high.

Figure 8 also illustrates how almost all entities serving as test bed parameters have an indirect connection with the primary outcome of interest, as they interact with other factors to create two influential subordinate outcomes. At the top of Figure 8, the subordinate outcome labeled 'Safety Time Required' refers to a enrolled provider's perceived need to withhold some appointment capacity to leave time for response to no-show appointments. This subordinate outcome drives capacity utilization downward, evident in the contrast between Figure 6 and 7 results. However, safety time required is mitigated by greater reliability of demand (fewer no-shows, or swifter means of back-filling no-show appointments) and/or relaxing of the cycle time limit  $\theta$ , as this leaves open the next week's order to be adjusted downward if no-shows have created lingering stock. The diagonal patterns of extreme capacity loss across the heat maps in Figures 3, 4 and 5 indicate how the interaction of the cycle time limit and the enrolled provider's size in the presence of a fixed lot size creates a subordinate outcome described as 'Accessible Capacity' at the bottom of Figure 8. This subordinate outcome is easily generalized; if  $\pi$  is defined as an enrolled provider's accessible capacity when planning arrival for week t, then

$$\pi = \left\lfloor \frac{f(\theta, t)}{Q} \right\rfloor \tag{13}$$

... using the production function  $f(\theta, t)$  and the lot size Q defined earlier in Figure 4.1. Capacity lost through this dynamic is then  $f(\theta, t) - \pi$ , an amount driven by the remainder in the division of  $f(\theta, t)$  by Q. Finally, Figure 8 clarifies how 'length of allowable cycle time' ( $\theta$ ) can impact utilization of enrolled provider capacity in more than one way, offering further evidence for the need to relax this constraint in particular.

In Figure 8, the fixed vaccine ordering lot size *Q* is pictured as an element of policy design. At first glance, this factor might appear exogenous to the state's problem, in that lot sizes for shipping are dictated by the manufacturers, at a value of 100 for Moderna and Janssen and well over 1000 doses for Pfizer. However, while this feature is not a parameter than can be adjusted in the state's governing rules, lot size could be effectively lowered if the policy were modified to permit the splitting of arriving shipments among adjacent providers. Creative extensions based from these results, including the lot splitting opportunity, are described next.

#### 6.2 Supplementary Arguments in this Case

The numerical test bed results demonstrate how capacity is lost through the conflict between the fixed cycle time requirement and the enrolled provider's ability to consume an order within that time. These results were provided to the state governing committee with three supplementary arguments for revision to policy rules governing the agent-based system, described next. The first two arguments speak more broadly of further benefits to be expected from relaxing the cycle time constraint in this context, while the third makes the argument for relaxation of the ban on spitting lots between providers.

6.2.1 Relaxing the Cycle Time Limit: Reduction of Provider Expense through Level Loading. One well known principle of operations management is the benefit of level loading, or working at a steady pace. This goal of smooth activity levels is also a core requirement of the Lean business philosophy, minimizing avoidable expenses incurred by starting and stopping. The heavier capacity losses in the Figure 4 base case scenarios represent only partial use an enrolled provider's weekly capacity, which likely manifests as weekly cycles of starting and stopping

vaccination. Since the cycle time policy prevents continual utilization of capacity in many cases, the underlying organizations cannot dedicate a portion of their resources to efficient vaccination without incurring the additional expense of forced idle time every week. As an example, a pharmacy may not be able to hire one or more people specifically for vaccination, where they otherwise might do so if the staff were reliably utilized throughout the week. Extending the time to finish vaccine shipments is simultaneously allowing an enrolled provider to find an ordering pattern supporting even loading of their work week.

6.2.2 Relaxing the Cycle Time Limit: Decoupling of Allocation Week from Event Week. Both reliability theory and complexity theory indicate successful outcomes are more likely if strict dependencies between different elements of the system can be relaxed, because each of these "hard connections" represents a potential failure point. Current policy is an example of a hard connection, because it requires the delivery of an allocation to be synchronized with its use within the weekly order cycle. This is not problematic in an environment where appointments fill immediately, such as witnessed at the outset of vaccination. However, increasing evidence from the time of the case study indicated newly eligible people were not seeking out appointments at the same rate as earlier medically vulnerable groups, and would likely require more encouragement to achieve the rate of participation necessary for herd immunity. One successful model of recruitment is the marketing of convenient and appealing vaccination events. However, these type of clinics, complete with campaign strategy, cannot be accomplished in a single week. Relaxing policy such that the arrival of vaccine for such an event can be more than one week prior to the event allows for full deployment of any targeted marketing campaign, and also provides additional flexibility to the state in the timing of the allocation. As an example, a three week usage window on an accepted event proposal allows the state to withdraw that allocation from stock available in any of the three weeks prior... the provider is assumed to be indifferent as long as it arrives in time for the event.

6.2.3 Relaxing the Ban on Sharing a Shipment: Increased Allocation Opportunities for Pfizer Vaccine Stock. Half of test bed experiments modeled the use of the Moderna or Janssen vaccine, as ordering was done with respect to the fixed lot size of 100 doses required by those manufacturers. The balance of test bed experiments reflected a halving of that particular

parameter, although its value is not a decision variable available to the state for modification. However, the state's policy also specifies that an arriving shipment cannot be shared between enrolled providers, a rule intended to mitigate complexity in a highly dynamic system. The dramatic recovery of vaccination capacity in the Figure 7 heat maps could be achieved if pair of providers were allowed to split incoming shipments, which requires a relaxation of the no sharing policy, at the risk of further complexity.

This benefit of lot size sharing is most apparent in the case of the one vaccine type that was modeled, the Pfizer vaccine. At the time of the case, Pfizer was the most plentiful vaccine type available, accounting for 52% of all doses in the total state allocations pictured in Figure 3. Unfortunately, opportunities to place Pfizer with providers were very limited, partly due to more stringent storage requirements, but also because of its substantially larger minimum lot size. Regardless of deep cold storage available, almost all providers in the vaccination network are precluded from using Pfizer because they do not possess enough delivery capacity to consume 1170 doses in a single week, leaving this particular stock for use by large government-operated mass vaccination sites almost exclusively. While an extension of a few days is not likely to net more candidates for Pfizer allocation, a more radical extension of the cycle time policy to two or even three weeks would make Pfizer an option to additional providers. However, a short cycle time requirement could remain in place if the state would consider relaxing the constraint on the breaking and reallocating of an arriving shipment among multiple parties, bringing the effective minimum lot size down to the range of accessibility by more enrolled providers. In fact, a Pfizerrelated exception granted to chain pharmacies, allowing redistribution among groups of chain sites area within a given area, provides more evidence of the benefit of relaxing this constraint on behalf of the system as a whole.

#### 7. Conclusion

In this paper, we present a case study in regional COVID-19 vaccine distribution by New York State, demonstrating both the relevance of standard inventory models in this unique endeavor, and the particular need to evaluate and update such models continuously in the context of an

emergency. Use of a mixed integer program to model the vaccine ordering problem of a single agent within in a decentralized vaccination network demonstrates how a 7-day limit on inventory cycle time, enforced with heavy penalties for failure to comply, ultimately penalizes the combined capacity of the network. These findings were used to argue the updating of that requirement by the governing body, who relaxed that constraint on April 19, 2021 in New York State Executive Order 202.102. We initially recommended that enrolled providers be allowed at least 9 days to finish orders without penalty, but NYSEO 202.102 completely removes the equivalent of earlier expression (3) from the governing inventory policy. This case study also offers an interesting example of the hybridization of centralized and decentralized coordination in vaccine delivery, and its underlying mathematical program is tractable enough to be used as a teaching example. It is notable that each of the policy features first discussed in section 2.1.2 have a rational motivation, including the intention of limiting cycle time as a mechanism for speeding delivery of vaccine to vulnerable people. Furthermore, the unintended inefficiencies of the problematic cycle time constraint are not created by the constraint itself, but rather by its interaction with the other limitations, principally the irreducible lot sizes of the vaccine and the capacity of the provider to both fill appointments and then vaccinate. As a result, this case study demonstrates the benefit of mathematical programming in supporting a "systems view", clarifying the combined impact of these various constraints. Maintaining a systems view becomes an even greater imperative in the presence of an adhocracy, as this study shows the potential sensitivity of this particular organizational form to small changes in the governing rules that allow its component organizations to work toward a common goal. As cooperative agentbased adhocracies appear to be best suited to many problems in emergency response, it is important to understand their particular requirements.

When a standard business model falters in the application to an emergency, it is logical to assume the shortfall results from a lack of fit. However, we show how the steady-state business model of fixed interval inventory management can be highly applicable to an emergency situation, yet still falter if the user does not recognize that the model and associated policies require continual revision, a condition less familiar in the steady-state. Against the backdrop of a rapidly changing

environment, we should expect to revise our designs, and understand that such changes do not signal mistakes in any steady-state sense.

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#### MOTIVATION FOR PARTICIPATING IN A HEALTH CONFERENCE

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#### ABSTRACT

The objective of the research is to assess participants' motivations for attending a nonprofit health-related conference, specifically one on complementary and alternative medicine (CAM) focusing on natural cancer treatment, in 2023. Several motivations for attending the conference were identified, ranging from being well-informed, open minded and seeking treatment options to connecting with invited speakers and doctors, connecting with patients with similar health concern, to professional-related motivations or external motivations such as contributing to the cause of the conference organizer or the serving of organic food and beverages at the conference. These motivations can be broadly classified as "intrinsic" or "extrinsic". The research also investigates how these motivations are influenced by the characteristics of the participants such as the participant type, health concern, experience with CAM, distance travelled, participation in local tourism, travel companion, number of sessions attended, and demographic variables. A post-conference survey was conducted using Qualtrics web-based survey sent through email to all registered participants between late February to late March of 2023. The response rate was 54% with 124 responses, which yielded 114 usable samples. The data was then analyzed using multinomial logistic regression in SPSS. The results showed that relative to extrinsic factors, participants who travelled less than 100 miles were more inclined than those who travelled more than 100 miles to be motivated by intrinsic factors. Likewise, participants who did sightseeing while attending the conference were more likely than those who did not to be motivated by intrinsic factors. Interestingly, those who attended only 10 sessions or less were more inclined than those who attended more than 16 sessions to be motivated by intrinsic factors. Similarly, and not surprisingly, participants who were accompanied by someone (family, friend, co-workers) were also more likely than those who travelled alone to be motivated by intrinsic factors. Finally, participants who are friends or family of patients were more inclined than the others (invited speakers, CAM practitioners, exhibitors, supporting staff/volunteers) to be motivated by intrinsic factors. Understanding how participants are motivated is one step towards understanding their needs in participating in a health conference and eventually how they make their choices regarding healthcare. The study will support further studies on conference motivation and to improve future health conferences to be more rewarding to participants.

# Innovative Education Assessment

# STUDENT LEARNINNG OUTCOMES OF TRANDITIONAL CLASS LECTURRES AND APPLICATION-BASED LEARNING

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#### ABSTRACT

Classroom teaching methods are among the factors which impact learning and may consequently influence student perceptions of university performance. Business schools are making efforts to improve curricula by integrating traditional classroom learning and experiential learning in the workplace. Ideally, faculty will connect theory-based teaching to experience-based learning by continually developing and improving instructional design, pedagogy, and the broader curriculum. Challenging assignments (e.g. problem-solving activities or realistic business scenarios) enrich and build students' competency in content learning. Likewise, learners can be motivated through hands-on techniques such as simulations, casework, group projects/presentation and guided discussions. Johnson (2021) and Medina et al. (2011) state that student engagement and learning are promoted by effective teaching methods. Johnson (2021) further emphasizes that cultural components (i.e., institutional culture and faculty subculture) strongly influence the potential outcomes of efforts to improve teaching excellence at higher education schools of business. The purpose of this study is to provide a useful framework for evaluating various classroom practices and their effects on student learning outcomes. For this study, a survey of graduating seniors at our institution was conducted in order to assess the various types of teaching methods and classroom practices which they had experienced. For example, survey items asked participants about the following: group presentations, computer assignments, textbook-based lectures, lecture from other sources, class discussion/debates, "realworld" speakers, brief in-class group projects, practical application of knowledge in a lab setting, service learning, etc. The results indicated that teaching methods may not have a direct influence on students' overall grade performance and satisfaction with the university.

#### MICRO-CREDENTIALS AND THE TRANSFORMATION OF HIGHER EDUCATION

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#### ABSTRACT

Recent incidents like COVID-19, changing workforce needs and the uncertainty surrounding student loan structures have challenged the higher education landscape. Educational institutions are forced to reconsider how they offer education. In particular, institutions are looking at ways to enhance the value of education. Students demand a contemporary and flexible delivery approach to update their knowledge and skills that are suited to current market trends. One possible methodology adopted by institutions is to increasingly work with industry to offer micro-credentials in order to fill the gap in the current practice of awarding credentials beyond that of degrees. Micro-credentials are short, focused credentials that are designed to provide in-demand skills and knowledge. They can be earned in a shorter period of time than a degree and can be stacked to build towards a certificate or degree. While continued upskilling and reskilling has proven essential, the challenge remains on how to deliver micro-credentials in ways that are manageable. This study aims to address these issues using a three-pronged approach: 1. Explore means to deliver microcredentials, 2. Identify mechanisms for verifying these credentials, and 3. Determine the association between micro-credentials and improvement in learning. This study has the potential to make a significant contribution to the field of higher education. By addressing the challenges and opportunities associated with micro-credentials, it can help institutions to develop and implement effective micro-credential programs. This can lead to a more contemporary and flexible delivery of education, which can benefit students and employers alike. The findings of this study will contribute to practice by providing strategies to sustain micro-credentials in higher education. Moreover, it will offer directions for integrating micro-credentials with employability through robust verifying mechanisms. Finally, it will confirm the benefits of microcredentials by asserting its association with improvement in learning.

# ENGAGING EARLY: THE IMPACT OF SPONSORED HIGH SCHOOL PROGRAMS ON RECRUITMENT

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# ABSTRACT

"The best way to know is to do." Miss Frizzle

As we near the enrollment cliff of student enrollment, colleges are looking for innovative ways to engage with potential students. Typical high school college recruitment fairs are not as successful as in the past. Our college has created a comprehensive program to reach high school students. With a \$1 million 3 –year grant from the Department of Labor followed by a new \$1.5 million funded grant for the next 3 years, the college is changing how we engage future college students.

The High School Business Academy's primary objectives are to expose a diverse high school student population to business-related courses and help to prepare them for the local workforce and beyond. The driving core principles for this program are 1. promoting the availability of workers for good jobs; 2. prioritizing equity; and 3. driving and sustaining economic transformation.

The Academy provides high school teachers with professional development along with curriculum and resources needed to disseminate to students. High school students receive essential business-based training, optional paid internship opportunities, support for expenses such as attire and transportation. The Academy prepares these students to be new worker entrants with a good job or to pursue a postsecondary degree.

This initiative is reaping benefits in many areas and providing pathways that students had not envisioned. After participating in the High School Business Academy, students are more confident in selecting a major and enrolling at our university. The level of community involvement and buy in has been remarkable. We have support from chambers of commerce, city mayors, workforce development/youth work programs, TRIO, and school boards in addition to local businesses. The Academy has improved the connection between students and businesses by making high school and college graduates more aware of local businesses and the range of career opportunities while providing support for our local businesses via grant funded internships.

During this presentation, we will provide an overview of how this program came to be and the outstanding results after only 3 years and where we plan to be in the next 3 years. We will discuss the process we worked through to receive funding and develop the program and how it works with our other college recruiting efforts.

#### CREATING THE FUTURE: FOSTERING ENTREPRENEURIAL SPIRIT FOR TRANSFORMATIVE SOCIETAL IMPACT

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#### ABSTRACT

Colleges and universities are being called to do more and to be more. They are increasingly being called upon to expand their role in preparing students for global citizenship. The unique needs of the community in which an institution is located often drives the school's mission. *AACSB-International*, the premiere accrediting body of business schools recognizes the importance of these institutions to society as a whole. Thus, AACSB requires each accredited program to identify and support a specific area of societal impact. AACSB Standards (2020) "deeply embrace an enhanced vision of transforming business education globally for positive societal impact."

The concept of societal impact goes beyond the traditional notion of service as normally held by business schools. Societal impact does not solely pertain to acts of charity or benevolence either. Instead, it encompasses all aspects of teaching, research, and service toward a dedicated and deliberate need. According to AACSB, societal impact means that business schools utilize their specialized knowledge to help alleviate significant economic, social, human, and environmental challenges faced by society. The vision is that business schools will contribute their expertise to address complex societal issues. Moreover, the standards emphasize a multi-stakeholder approach where diverse parties with complementary skills collaborate to collectively tackle these intricate problems, aiming for transformative change.

In our small corner of the Louisiana Delta, we are focusing our societal impact on building entrepreneurial spirit. This focus or emphasis is more than an item in our strategic plan. It is interwoven in all that we do.

This presentation will provide a step-by-step process of how to define, develop, and direct your own area of societal impact. The presentation will cover why we selected entrepreneurial spirit as our focus; how we have practically integrated developing the entrepreneurial spirit in our students, faculty, and community; and what we will be doing next. The greatest value of the presentation will be in providing the concrete examples of how to choose your focus, how to set goals, and how to measure outcomes as your institution defines its own way of 'Creating the Future'.

# MASTERY PATHS: A TOOL TO FACILITATE ONLINE CLASSES OF STRESSED-OUT STUDENTS

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# ABSTRACT

Larger percentages of our online students are stressed to the point of being emotionally and mentally fatigued even before they enter our classes [1] [2] [3]. This stressed-out condition may require differential learning experiences. This workshop addresses the needs for student needs based and allows for excellent students to move ahead while ensuring that students, who need more exposure to concepts, to receive it. The tool used to facilitate this is the Mastery Paths tool provided by the Canvas Learning Management system. This workshop demonstrates one course structure and how to implement it in Canvas. Canvas users bring laptops; otherwise, handouts are provided.

# THE WORKSHOP

Many students want to make decisions but given the level of student stress in college[4], when confronted with actually making a decision, they freeze and do not know what to do or where to begin. One way to allow customization of a curriculum to a student's needs to is allow demonstration of expertise at the time of the class to determine the student's progress through the various pedagogical means used.. Another way to provide such customization is to allow for self-assessment along with outside faculty provided assessment opportunities. This workshop takes the first customization approach which will allow students with demonstrated backgrounds in an area to skip to the assessment feature of the course and move on. Moving on may be to a homework or applied project or it may be to a new topic area.

This workshop is set up with one hour, 1.25-hours and 1.5-hours options. It is set up to be interactive. If a shorter time than 1 hour is needed the interactive sessions will be reduced in time or eliminated. See Table 1 below for the detailing of the timing, activity and needed equipment/supplies.

<u>Time Reference</u>	Activity	<u>Equipment</u>	<u>Supplies</u>
00.00.00 to 00.05.00	Introductions Around	Set up of laptops if already using Canvas or receipt of Paper versions if not using Canvas or no laptop.	Handouts of Steps in Process & Pencils
00:05:00 to 00:10:00	Reasons why to choose Mastery Paths	PPT Show through Projector	
00:10:00 to 00:15:00	How to set up Mastery Paths in Canvas & Tips	Projector Follow along and/or Paper Handouts	
00:15:00 to 00:25:00	Discussion on General Layout Of Online Courses and Canvas	Pair & Share and then report out on ways workshop attendees ha	t ve

#### TABLE 1. Workshop Agenda

	Variations	Structured their courses with any issues found
00:25:00 to 00:40:00	Summary of shared info Sharing of Course Structure Used and Reasons Why identification of key component in use in Canvas and impact if you choose to designate a component as bein a part of Mastery Path	Projector Follow along and/or Paper Handouts ng
00:40:00 to 00:45:00	Logic used in structuring a Module Using Mastery Paths With Example Mastery Paths	PPT Show through Projector
00:45:00 to 00:60:00	Showing of how to use premate components to create a simple Mastery Paths Module (lesson + Quiz)	de Projector Follow along and/or e Paper Handouts

#### **OPTIONAL SESSION A**

00:60:00 to 00:75:00 Paired Discussions on potential uses of example paths in own Classes

#### **ADDITIONAL OPTIONAL SESSION B**

00:75:00 to 00:85:00 Showing of how to use premade Projector Follow along and/or components to create a Weekly Paper Handouts HW Mastery Paths Module (lesson + Quiz + Homework)

00:85:00 to 00:90:00 General workshop Discussion and Feedback/Close

# WHY STRUCTURED THIS WAY AND WHY OF INTEREST TO SEDSI ATTENDEES

Formerly, students in higher education often appreciated being able to make choices in what to do [5]. Current students often find that making choices is very hard when they have high levels of stress [4] [6]. This process helps them to receive the educational structure they need while putting the choice into their demonstration of current knowledge, skills, and abilities. While there are work arounds which are similar, the Mastery Paths tool in Canvas is ideal to enable this type of education while encouraging engagement.

This workshop is designed for attendees to follow along (via laptop or handouts) and to have several times when they discuss and share their reactions and potential uses in an active learning environment encouraging them to relate the information provided in the workshop with their daily teaching lives.

Because a variety of learning management systems are in use by faculty, Canvas users are prompted to follow along and others have handouts of the canvas interface so that they can take it back to their system and map the opportunities found in this system to their own.

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# BIG DATA, SMART BUILDINGS, POST-COVID OFFICE REAL ESTATE DECISION MAKING, AND MULTI-DISCIPLINARY UNDERGRADUATE LEARNING: A CASE STUDY IN DISCOVERY THINKING

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# ABSTRACT

Smart buildings, complete with various IoT devices, have been collecting lakes of underused data prior to, during, and after COVID pandemic stay-at-home orders. Office building vacancy rates continue to rise in 2023 and it is estimated that 10-20% of existing office space will require repurposing [1] as work from home and other hybrid work arrangements are stabilizing as commonplace. A multi-disciplinary team of undergraduate students from an experimental honors degree program worked with a Real Estate Investment Trust (REIT) company to translate big data sensor information into immediate, actionable cost saving decisions accompanied by recommendations for future space reutilization. The team leveraged discovery and collaboration skills taught in the program to deliver an innovative solution for current market challenges.

# **Discovery Thinking**

The program is built to teach collaboration and innovation sufficient to tackle complex problems by leveraging diversity in both team construction and mentorship. In this instance of the program, the team consisted of 14 third- and fourth-year students from six colleges across the university. This experience complements their individual pursuits of discipline-specific undergraduate degrees in data analytics, industrial and systems engineering, business information technology, computer engineering, smart and sustainable cities, industrial design, finance, or management. They were joined by faculty from Business, Engineering, and Architecture & Design, and industry partners consisting of a VP of Finance, a Chief Technology Officer, and a Director of Technology Initiatives from the REIT. Together they explored a problem space using a novel complex problem-solving framework called Discovery Thinking as presented by [2]. Over the course of two semesters, the team explored the problem space from a sociotechnical perspective to discover an innovative set of recommendations that their industry partners could put into action for desired outcomes. Innovative, sociotechnical solutions are discovered through a four-set assessment of Desirability, Feasibility, Viability, and Sustainability and producing business and system artifacts: a concept of operations, systems architectures, risk matrices, verification and validation requirements, business plans, and assessment of sustainability concerns such as legal, regulatory, or operational barriers, and more. The case study demonstrates the process and outcomes of teaching discovery thinking.

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#### A DUAL PROCESS MODEL OF LEARNING ENGAGEMENT WITH INSTRUCTIONAL VIDEOS: A HEURISTIC-SYSTEMATIC MODEL PERSPECTIVE

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#### ABSTRACT

Along with technological advances of user-generated contents (UGCs), instructional videos play a critical role as educational resources in all classroom settings. Instructional videos have been widely adopted to teach skills, concepts, and problem-solving techniques; learning skills and knowledge from instructional videos simplify and enrich individuals' everyday lives. Hence, with the growing popularity of instructional videos as a powerful and effective tool in educational settings, understanding how they influence individuals' learning process is crucial. Learning engagement refers to the degree to which an individual is actively involved in the learning process and motivated to achieve learning outcomes. Engaged individuals are more likely to achieve better learning outcome and have a more positive learning experience. In a sense, instructional videos can be regarded as a salient medium of learning engagement. However, there has been few studies on (1) the relationships between instructional videos and learning engagement and (2) the significant roles of instructional videos on the process under which individuals utilize the instructional videos in educational settings. To void this knowledge gap, we pose the following research question: how do instructional videos facilitate individuals' learning process, which in turn, enhances their learning engagement and effectiveness? For this, we draw on a heuristic-systematic model (HSM) that emphasizes two modes of systematic and heuristic cues when individuals process new information. Based on HSM, this study aims to investigate how instructional videos impact individuals' learning engagement (consisting of affective, cognitive, and behavioral engagement). In detail, this study examines that individuals' learning engagement can be enhanced by instructional videos' source characteristics (source expertise and likeability) as heuristic cues and content characteristics (content quality as a systematic cue and content orientation as a situational factor), and that content orientation (informative vs. entertaining) moderates individuals' dual process of learning engagement. Data will be analyzed using Partial Least Squares (PLS) analysis with a multi-group analysis. This study theoretically contributes to extend the roles of instructional videos in learning environments by emphasizing individuals' learning process based on a heuristic-systematic model. Our findings also provide an insight of how practitioners develop and utilize instructional videos to encourage individuals' engagement in educational settings.

# POST-COVID WORLD, STUDENT DISENGAGEMENT IN HIGHER EDUCATION: A MODERATED MEDIATION

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#### ABSTRACT

Starting in 2022 and continuing today, faculty have observed an increased rate of student disengagement, defined as a lack of involvement in higher education typically through active participation, curiosity, interest, and motivation. Currently, 30 to 75% of students are absent from class, don't complete assignments, are forgetful, and, when present physically, don't appear mentally present. We investigate the current student environment where students come to higher education, whether in residence or online, with symptoms of high stress. Traditionally-aged students are behaving at even lower maturity levels and expecting high school-level dispensations, such as light workloads, fluid deadlines, and minimal oral engagement.

Compounding the outlook of traditionally-aged students, both traditional and non-traditional students were impacted by the COVID-19 pandemic and may experience COVID-19 Brain Fog or, in some severe cases, posttraumatic stress disorder (PTSD). We delve into these two conditions and what they mean as antecedents to perceived organizational support (POS) and trust. Then, we develop a model which can be used to test how POS and trust affect student disengagement and whether psychological safety and stress strengthen or weaken those relationships.

With the theories of Maslow's Hierarchy of Needs, Social Exchange, and Conservation of Resources, and our research construct, we identify underlying stress-related issues and highlight how stress factors may impact education systems during COVID-19 and student expectations, which spilled over into post-COVID re-instigation of "normal" higher education experiences. We also delve into what is known from a more than 20-year history of attempting to address student disengagement.

Based on this review and implications from theory, we provide direction for Higher Education faculty members in reaching and facilitating the growth of all of their students, not just those at the extreme end of disengagement. Further, we discuss resource allocation implications to address unintended consequences of social actions resulting from the COVID-19 pandemic. We address how some suggested means may not be appropriate given the stress level compounded by the impact of COVID-19.

We end with potential scenarios going forward. Scenarios include addressing the role of higher education in our communities and civilization and processes such as integrating approaches to helping students develop into mature, productive citizens. Dilemmas such as balancing where a student best fits in range of the post-secondary educational and training networks while remaining true to the mission of higher education of knowledge acquisition, dissemination, and developing scholars are addressed. Who pays for these societal needs is discussed.

#### THE ROLE OF COGNITIVE LOAD IN STUDENT LEARNING FOR BUSINESS EDUCATION

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#### ABSTRACT

Cognitive load theory (CLT) is based on knowledge of human cognitive structures and processes and was formally introduced into the field of educational psychology in the 1980s by Sweller and colleagues [1]. Since then, it has been extended and studied by researchers around the world in a wide range of educational contexts. CLT emphasizes that new information is first processed in working memory, subject to capacity and time constraints, and then stored in an unlimited long-term memory for later retrieval and application. It aims to provide guidance for effective instructional design that strategically manages three types of cognitive load—intrinsic, extraneous, and germane—to achieve optimal academic performance.

We provide a comprehensive overview of CLT and its major instructional effects including splitattention, worked examples, and expertise reversal. Then we present preliminary results from a systematic literature review of CLT in business education. Our objective is to assess the extent to which this theory has been investigated, and its impact on curricula and teaching, in the business school setting. We summarize the most prevalent themes for CLT found in the business education literature and discuss their implications for teaching and learning. Our review will also identify opportunities for further pedagogical research on CLT and make recommendations for incorporating CLT design principles in business classrooms.

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#### STUDENTS' ENTREPRENEURIAL EXPERIENCE AND NEW VENTURE CREATION: DOES A CONNECTION EXIST?

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#### ABSTRACT

Entrepreneurship plays a pivotal role in socio-economic development, primarily through job creation and poverty alleviation [5]. Due to this prominent role, higher education institutions worldwide have integrated entrepreneurship into their curricula. As a result, Entrepreneurship Education (EE) has emerged over the past few decades as a tool to enhance entrepreneurial activity [2]. The central role of entrepreneurship has spurred scholars to study the relationship between EE and new venture creation. Most of the literature has been focusing on the impact of EE on entrepreneurial intentionality and the associated mechanisms that either encourage or deter students from pursuing entrepreneurial ventures. This emphasis on intentions stems from the belief that when students perceive entrepreneurship as a desirable career choice, they are more likely to start a new venture rather than seek traditional employment [3].

Literature is still debating about whether entrepreneurship education can impact students' career choice regardless of their individual characteristics, personal circumstances [4], economic and business context. This discussion revisits the age-old debate: are entrepreneurs made, born, or both? The debate becomes more complicated when considering the environment in which an individual might practice entrepreneurship [1].

This research aims to contribute to the entrepreneurship education literature by uncovering how the experiential, "learning by doing" components of entrepreneurship courses influence not only the intentionality but also the likelihood of students to start a business within 5 years after graduation. We focus on three different practical experiences: the I-Corps program, the gener8tor acceleration program and the award-winning EXEC (Experiential Entrepreneurship Curriculum).

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# TAKING ADVANTAGE OF ANALYTICS IN ANALYTICS EDUCATION

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# ABSTRACT

For every discipline, there is a vocabulary that students must acquire in order to comprehend the material presented for various courses. However, without some form of assessment, it is very difficult to determine whether students have acquired the necessary language or not. Assessing reading or discussions is extremely laborious for the instructor. With a large number of online students, it is nearly impossible to determine whether students are actually reading and sharing their own thoughts in annotations or discussions. Data analytics is no different. There is a vocabulary to acquire, but reading a textbook and taking a vocabulary test seems a dismal approach. In analytics courses, teaching the necessary vocabulary to students in a way that is engaging and produces retention and comprehension is very desirable. Simply listening to a lecture that incorporates new vocabulary is insufficient. Reading a textbook or paper is inadequate. Trying to complete assignments without understanding the vocabulary beforehand usually doesn't produce a good result. A 3-pronged approach of having students complete reading (and/or listen to lectures or videos) that incorporates some practice to familiarize themselves with terms, and then requiring students to use the terms in discussion might prove more beneficial than any one of these things alone. To explore this idea, I created assignments that incorporated all three prongs, and used a tool called Perusall (www.perusall.com) that makes use of AI to grade students' interaction with online reading materials and their discussion of the terms and concepts. Students also completed practice assignments outside of Perusall that required use of the terminology I hoped they had learned. I will share my experience using this approach and ideas for further study.

#### CULTURAL STEREOTYPES IN A QUANTITATIVE BUSINESS MAJOR

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#### ABSTRACT

This study examines the stereotypes that second and third year business students have about majoring in a quantitative field of study. Using a large survey of undergraduate business students, we examine trends in stereotypical thinking and how it impacts a student's decision to declare a major in finance. Previous studies have found that gender stereotypes negatively impact performance on quantitative exams (Shapiro & Williams, 2012), and that students' reasoning for majoring in a field can deviate from simple interest in the field (Brau et al., 2020). In our study, we examine stereotypes based on cultural conceptions, gender, and quantitative skills, while also controlling for other factors that could drive the decision to declare a major. We discuss ideas to counteract pervasive negative stereotypes, and discuss how our research could be extended to examine potentially similar trends in other quantitative business majors.

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# Exploratory Literature Review of Best Practices of Fair Grading in Higher Ed Teaching

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## ABSTRACT

The objective is to understand what are the best practices of fair grading in higher ed teaching. We review the concerns and best practices of both grading and teaching for assessments in higher education setting. We find that students are more sensitive to fairness in grading when compared with grading validity. Additionally, there exist several teaching and grading practices which instructors of higher education could utilize in efforts to mediate some of the above concerns.

Keywords: Grading, Fairness, Higher Ed

## **Introduction and Background**

Grading is frequently considered as the least aspect of teaching (Frisbie, Diamond, & Ory. 1979). Based on the author's personal experiences, it is also the most challenging aspect of teaching. However, it does not seem to have received sufficient attention from educators (Green & Emerson 2007).

#### Method

The original intention is to conduct a comprehensive and systematic review; however, after initial examining and search of the literature, we find that the relevant number of papers is limited. Therefore, we decide to take a snowball approach at this point of time. Starting with a few relevant papers on the topics and using their references to identify more relevant studies and find some best practices in grading with the goal of having positive attitudes from students towards grading.

#### Findings

#### **Students Perceived Fairness**

Whereas educators care about both fairness and validity, students might pay more attention to fairness than validity, which could be attributed to their lack of experiences with assessment and ability to connect assessment with their career development (Sambell, McDowell & Brown 1997). Interestingly, not only students with poor performance could be dissatisfied with fairness, but students with other levels of performance could be dissatisfied for the same reason (Nesbit & Burton 2006). Students' perception of fairness could have significantly repercussions including judgement about instructor's ethics (Kurher 2003), their attitude toward the instructor and students' motivation and learning (Chory-Assad 2002). Rodabaugh (1996) find a set of college instructors' practices that lay the foundation of students' perception, which include multiple assessments, and application of equal standards towards all students.

## **Teaching Practices Related to Grading**

There are a number of teaching practices that could help students prepare for assessments (e.g., examination). A practice examination seems widely appreciated by students (Davies 1986). Study guide is another population teaching practice that could support performance on assessments on the basis of understanding the knowledge (Wood 1989). Practice exams with similar questions to those on the actual exam appear to enhance students' performance (Perlman 2003).

## **Grading Practices**

There exist several specific grading practices that could potentially improve students' grades: curving grades, retaking examinations, discarding the lowest grade, and grading on the basis of improvement. The argument fir grading on the basis of improvement lays on the assumption that students learn more during the later part of the semester than the earlier part and thus an improvement suggests that they are becoming a more effective learner. There also exist such an assumption that scores based on earlier part of a marking period represents less of students' learning than test results from the later part of the course (Guskey & Bailey 2001). With regression analysis, Gordon and Fay (2010) show that grading fairness is better predicted with teaching practices than grading practices.

Peterson & Peterson (2016) use an unique grading mechanism with 10,000 points, which appears to perform better than traditional approaches assigning 100 points in terms of evaluating students' learning, providing useful feedback to students, reducing the burden of grading on faculty and alleviating students retaliatory ratings and comments on students evaluations of instructors.

## Conclusion

In this paper, we explore the issues and best practices in terms of both teaching and grading in grading in higher education context. We find that students pay more attention to fairness in grading as compared to the validity of grading. In addition, there are a number of teaching and grading practices that instructors of higher education could attempt to alleviate some of those concerns.

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## THE FUTURE OF DATA SCIENCE EDUCATION

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## ABSTRACT

The definition of "Data Science" is a hotly debated topic. For many, the definition is a simple shortcut to Artificial Intelligence or Machine Learning. However there is far more depth and nuance to the field of Data Science than a simple shortcut can provide. The School of Data Science at the University of Virginia has developed a novel model for the definition of Data Science. This model is based on identifying a unified understanding of the data work done across all areas of Data Science. It represents a generational leap forward in how we understand and teach Data Science. In this paper we will present the core features of the model and explain how it unifies various concepts going far beyond the analytics component of AI. From this foundation we will present our Undergraduate Major curriculum in Data Science and demonstrate how it prepares students to be well-rounded Data Science team members and leaders. The paper will conclude with an in depth overview of the Foundations of Data Science course designed to introduce students to the field while also implementing proven STEM oriented pedagogical methods. These include, for example, specifications grading, active learning lectures, guest lectures from industry experts and weekly gamification labs.

## BACKGROUND TO THE FIELD OF DATA SCIENCE

## Introduction

The field of Data Science has thrown itself onto the landscape of academia at what seems like an unprecedented pace. The consequences of this accelerated immersion is a wide variety of organizational structures supporting various forms of Data Science initiatives. This includes everything from single departments inside pre-existing colleges/schools to stand-alone schools with dedicated Deans and tenurable faculty. These varying approaches have produced significantly different academic programs and curriculum, with seemingly no two schools supporting identical coursework. This is nowhere more evident than with a simple review of introductory data science courses from across the US higher education landscape. The results of which show a variety of topics and requirements that seem to be able to span several disciplines including Statistics and Computer Science. It is a result of this wide spectrum that the School of Data Science at the University of Virginia worked to establish a unifying vision of what a Data Science curriculum should encompass, free of prior influence. Rafael Alvardo outlines this perspective in his essay "The 4+1 Model of Data Science" [1]. Once this vision was finalized and agreed upon, the high level structure became the foundation to the development of academic programs to include the creation of a PhD and Bachelor of Science degree. The following will

provide a bit of history of the field of Data Science, map out the Virginia Model of Data Science (4+1), detail the Bachelor of Science in Data Science, and end with what we believe is a natural evolution of introductory data science courses, to include both a more narrowed and expanded view of the field that better represents how Data Science is actually practiced outside the walls of academia.

# **Brief History of the Field**

The term Data Science has actually been around for more than 60 years. The two word combination was first seen in 1962 with the creation of a Data Science Laboratory by the US Air Force in Cambridge. The focus of the (DSL) was to organize the effort that had been generated since the end of WWII in advances in computation, data collection and usage. From this initial seed a series of government and academic collaborations would simmer the field forward for the next 40 years. This includes the creation of the International Council for Science Committee (ICSU) on Data for Science and Technology (CODATA) in 1966 which is still present today and founder of the Data Science Journal in 2001[2].

These several decades worth of academic simmer often came in the representation of tensions between the field of Statistics and more algorithmically driven approaches in Computer Science. A rather well known representation of this tension came from Leo Briemen in his 2001 essay "Two Cultures" [3]. Briemen suggests that the field of statistics works to collect data and model real world scenarios whereas the data mining or algorithmic driven approaches uses data first without consideration of underlying realities. While Briemen was a Statistician and had his biases, the suggestion of two rapidly evolving cultures was correct. Traditional approaches would design data gathering around a problem foregrounding the hypothesis at hand whereas data mining (data science) approaches often go searching for a problem that can be answered with data already in hand.

This separation represents a turning point in the field where data analytics as an antecedent to the formal field of Data Science really starts to take hold, largely driven by private sector interests. It is during this period of development that a significant increase in the call for expanding educational offerings to include data skills more generally, in addition to commonly offered inferential or econometric methods was heard [2]. This 50 year journey came to head in 2008 with the publication of a Harvard Business Review article entitled: "Data Scientist: The Sexiest Job of the 21st Century." The article detailed the use of the term in Silicon Valley startups, in particular Facebook and Linkedin, for what their employees were doing on the ground. The article also suggested, not so subtly, that the field was ripe for explosion [4].

The prediction could not have been more accurate. This moment represents a point in time where private sector demand and the long running academic evolution seemed to meet for a uniquely beneficial moment. The result is an unprecedented growth of a new academic field.



FIGURE 1: The Growth of Analytics and Data Science Master's Degree Programs in the United States (2006-2022)

Michael Rappa, the Director of the Advanced Analytics Center at NC State, was one of the first programs in the country to formally introduce what we know of today as a Data Science curriculum at the graduate level, doing so in the early 2000s. Consequently, he has had a unique perspective on the growth of the field and has tracked the expansion of graduate programs over the last 15 years. Figure 1 shows the explosion of graduate programs between 2010 and 2022 [5]. Driven by this collision of private sector demand and the academic maturity of Data Science. This demand for growth, however, came at a cost. The field has been rolled out onto campuses at such a rapid pace that it seems no two programs have significant overlap, both as it relates to organizational structure and curricular content. Nowhere is this more clear than a review of Introductory Data Science courses.

Figure 2 shows text analysis conducted by our team on sampled syllabi for 40 current Introduction to Data Science courses from four year institutions across the US (collected in 2023) [6]. We worked to limit the inclusion of courses to only those with "Data" and "Science" in the title or courses that were known to have a Data Science orientation. Berkeley's Data 8, for example, is included despite having no "Science" in the title. Fuzzy clusters were extracted from the corpus by using Latent Dirichlet Allocation (LDA). These clusters were then visualized using word clouds with the beta values dictating size, as opposed to the traditional use of word count. The output was well separated into four categories.



FIGURE 2: Fuzzy clusters derived from 40 syllabi using Latent Dirichlet Allocation (LDA).

Figure 2-A represents courses focused exclusively on analytical approaches, likely machine learning starting with linear regression. Figure 2-B emphasizes data presentations and communications while focusing still on analytics primarily. The third cluster, Figure 2- C has much more of a focus on programming with python specifically, in combination with traditional statistical methods likely offered through a statistics or mathematics department. The final cluster, Figure 2-D seems exclusively focused on programming/coding seemingly offered through a Computer Science department. This analysis, while limited, gives us a nice initial sense of the variety of approaches used for introductory courses. We can infer that these courses inherent content as a by-product of the department offering the courses, with CS courses focusing more on programming and Mathematics/Statistics focusing more on introductory analytical methods like linear regression. However, more importantly than what is present is what is not. In none of the courses is there any significant mention of data ethics or databases or data visualization. This is not overly surprising given how the field exploded onto college campuses. It is almost certainly the case that the pressure to begin Data Science programs meant that universities took advantage of current resources whenever possible. Which meant repackaging current courses or content to have a bit more Data Science flavor while still being heavily influenced from the original content.

The results of this review, though not surprising, does raise some questions about how the field is being represented. While it is hard to argue against the core being analytical approaches delivered through programming, focusing on those topics exclusively is reductive to what Data Science has been growing towards as a unique and independent discipline. As an example, there is a legitimate argument to be made that knowing and understanding data systems (structures, database, querying languages, etc.) and/or the complicated ethical issues of the field should come before entering analytics all together. Regardless of the order with which topics are presented this representation of the field appears incomplete.

The School of Data Science at the University of Virginia was the first stand-alone School of its kind in the US. As a result, we had the luxury (and burden) of designing our Data Science curriculum from the ground up. In doing so, Rafael Alvardo, a Professor in the School, worked in collaboration with the first wave of faculty to create a framework for the field. This framework was the DNA utilized over the last three years to generate the PhD and undergraduate programs. The following section will provide an overview of the framework followed by details on how it influenced the development of the undergraduate program and specifically the Foundations of Data Science course.

## University of Virginia Model of Data Science

UVA's areas of Data Science model (4+1) was generated by Rafael Alvarado in collaboration with Data Science faculty in 2019 leading up to the official beginning of the School of Data Science in the fall of 2019. The framework is designed to represent areas of focus or areas that should be foundation to all data science curriculum. These include Value, Design, Systems, and Analytics. These areas are umbrella concepts that could and should encompass a variety of more specific learning outcomes dependent on context. However, implicit in the structure is that an effort to balance the curricular content across the four areas is critical, as each contains necessary aspects for becoming a successful data scientist. We see the movement toward this structure as a natural evolution of the field away from being viewed as subsets of Computer Science and Statistics/Mathematics (Figure 3 - left) to a new independent field with both cultural and intellectual uniqueness. Figure 3 (right) represents the four areas with practice being the use of these skills inside a specific area of expertise or project [1].



FIGURE 3: Two Visual Representation of Data Science

Value represents the human aspects of Data Science and inherits methods and practices from the field of ethics, but considers data oriented business practices. Cultural movements that fall into this area are widely supported across the Data Science ecosystem such as "Data for Good" or "Data and Society". Initiatives focus on "Open Data" and transparency are additional examples that would align with the overarching concept of ethical data use..

Design encompasses the creative aspects of Data Science and how we interact with data products and communicate results. Data visualization and storytelling are cornerstones along with aspects of Human Centered Design or Human Computer Interaction. The importance of this area is often understated. However, in conversations with industry and working data scientists the importance of being able to effectively communicate and show data science products is consistently mentioned as critical for success.

Systems represent the necessary tools for storing, organization, moving and processing data. Core to this area is how we represent data in databases and the tools we use to build, train and deploy algorithms. This area is closest to the field of engineering in the sense that it represents all technological infrastructure necessary for data driven products to become a reality.

Analytics represents the mathematical aspects of the field. This can come in the form of traditional statistics methods, foundation applied mathematical concepts along AI and machine learning. Correlated fields such as information theory or operations research have also contributed heavily to this area.

Practice is the connective tissue holding all the areas together. It represents the life cycle in which all the components interact to form a comprehensive data driven project. Practice also includes subject area expertise that is critical to effectively solving most, if not all, data science problems [1].

# THE BACHELOR'S OF SCIENCE CURRICULUM AT UVA (BSDS)

## Overview

On September 19th 2023 the State Council of Higher Education in Virginia (SCHEV) approved a bachelor's degree in Data Science at the University of Virginia (BSDS) [7]. The cornerstone of this degree is a novel curriculum based on the model of Data Science developed by Professor Rafael Alvarado which was outlined in the previous section. In this section we will describe the key features of this curriculum and how it brings the model of Data Science to life at the Undergraduate level.

At the University of Virginia the BSDS program resides within the School of Data Science (UVADS). During their first year the students take the two prerequisite courses for admission to the major program and apply over the summer. Those courses include DS 1001, which focuses on Foundational concepts and is unique among colleges globally, and DS 1002, which focuses on the use of computers in data science – specifically programming. The DS 1001 course is the subject of extended discussion further on in this paper.

Once admitted into the major program the students pursue a core course of study consisting of 40 credits spread across two courses each in the main areas of Data Science (Design, Value, Systems, Analytics). The core also includes a specialized mathematics series that are tailored to the needs of the program. In addition to the core courses students select one or two

concentrations populated with elective courses. The concentrations come in two general forms, a further exploration of one of the areas (e.g. a concentration in analytics would go further into machine learning) or an academic area outside of the school in partnership with another department (e.g. Astronomy, Physics, or Digital Humanities) [8]. One particular course to note is DS 4022, named "Final Project". In this course students will synthesize what they have learned over the entire curriculum. This course is also larger than just the semester in which it is taken. The students will be thinking about how they can use that time all along the way. They will then be given great agency to explore and build a data science project, which for some, will lead to future career opportunites [9].

Year 1 Semester 1 (Fall)	Year 1 Semester 2 (Spring)	Year 2 Semester 3 (Fall)	Year 2 Semester 4 (Spring)	Year 3 Semester 5 (Fall)	Year 3 Semester 6 (Spring)	Year 4 Semester 7 (Fall)	Year 4 Semester 8 (Spring)
DS 1001 Foundations of Data Science	DS 1002 Programming for Data Science	DS 2002 (Systems 1) Introduction to Computing DS 2026 Computational Probability MATH 1190/1210/1310 Calculus 1	DS 2023 (Design 1) Communicating with Data DS 2024 (Value 1) Ethics & Policy in Data Science DS 3025 Mathematics of Data Science	DS 3021 (Analytics 1) Machine Learning 1, Foundational Concepts DS 3022 (Systems 2) Cloud Architecture & Sustainable Pipelines Pipelines	DS 4021 (Analytics 2) Machine Learning DS 4023 (Design 2) Interactive Applications & Dashboards Concentration Course Elective	DS 3026 Principles of Inference & Prediction DS 4024 (Value II) Data Ethics Concentration Course Elective	DS 4022 Final Project
Recognize		Under	rstand	Ар	ply	Cre	eate
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FIGURE 4: Sample course of study for a student enrolled in the BSDS program. The first year, before the student is admitted to the School of Data Science BSDS Major Program, is indicated in blue in the first two columns, and contains the two prerequisite courses. The middle band of 13 courses covered over the 2nd, 3rd, and 4th years are the core curriculum. The final band of three courses shows the requirement for fulfilling one concentration.

Leadership and Teamwork

In the rapidly evolving field of Data Science, leadership and teamwork play pivotal roles in driving innovation, fostering collaboration, and ensuring the effective utilization of data-driven insights. Data Science projects inherently involve cross-functional teams with diverse skills ranging from machine learning to domain expertise and engineering. A thoughtful leader is essential to provide a clear vision, set strategic objectives and for navigating ethical considerations and ensuring compliance with data privacy regulations.

As a result, team based learning is ubiquitous in the program with the majority of classes requiring students to work together and lead projects as core assessments. The completion of a Service Learning project is also a requirement for graduates. This can include tutoring new students, serving as a TA, or actively participating in the various community learning activities in the Charlottesville area. The common thread is that this is a new field that is growing quickly and we all need to work together to shape the present and the future of Data Science for the better.

## After Graduation

Previously we discussed that most Data Science courses at the undergraduate level are really Computer Science or Statistics courses with a Data Science title. When we discuss the advantage that our graduate will have we focus directly on that fact. In this curriculum there are elements critical to succeeding in Data Science work that are not addressed in those other curricula. The core feature is the fundamental acknowledgement that humans are the beginning and the end of every Data Science endeavor. There is always a person who sets the goals at the start, there is always a person conducting the work along the way, and there is always a person who is impacted by the results of the project. As more and more advances are made in AI the value of the college education will shift more and more towards the graduates ability to make the deliverables fit into the human world.

In particular we highlight the lessons in leadership and teamwork. Those themes run across all human endeavors and have specific nuances which must be mastered for every specific field. Data Science is no exception and our curriculum addresses this directly in the Design and Value components.

Another critical component is the understanding of the principles of an Established Data Set. That is to say a Data Set which will stand the test of time. Concepts like provenance and licensing, as well as data management and ethical impact are explicitly taught and practiced throughout this curriculum.

The final critical differentiator for our graduates is their ability to communicate their results to other humans. Most programs do not teach data presentation and in many places it is pejoratively called a "soft-skill". This curriculum rejects that premise and through the Design courses students are explicitly trained in the skills required to present work with a foundation in data analysis.

## **DS 1001 Foundations of Data Science**

The Foundations of Data Science course sets the table for the next three years by presenting the field through UVA's easily consumable and understood model. The end result is that students understand potential pathways for study and more importantly can envision themselves walking these pathways through the curriculum and eventually out into the world. This is accomplished through the inclusion of guest lectures, both in and out of academia, applied weekly labs and

more traditional lecture sessions. The combination of these three main pedological components provides students with an understanding of the current state of the field and an initial understanding of the depth of each of the four areas. The calendar of the course is such that each area represents a fourth of the class, which is also how the core classes of the major are divided. This sends a clear message that data ethics and data communications are equally valued alongside analytics or systems. This equal balancing creates a wider spectrum of potential interests students can pursue and consequently a wider spectrum of students that will pursue the field, which is one of the main objectives of the course.

It is our hope that the structure of the class will be used as a model on other campuses to consider when creating "Introductory" type classes. The approach could also be pushed down into the K-12 school system, as the topics and concepts being presented do not assume prior knowledge of the field. The course also uses a series of purposeful and contemporary design approaches, which are detailed below.

## **Pedagogical Techniques**

In the following subsections we will describe several pedagogical techniques that are incorporated into DS 1001, indicating why they were selected, and sharing details of their implementation. The techniques we have chosen to highlight here are not an exhaustive list but rather most critical for the success of the students in the class. At the highest level each was chosen to help us achieve the prime directive of our course design, "any student can enroll and excel". The techniques detailed here are Specifications Grading, Active Learning in Lectures, Active Learning Labs with gamification, Team Teaching, and Enhanced Student Agency.

# **Specifications Grading**

When constructing this course we needed to select a grading system that fit our design principles. A major component of Data Science work is that you must complete and finish your work for it to have value. If the analytics component is in place it is of no value without the systems solution to deliver it. As a result we selected a grading system that focuses on completion of projects rather than on accumulation of points. The point system, pedagogically referred to as "mean-weighted average", is most commonly used throughout American high school and college but fails to meet the completion needs [10].

The system called specifications grading is designed to foster a spirit of completing projects [11]. The stand out features are single-level rubrics coupled with assignment bundles corresponding to letter grades. In this way every student can select what letter grade they want to earn and pursue the assignments for that bundle. The single-level rubrics also create a dynamic where the vision of the task is clearly laid out for the students. They know precisely what the criteria are for their assessment. This element also ties into the student agency component discussed later.

## **Active Learning Lectures**

The Foundations of Data Science course is a survey course designed for first-year college students. As a result one of the design specifications for the course is a community building

objective, another is introducing students to concepts for the first time. The use of active learning activities like "think-pair-share" are well suited to addressing both of these objectives [12]. The downside of most active learning exercises is that they take more time and more engagement from the instructor. Fortunately neither of this is a problem for this course design. Given the survey and introductory nature of the course there is no objective to "cover" as many topics as possible. Rather the goal is to land a few key questions and ideas at a deep level. This permits ample time. In addition the team teaching nature of the class, elaborated on below, helps to spread the work out and not overburden the instructors.

## Active Learning Labs with Gamification

This course is designed with a lab component. Students enrolled in DS 1001 simultaneously enroll in a lab section. It is fully integrated with the lecture portion of the course and labs are delivered in sequence with the material in the lecture portion of the course. In these lab sections students are given time to explore practical examples of the topics discussed in lecture. A key feature of these labs is the use of gamification.

Many children's games, such as Battleship or Mastermind, are elementary puzzles based directly on principles taught in the lecture portion of the class. When the students play the games with each other in the lab period they naturally ask questions about how the game works and what strategies will be the most successfull. The students are able to explore the topics from class in a self-directed way and find solutions to the puzzles presented by the games by tapping into the knowledge they gained in class [13] [14]. (As a side-note: some distinguish between "gamification" and "game based learning", for our purposes here we use them interchangeably).

# **Team Teaching**

A fundamental principle of Data Science is that it is a "Team Sport". As a result the design of this course was mandated to demonstrate that principle wherever possible. To that end the design and delivery of the course was conducted by a team of instructors in discussion with the wider faculty of the school. During a typical semester the students will interact with: two primary co-instructors, a staff data scientist, the TA for their lab section, four additional professors invited to give guest lectures, and four industry experts invited to give guest lectures. There are several benefits from the team approach. The first is modeling to the students the principles of teamwork in data science. The second is to offer them diverse views and demonstrate that there are many ways to look at an issue. On the backend side the division of labor allows for specialization and reduces the workload on any individual instructor. This allows the instructors to focus on developing individual assignments at a much higher quality than normal. The downside of this approach is the increased time of coordination. This is a real concern and requires the team to function well together.

# **Enhanced Student Agency**

The final design goal that we want to highlight here is the goal of empowering students. The primary mechanism we use is by giving the student agency in the classroom when possible, and at an appropriate level. The most explicit way this is done is by giving the students the choice of

which grade they set as their goal. The requirements for each letter grade are mapped onto a specific bundle of assignments. Traditional classrooms mandate completion of every assignment and produce an aggregate score at the end.

Another key aspect of student agency are the deep dive assignments. The "look ahead" and "case study extension" assignments are designed to be deep dives where a student can fully explore an idea. Over the course four of each type are offered for a total of eight assignments. However the "A" bundle only requires four to be completed. The students can take their own career goals in mind when choosing which assignments to complete. And is this way able to tailor their learning to meet their needs.

# CONCLUSION

The field of Data Science has rapidly appeared on university campuses nationwide and is a remarkably young academic field, by some measures only a decade or so old. The next iteration will be the creation of undergraduate programs at likely hundreds of schools across the country, if not the globe, over the next three to five years. The curriculum content of those programs could shape the field for generations, making it imperative that as a community we work together to develop a consensus on what should be first principles for the field. It is in this context that we worked to create the overarching framework (4+1 model), an associated Bachelor of Science curriculum, and a broad introductory course whose goal is to present more accurately the field of Data Science as an independent discipline with unique knowledge and skill requirements. Our hope is that this will trigger a larger conversation, or at a minimum encourage some reflection for those confronted with building or shaping Data Science academic programs.

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What story can you tell from your cell phone apps?: A Data Science Lab Exercise

#### ABSTRACT

In this workshop we will deliver a Lab exercise from our Foundations of Data Science course. What follows is the structure of the 50 minute session we have used in our class and want to bring to a broader audience. They are continuously updated and we will deliver the newest iteration (small changes from what you see here are to be expected). This can be modified to fit different time parameters as the conference requires.

This description begins with the Purpose and Task so that the students/participants know what the goal is and why we are doing this work. Then it proceeds to describe the details of what work to do. The session begins with a short introduction from the instructor and then the bulk of the time is for individuals to work through the materials. The instructors move around the room and answer questions and coach the students/participants.

#### Purpose and Task

**General Description:** This lab is all about collecting personal data and telling a story. The data source will be your cell phone and the story you will tell is about yourself. Along the way you will explore your phone, make visualizations, and turn in a 1-page pdf as your deliverable.

**Why am I doing this?** UVA students use their cell phones all the time. Today you will explore your own cell phone usage with the goal of practicing collecting and visualizing data. You will also think about how to communicate that information to others. This data is personal so you will have to confront emotional reactions and be honest. As well as think about the ramifications of sharing this information. (Don't worry, you are not obligated to share the names of any apps, and you have permission to take whatever steps you deem necessary to protect your privacy). Ultimately our goal is for you to learn something about yourself and practice your data science skills.

- Course Learning Objective Alignment: Observe the world around you and record your observations in a systematic way.
- Course Learning Objective Alignment: Reflect on your data and transform it into a medium for efficient communication to other humans.

What am I going to do? You will use a data collection approach from Georgia Lupi's book "Observe, Collect, Draw!" to understand your cell phone usage. The exercise is explained in the following section and involves noting the purpose and usage rate of every\* app on your phone. You will start by reviewing your apps and thinking about what categories they fall into. Then you will pick 5-10 categories into which you put the apps (e.g. social media, music, stuff my phone came with that I never use but cannot delete, etc.). From there you will visualize your dataset using Lupi's style (about 5-10 apps per category). When choosing the number of categories and apps you will be guided by the story you are trying to tell, include what you need and leave out what you don't. Finally you will compose a short narrative explaining what someone can learn from studying your apps as well as what they cannot.

## Lab Exercise Details

- Open your phone and review your apps. The goal is to gain an understanding of what apps are installed. You use this device everyday but there may be apps you overlook or don't think about often. Pay attention to what you normally don't see.
- Decide on how to categorize your apps. This is an iterative process and you
  may rethink your categories as you go. That is ok. Consider different
  possible ways to group your apps into categories. Pay attention for what
  story emerges and use that to guide your decisions.
- 3. Create your visualization. On the worksheet provided you will see a grid of circles. Now is the time to fill them in using the Lupi style. Here is how it works.
  - 1. Each circle represents one app
  - 2. Use the color to represent the category (assign a color to each category)
  - 3. Use the amount of fill to indicate more app usage
  - 4. Include your category legend on the sheet as well
  - 5. Add annotations: circle apps you cannot live without, add little comments (see example below)
- 4. Data analysis time. Stare at your visualization, what pops out. Take a few minutes. It may seem like a while but this takes time.
- 5. Look at the data on your phone for battery usage and screen time by app. If there is something of note from that comparison fold it into your story.
- 6. Create your deliverable. To complete this assignment you will <u>upload to</u> <u>canvas, a 1-page pdf, single sided</u>.

- 1. Put your name and the assignment at the top along with today's date
- 2. Include the visualization you just made as a figure
- 3. Part I: Write a story that someone could tell by looking at your apps and their usage.
- 4. Part II: Tell an additional story about yourself that **cannot** be told based on the apps in your phone and their usage. Think about what parts of your life connect with your phone and which do not. Put another way, tell us something about yourself that does not live on your phone.

Tip on story writing: You have a constraint of fitting two stories onto one side of a piece of paper. First figure out the core idea/point/message and then think about what are the key elements to tell that story. Be economical. or ... put another way .. Think carefully about what to leave in and what to leave out.

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## EXPLORING A NEW PERSONALITY ASSESSMENT WITH STRATEGIC MANAGEMENT STUDENTS AND TEAMS

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## ABSTRACT

As part of his attempt to measure and optimize everything about his organization, Bridgewater founder Ray Dalio has co-developed a new personality assessment, PrinciplesYou, in collaboration with Wharton Organizational Behavior professor Dr. Adam Grant. This instrument identifies 28 personality archetypes in 10 themes based on a 40minute assessment. Unlike the Myers Briggs Type Indicator, the archetype results (and two runners up) are shared using commonly understood terms such as Commander, Orchestrator, Explorer, Technician, Promoter, and Peacekeeper. The results also describe the most likely archetype in greater detail and tell which types are the least likely fit. Each personalized result includes a breakdown of 12 categories of measures including how you prefer to think, how you engage with others, and how you apply yourself. Students view which archetypes are least like themselves as well. Through this tool, students can learn more about how to articulate their strengths and weaknesses, find ways to complement others on their teams, and explore career paths that best fit their thought processes, interpersonal behaviors, and work habits. Faculty members can utilize this tool to assign students into teams with complementary types that simulate future work teams. The online test is free for individuals. Using it more extensively for collaboration in a work environment requires paid consulting services from their organization.

#### THE BENEFIT OF AN INTERDESCIPLINARY PROJECT DESIGNED TO ENHANCE THE INTEGRATIVE LEARNING OPPORTUNITIES ASSOCITED WITH MBA COURSEWORK

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# ABSTRACT

This pilot study examines the ability of an interdisciplinary group project to develop graduate student's abilities to work successfully in groups and to appreciate the intersection of several different functions of business. The single group project incorporates the desired learning outcomes of three separate courses taught in the same semester for a Master of Business Administration class. A repeated measures survey is analyzed using traditional t-tests to assess student perceptions before the implementation of the interdisciplinary group project and then again after its completion. Results are analyzed and discussed.

## **INTRODUCTION**

An important goal of graduate programs is to equip students with the necessary skills and knowledge to move beyond the classroom setting. More specifically, the expectation of Master of Business Administration (MBA) graduates is that students will be able to progress from the simple retention and organization of knowledge to the much higher-level skills of integration and application in the field of business. More specifically, research suggests that graduate-level learning should move students to the application, interpretation, and/or synthesis of information from disparate contexts and perspectives (Barber, 2012). Further, according to the AAC&U and the Carnegie Foundation's (2004) statement: "Fostering students' abilities to integrate learning -

over time, across courses, and between academic, personal, and community life - is one of the most important goals and challenges of higher education."

But while the MBA is considered by many to be the educational cornerstone for the successful preparation of students' ability to succeed in the business world, there is increasing skepticism that the degree provides graduates with the desired competencies (Tan & Ko, 2019). In a 2009 study, Rubin and Dierdorff found that the competencies that managers considered to be the most critical (decision-making, strategy, innovation, and managing human capital) were not well represented in the core curriculum for most MBA programs. However, more recent studies have suggested that while MBA degrees are still widely criticized, there has been increasing alignment between MBA curriculum and desired management competencies through the implementation of "intercompetency" approaches (Amblee, Ertl, Dhayanithy, 2023).

With the value of an MBA still being questioned, it is imperative that higher education cultivate the skills necessary to help students connect information in an integrative and applicative manner. Further, degree programs must attempt to align curriculum with desired managerial outcomes.

These goals motivated the desired learning outcomes and curriculum design decisions for a new MBA program at Roanoke College. This small liberal arts institution in Virginia created the college's first MBA graduate program in 2023 with an inaugural class of eleven students. Being a new endeavor for the Business Administration and Economics Department, much effort has gone into designing and assessing the program's goals and objectives.

Motivated by an article by Johansen, Scaff, & Hargis (2009) that measured the benefits associated with an interdisciplinary project-based model and an article by Oosthuizen, De Lange, Wilmshurst, & Beatson (2021) that discussed the importance of teamwork for accounting students, a relatively last-minute decision was made by the three instructors for the fall 2023 semester to attempt to enhance students' skillsets in interdisciplinary understanding and human capital management by combining each course's final group project into one combined group project that incorporated the subject matter from all three courses (BUAD 525 – Managerial Accounting, BUAD 533 – Strategic Marketing, and BUAD 560 – Global Investments & Portfolio Management).

The interdisciplinary approach used for the final project uses accounting skills to identify strong companies, finance skills to value the firms for the inclusion of the firm's stock in an equity mutual fund, and marketing skills to sell the fund to the public. This approach served to create a "team" of instructors for the semester-long project, with the goal of an enriched educational experience for the students (Jones, 2010). See Appendix 1 for the complete assignment description.

This pilot study examines the ability of this MBA student cohort to develop their social skills and integrative capabilities as they work together to successfully incorporate the knowledge and learning objectives of three separate business disciplines into a single group project.

# METHODOLOGY

Influenced by the survey design of Johansen, Scaff & Hargis (2009) in a similar assessment of a graduate program, a 10-question survey was developed that attempts to measure student perceptions of group projects and their ability to obtain the desired integrative learning objectives. Student perceptions, concerning their "group satisfaction" as well as their appreciation for the relationships among the disciplines, referred to simply as "subject interaction," are measured both before and after the completion of the interdisciplinary group project. Survey question one could be interpreted to achieve both goals, whereas questions 2, 3, 4, 5 and 7 attempt to assess group satisfaction alone. Questions 6, 8, 9, and 10 attempt to measure the student's appreciation for subject interaction. See Appendix 2 for the full survey.

The goal of the experiment is designed to begin to answer the research question: Does a single group project that attempts to incorporate the desired learning outcomes of several disciplines provide measurable student benefits? But perhaps more specifically: Is the extra communication, coordination, and effort associated with an integrated group project worthwhile from an administrative standpoint?

## Hypothesis 1 – Group Satisfaction

There is a positive change in mean relationships after completion of the project between the attitudes, motivations, and perceived value of the group's interaction.

## Hypothesis 2 – Appreciation for Subject Interaction

There is a positive change in mean relationships after completion of the project between the stated appreciation and understanding of the relationship between the different business functions (in this case, accounting, finance, and marketing).

The survey was administered to the first 2023/24 MBA class at Roanoke College. This test is considered a pilot study due to the small number of eleven students participating in the inaugural class of the college's MBA program. Due to several constraints as well as a desire for anonymity, traditional t-tests are run on the mean survey responses to compare the results for each question before the implementation of the final project, and then again after the conclusion of the final project (but before grades have been distributed). Due to some personal and interpersonal issues, one student did not participate in the project, lowering the number of post-project respondent surveys to ten. Three student groups completed the project (one group of four students, and two groups of three students). All students are graduates of Roanoke College and have taken required business coursework as undergraduates. The sample consists of two female students and nine (eight post-survey) male students.

## RESULTS

Before completing the analysis, response means and standard deviations were calculated on the data results. The means and standard deviations for the results of the pretest and posttest questionnaires are exhibited in Table 1 and 2, respectively. Table 3 calculates the increase in means responses in the posttest from the pretest.

Question	Mean Result	Standard Deviation
Q1 – Both	4.64	0.50
Q2 – Group Satisfaction	3.55	0.52
Q3 – Group Satisfaction	3.55	1.04
Q4 – Group Satisfaction	4.36	0.67
Q5 – Group Satisfaction	3.82	0.87
Q6 – Subject Interaction	4.09	0.70
Q7 – Group Satisfaction	4.36	0.81
Q8 – Subject Interaction	4.09	0.70
Q9 – Subject Interaction	4.18	0.75
Q10 – Subject Interaction	4.45	0.69

Table 1 – Descriptive Statistics of the Pre-test Questionnaire (N = 11)

Table 2 – Descriptive Statistics of the Post-test Questionnaire (N = 10)

Question	Mean Result	Standard Deviation
Q1 – Both	4.50	.53
Q2 – Group Satisfaction	4.20	0.79
Q3 – Group Satisfaction	4.30	0.82
Q4 – Group Satisfaction	4.50	0.71
Q5 – Group Satisfaction	3.70	1.06
Q6 – Subject Interaction	4.40	0.70
Q7 – Group Satisfaction	4.60	0.70
Q8 – Subject Interaction	4.10	1.10
Q9 – Subject Interaction	4.20	0.92
Q10 – Subject Interaction	4.60	0.70

 Table 3 – Mean Difference (Post-test – Pre-test)

Question	Post-Mean	Pre-Mean	Difference
Q1 – Both	4.50	4.64	-0.14
Q2 – Group Satisfaction	4.20	3.55	0.65
Q3 – Group Satisfaction	4.30	3.55	0.75
Q4 – Group Satisfaction	4.50	4.36	0.14
Q5 – Group Satisfaction	3.70	3.82	-0.12
Q6 – Subject Interaction	4.40	4.09	0.31
Q7 – Group Satisfaction	4.60	4.36	0.24
Q8 – Subject Interaction	4.10	4.09	0.01
Q9 – Subject Interaction	4.20	4.18	0.02
Q10 – Subject Interaction	4.60	4.45	0.15

After calculating the descriptive statistics, a traditional t-test was run on the responses to determine if any differences could be considered significant. The results for the t-test can be found in Table 4. Significant findings are highlighted. For the full analysis, see Appendix 3.

Question	t Stat	<b>P-Value</b>	P-Value	
		<b>One-Tail</b>	Two-Tail	
Q1 – Both	0.606	0.276	0.552	
Q2 – Group Satisfaction	-2.26	0.018*	0.036*	
Q3 – Group Satisfaction	-1.84	0.041*	0.082	
Q4 – Group Satisfaction	-0.452	0.328	0.656	
Q5 – Group Satisfaction	0.280	0.391	0.783	
Q6 – Subject Interaction	-1.01	0.162	0.325	
Q7 – Group Satisfaction	-0.713	0.242	0.485	
Q8 – Subject Interaction	-0.023	0.491	0.982	
Q9 – Subject Interaction	-0.050	0.480	0.961	
Q10 – Subject Interaction	-0.480	0.319	0.636	

Table 4 – Summary of t-Test Results (.05 level of significance)

In this small pilot study, the strong majority of the results measuring the responses from students were not statistically significant. However, two questions that related to the nature of groupwork are worth noting.

The pre and post responses for Question Two suggest that after completing the comprehensive final project, the students felt that they learned more from groupwork than by working alone. In addition, results also suggest that after completing the final project, the students felt that they worked harder on group assignments than when working alone (suggested by the significant one-tailed test result of Question Three).

#### CONCLUSION

Given the extremely small sample size of this pilot study, it is somewhat surprising that any results were found to be significant. Even so, the study's other limitations (that include the untested survey design) would suggest that any significant findings are, at best, questionable. However, several aspects of the study are reassuring. The first notable aspect of the students' responses is the relatively high scores provided, both before and after the interdisciplinary group project. In fact, a possible explanation for the lack of a significant difference related to any of the "subject interaction" questions is due to the fact that the students already feel as if they understand and appreciate the interaction associated with the different functions of business (that they learned as undergraduates of the college). The second notable aspect of the experiment is the fact that (with limited exceptions) mean scores did increase from the pretest to the posttest. Even if those findings fail to be statistically significant, it is a reassuring sign that the effort that was put into the interdisciplinary project was not unwarranted. And finally, the significantly higher scores for the group satisfaction question(s) are encouraging, especially given the fact that these students all just completed a particularly-challenging comprehensive group project in their capstone undergraduate coursework.

Being a first attempt at an interdisciplinary project by all three course instructors, there are obviously improvements that can be implemented going forward. Several project weaknesses were evident in the students' work and presentations. However, the overall success of the project deliverables along with the promising results of the survey responses suggest that the effort may be worthwhile.

Adding value to an MBA program can take on many forms. It can be a result of the credential itself, the knowledge and skills gained, an increased level of self-confidence, and the networking opportunities cultivated (Florence, 2009). While the coordination and communication required to implement an interdisciplinary project is challenging, the contribution may be worthwhile.

## **APPENDIX 1**

## **Description of Interdisciplinary Group Project**

Your semester's final project will be a single, combined group effort that encompasses the topic material and knowledge gains of all three semester's courses: BUAD 525 – Managerial Accounting, BUAD 533 - Strategic Marketing, BUAD 560 – Global Investing. For this semester's project, your group will create and market a mutual fund.

#### **General Context and Overview**

Your group has been tasked by RC Investment Company (registered as an Investment Advisor with the SEC) to create a new equity mutual fund. The firm currently has \$10 million dollars of investor capital that must be soon re-allocated into the fund. While your group has significant flexibility in the fund's creation, there are certain criteria that RC Investment Company requires:

- 1. The fund must include one stock from each sector of the S&P (for a total of eleven stocks)
- 2. Any stocks selected for your portfolio must have at least 5-years' data. The basis for a stock's inclusion into the fund will be a comprehensive fundamental analysis on the firm's financial statements
- 3. Decide if your fund is a growth fund (focus on earnings) or a value fund (focus on price)
- 4. The fund must be considered a "global" fund to include a minimum of three non-US equities
- 5. Portfolio performance data must be calculated and provided
- 6. Decide if your fund will be a low-cost fund, or an actively-managed fund.
- 7. Provide recommendations for the marketing strategy for the fund

Once your analysis is complete, you will present your analysis, findings, and recommendations to RC Investment Company's board as both a written document and as an oral presentation.

#### What to include from BUAD 525

The selection of securities that are to be included in your fund will be based on fundamental analysis. You will identify one stock for inclusion into the fund from each of the sectors of the global economy. These sectors include:

Communication Services Consumer Discretionary Consumer Staples Energy Financials Healthcare Industrials Information Technology Materials Real Estate Utilities

Other-things-equal, you will want to include the stock of only the best firms. In choosing the stock for each sector, you may perform any initial screening methodology you desire (reputation, analyst reports, reviews, etc.); however, you must perform a full analysis on at least two stocks (for each sector) in order to demonstrate the superior choice for inclusion into the fund. At least three firms must be non-US companies.

A full fundamental analysis includes:

- 1. An overview of the company that includes a brief description of its products and/or services. Discuss any recent events or trends that may be relevant to your decision. Be sure to define the stock's sector for the purposes of your analysis (some stocks may fit into more than one sector but may only be included once in the fund).
- 2. Using the most recent data (10-Q, 10-K, Annual Reports), provide an analysis of the company's financial statements for a minimum of the most recent three years of available data. Common-size the income statement and balance sheet. Use the common-sized statements to point out any potential red flags with the firm's management or performance. Compute the following ratio calculations and provide a brief description of the ratio findings.

Profit margins, Return on equity, Debt-to-equity, Interest coverage, Accounts receivable turnover, Inventory turnover, Current ratio, Quick ratio.

Compare the ratios over the three-year period. Look for trends. Compare the ratios (and trends) for each firm. Discuss. Identify the company with the stronger financials.

In order to complete this project, you will need access to a finance-related website (like Yahoo Finance and/or MSN Money) to obtain the most recent end-of-year financial statements for your selected companies.

## What to include from BUAD 560

1. Once you have identified the best relative company of each pair, you now need to identify the best stock. Choose at least one relative valuation method (P/E, PEG, etc.) and at least one absolute valuation method (DDM, DCF) and calculate the results for both firms (for a total of twenty-two calculations).

- 2. Once you have the results of your ratio calculations and your valuation calculations, you must choose which of the two stocks you will include in your fund (you may choose a growth strategy, or a value strategy). Discuss your reasoning.
- 3. Now that your stock choices have been finalized, calculate the 1-year, 3-year, and 5-year returns for each stock that will make up your portfolio. Research the beta of your stocks using online resources.
- 4. Allocate the \$10 million investment to your eleven securities to create your mutual fund portfolio. Calculate your portfolio's 1-year, 3-year, and 5-year expected returns and beta.
- 5. Compute the Treynor ratio and Jensen's alpha (use 5-year Treasuries as your risk-free rate) for your portfolio. For Jensen's alpha, you will need to calculate the expected return for your fund's benchmark, the MSCI World Index (use XWD to calculate the 5-year return only). Show your work and discuss your findings.
- 6. Decide if your fund will be managed as a low-cost fund or an actively-managed fund. If you choose to manage your fund as a low-cost fund, your annual expense ratio will only be 0.1%; however, you are limited to a constant-weighting asset allocation strategy (for discussion in your fund's marketing). If you choose to actively manage the fund, your annual expense ratio will be 1.1% per year, but you may utilize a tactical asset allocation and/or smart beta strategy (for discussion in your fund's marketing).

## What to include from BUAD 533

- 1. As an assumption, the fund is strictly a proprietary product of RC Investment Company, as such it is only sold through RC Investment Company's website/app and from RC financial advisors.
- 2. Based upon your fund management choice (e.g., low-cost fund or actively managed fund), define your target market for the fund. Be specific. At a minimum, describe the target market by variables associated with behavioral, demographic, and psychographic segmentation. You may wish to break down your target market into your primary and secondary target markets. What is the size of your target market?
- 3. What are your market share projections? What percentage of your target market might invest in the fund in the first year? Discuss the diffusion rate and estimate the growth rate of your sales (year by year).
- 4. What types of advertising and promotions do you recommend? Base your marketing program decisions on your earlier decision to utilize a low-cost or differentiated fund management style. Discuss why your target market will be influenced by your decisions and channels.

5. Research and list current competitors/substitutes. What funds currently provide similar functions and strategies. Create a competitive grid.

## **Deliverables and grading**

The total percentage value of your final project may not be the same for all three courses. Please see the syllabus for each course for more information on the value of the project as it relates to each specific course.

## Written deliverable

Your group will need to create three bound, professional-looking copies of your work (one for each of your professors). Include any/all charts, graphs, and supporting information you deem relevant. Your write-up should incorporate an overview of the project and the requirements listed above. In addition, your write-up should contain the details on your calculations and assumptions. Your course instructors will primarily be grading you on your use of content; however, your instructors will also consider your design (organization), the mechanics, and spelling/grammar. Professionalism counts! Your write-up needs to be as many pages as you deem necessary – there is no minimum or maximum. In order to avoid a late penalty, your professors must have your completed document at least 24-hours before your presentation. Unless there is an extreme and verified reason (as assessed by your course instructors), late papers will receive an immediate 10-point deduction. Papers will not be accepted 24-hours after the scheduled presentation and will receive a zero. Your written deliverable will represent 70% of your project grade.

## Presentation

In addition to the written deliverable, your group will also need to present your findings to your professors. Your group's presentation will be scheduled during an open block of time (TBA) at the end of the semester. In addition to your presentation's content, your instructors will also be grading your presentation style. Your presentation will represent 30% of your project grade.

It may be best to think of your presentation as if you are pitching your idea for the fund to the investment company executive team. Your instructors encourage and strongly value creative and interesting presentations. Be prepared to answer questions after your presentation.

## **Presentation guidelines:**

- Timed to approximately 30 minutes (*no less than 25, and no longer than 35*)
- Structure the presentation as if you are trying to sell your idea
- Everyone in the group must present (*aim for everyone to speak roughly the same amount*)
- Informally cite your work in the presentation and as you present

## **Considerations for presentation grading:**

- Does the presentation have sufficient detail?
- Have you practiced sufficiently to be confident in your presentation?
- Is your voice clear with accurate pronunciations?
- Do you seem interested in your topic?
- Did you dress appropriately? This is a professional presentation.
- Is your presentation designed logically?
- Does your presentation have typos?
- Are your slides easy to read?
- Are your visual aids appropriate, interesting, and meaningful?

There will be no late or make-up presentations with the exception of an extreme and verifiable emergency situation that impacts multiple members of the group. If any member of your group becomes ill, the remainder of the team is still responsible for completing the group presentation on time. If an ill member must miss the presentation, another teammate must step up and fill the void. Keep this in mind as you develop your presentation. It is not enough to only know "your part" – you must know "everyone's part". However, there is no make-up policy or direct grading penalty if an individual misses a presentation as long as the assignment is still presented by the remainder of the group.

# **APPENDIX 2**

## **Survey Instrument**

The following survey will be administered (pre-post) using a 5-point scale that is designed to assess the students' attitudes regarding their group interactions and the interdisciplinary nature (related to the learning outcomes of the three separate courses) of the assignment.

- 1. Creative thinking about a particular goal is important to achieving the best solution to the goal.
- 2. I learn more working in a group on assignments than I do working alone on assignments.
- 3. I work harder on an assignment when working in a group than when working alone
- 4. I enjoy and appreciate the interaction I have with group members when doing a group project.
- 5. In general, I prefer group projects to individual assignments.
- 6. Combining disciplines in a group project is a helpful way to integrate my knowledge.
- 7. After the completion of a group project, I feel more confident about my ability.
- 8. My training in group projects has helped me to think about new ideas/opportunities.
- 9. My training in group projects has helped me to be more confident about my ability to integrate all of my knowledge.
- 10. I see how all of the different functions of business fit together.

All the questions above employed a five-point Likert scale where:

- 5 = Strongly Agree 4 = Agree 3 = Neither Agree nor Disagree
- 2 = Disagree
- 1 = Strongly Disagree

#### **APPENDIX 3**

#### **Full Statistical Analysis**

	Pre-1	Post-1
Mean	4.636363636	4.5
Variance	0.254545455	0.277778
Observations	11	10
Pooled Variance	0.265550239	
Hypothesized Mean Difference	0	
df	19	
t Stat	0.605636332	
P(T<=t) one-tail	0.275961492	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.551922984	
t Critical two-tail	2.093024054	

	Pre-2	Post-2
Mean	3.545454545	4.2
Variance	0.272727273	0.622222
Observations	11	10
Pooled Variance	0.438277512	
Hypothesized Mean Difference	0	
df	19	
t Stat	-2.262829921	
P(T<=t) one-tail	0.017776401	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.035552803	

t Critical two-tail	2.093024054	

	Pre-3	Post-3
Mean	3.545454545	4.3
Variance	1.072727273	0.677778
Observations	11	10
Pooled Variance	0.885645933	
Hypothesized Mean Difference	0	
df	19	
t Stat	-1.835025214	
P(T<=t) one-tail	0.041103927	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.082207855	
t Critical two-tail	2.093024054	

	Pre-4	Post-4
Mean	4.363636364	4.5
Variance	0.454545455	0.5
Observations	11	10
Pooled Variance	0.476076555	
Hypothesized Mean Difference	0	
df	19	
t Stat	-0.452321126	
P(T<=t) one-tail	0.328079742	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.656159484	
t Critical two-tail	2.093024054	

	Pre-5	Post-5
Mean	3.818181818	3.7
Variance	0.763636364	1.122222
Observations	11	10
Pooled Variance	0.933492823	
Hypothesized Mean Difference	0	
df	19	
t Stat	0.279950902	
P(T<=t) one-tail	0.391270142	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.782540284	
t Critical two-tail	2.093024054	

	Pre-6	Post-6
Mean	4.090909091	4.4
Variance	0.490909091	0.488889
Observations	11	10
Pooled Variance	0.489952153	
Hypothesized Mean Difference	0	
df	19	
t Stat	-1.010639089	
P(T<=t) one-tail	0.162443672	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.324887344	
t Critical two-tail	2.093024054	

	Pre-7	Post-7
Mean	4.363636364	4.6
Variance	0.654545455	0.488889
Observations	11	10
Pooled Variance	0.576076555	
Hypothesized Mean Difference	0	
df	19	
t Stat	-0.71273364	
P(T<=t) one-tail	0.242336279	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.484672557	
t Critical two-tail	2.093024054	

	Pre-8	Post-8
Mean	4.090909091	4.1
Variance	0.490909091	1.211111
Observations	11	10
Pooled Variance	0.832057416	
Hypothesized Mean Difference	0	
df	19	
t Stat	-0.022809584	
P(T<=t) one-tail	0.491020007	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.982040013	
t Critical two-tail	2.093024054	

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	Pre-9	Post-9
Mean	4.181818182	4.2
Variance	0.563636364	0.844444
Observations	11	10
Pooled Variance	0.696650718	
Hypothesized Mean Difference	0	
df	19	
t Stat	-0.049855889	
P(T<=t) one-tail	0.480378807	
t Critical one-tail	1.729132812	
P(T<=t) two-tail	0.960757614	
t Critical two-tail	2.093024054	

Pre-10	Post-10
4.454545455	4.6
0.472727273	0.488889
11	10
0.480382775	
0	
19	
-0.480308508	
0.318245792	
1.729132812	
0.636491583	
2.093024054	
	Pre-10      4.454545455      0.472727273      11      0.480382775      0      19      -0.480308508      0.318245792      1.729132812      0.636491583      2.093024054

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#### STUDENT PERCEPTIONS GOING INTO AN UNDERGRADUATE BUSINESS ANALYTICS COURSE

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#### ABSTRACT

The purpose of this study was to examine perceptions of students coming into an undergraduate business course in management science. As educators, we know the rising importance of analytics in business, and the need for skilled employees in roles related to data analytics. Thus, we want to help students not only be successful in these classes, but to also have positive experiences in them. We developed a survey to measure various components of students' perceptions *going into* this course and used factor analysis to obtain overall findings on factors such as stress and anxiety levels, usefulness, self-efficacy, difficulty level, time commitment, and prior knowledge. We also examined the impact of demographic factors such as ethnicity, gender, and major on student perceptions going into the class. The descriptive results of the survey help us understand the gaps in the effectiveness of our instruction and lay groundwork for future research in how to improve students' experiences in undergraduate business analytics courses.

# NO MORE BORING CLASSES: ACTIVE LEARNING FOR THE OPERATIONS MANAGEMENT CLASSROOM

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#### ABSTRACT

Teaching Operations Management does not have to be boring for the instructor or for the student. Dr. Jones will share several active learning activities he has developed specifically for teaching Operations Management - and participants will experience one of those activities themselves! Dr. Jones has been teaching at the college level for over a decade and has taught Operations Management for the past several years; before that, he was an operations manager! These activities have been tested by students within a real classroom setting and have proved effective for engaging students' interest by requiring students to simultaneously use their cognitive, sensing, and psychomotor skills. Dr. Jones will explain the theory and share research related to active and experiential learning to support the instructor's use of such exercises.

# A CONCEPTUAL FRAMEWORK FOR ANALYSIS OF THE STUDENT-BASED BINDING CONSTRAINTS ON THE TIME-TO-DEGREE IN STATE-FUNDED TEACHING-FOCUSED BUSINESS SCHOOLS.

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#### ABSTRACT

Most AACSB-accredited business schools in the U.S. have classified Master or Bachelor levels. These universities are teaching-focused and serve a nontraditional, first-generation diverse population, with a significant coefficient of variations in skills, knowledge, and abilities, who also work 20-60 hours a week and often have added family responsibilities not found in traditional 18–22-year-old students residing on campus. With these added demands on their time, these students may dedicate less time to academic studies. These nontraditional students may need more teaching assistance, burdening the state-funded teaching-focused business schools (SFTFBSs) with low funding levels, relying more on lower tuition fees, less or little endowments, and less grant funding. Unfortunately, the academic success of these nontraditional student groups is disappointing. Time-to-degree is prolonged, and grade-point-averages are marginal. While administration and faculty strive to improve the situation, success is impossible without students' concentration.

Using existing literature and data from a prototype SFTFBS, this study builds a conceptual model introducing student presence as the binding constraint in achieving reasonable grade-point-averages, time-to-degree, and graduation rates. Student presence is defined as a four-dimensional space of (i) physical presence, (ii) mental presence, (iii) collaborative presence, and (iv) emotional presence. Physical presence is the ratio of the hours a student allocates to his/her education to the unit load in a semester. Mental presence is the focus, concentration, and intellectual engagement level during physical presence. Collaborative presence is the availability and willingness of the students to teamwork, forming clusters of teams not only for a course or a semester but to extend these networks to the following semesters and professional careers. It also defines the willingness and collaboration of students and instructors in linking the teaching material to real-life applications. Emotional presence is the distance from depression and anxiety. The conceptual framework supports students, faculty, and institutions to improve academic success as measured by grade point average, time-to-degree, graduation rate, and life-long re-invention capabilities.

#### Meditating Influence of General Process Management Competency on the relationship between Task Inattentiveness and Role Stress for Undergraduate Business Students

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## ABSTRACT

**Purpose** – This research study extends both student role stress and attention deficit research by examining the mediating influence of general process management competency (GPMC) on the relationship between task inattentiveness (TIA) and role stress (RS) among undergraduate business students at a public university. Attention deficit executive cognitive challenges with timing and sequencing suggests a constraining impact on general process management competency which has not been examined within the public undergraduate student population. **Design/methodology/approach** – 254 business management undergraduate students completed self-assessment measures of TIA and RS, and a close associate completed an observer version of the GPMC scale. Product moment correlations were used to examine the hypothesized relationships between RS and both TIA and GPMC, and both the Hayes process and the Sobel test was used to test the hypothesis that GPMC mediates the relationship between TIA and RS. **Findings** – RS was significantly correlated with GPMC (r = -0.44, p < 0.01). Both the Hayes process and Sobel test (Z = 4.48, p < 0.00) confirmed that GPMC partially mediates the relationship between TIA and RS.

**Practical implications** – Undergraduate educators need to be aware of the influence of task attentiveness and general process management competency on role stress. Teaching strategies and support resources that promote task attentiveness and process management competency in an integrated manner may help to lower role stress and address some of the consequences of high role stress, including program incompletion.

**Originality/value** – This study extends research on the relationship between attention deficit challenges among higher education management students and role stress by identifying the partial mediating influence of general process management competency. This expands the understanding and portfolio of intervention points that may help to reduce student role stress and some of the related consequences like program incompletion.

#### **INTRODUCTION**

High levels of stress are both prevalent and negatively associated with health and academic performance among university students (Alhamed, 2023; Allen et al., 2020; Akram et al., 2023; Al-Shahrani et al., 2023; Feussner et al., 2022; Jenkins, Weeks & Hard, 2021; Kotter et al., 2017;

Pereira et al., 2018; Richardson, Abraham & Bond, 2012). The general model of individual performance (McShane & Glinow, 2017) identifies motivation and competency as key determinants moderated by a variety of variables including role perceptions (Campbell, Hanson & Oppler, 2001; Kahn et al., 1964; Kumar & Meena, 2021; Rotshtein et al., 2015). Role perceptions are delineated into perceptions about the clarity, compatibility, and workload of role requirements (Coetzer, 2022; Scheib, 2003; Siegal, 2000; Taft, 2023). Role related stress is associated with high levels of role ambiguity (confusion), role conflict (incompatibility between role requirements) and role overload (Coetzer, No & Omonuk, 2023; Rizzo, House & Lirtzman, 1970; Taft, 2023), which in accordance with the general adaptation syndrome and stress model (Selye, 1976), may lead to exhaustion and a reduction in health and performance (Anikhovskaya et al, 2015; Das, Jaya & Binoy, 2022;).

The general role stress hypothesis within higher education suggests that students must often manage new, complex, ambiguous, and continually evolving role related information (Coetzer, No & Omonuk, 2023). They must also integrate expanding role requirements and manage high workloads (including non-academic commitments) and address a variety of conflicting role demands (e.g. developing a course schedule that meets both academic, nonacademic, work and personal role requirements), all of which increases the likelihood of role stress (Coetzer, No & Omonuk, 2022; Coetzer & Richmond, 2009; Coetzer, Hanson & Trimble, 2009). Research on student stress has identified a variety of situational, personal, and interactional determinants (Cheema et al., 2022; Lazarevic & Bentz, 2021; Yu, Joh & Woo, 2022), including the personal contributor of adult attention deficit (Sahmurova et al., 2022; Hamilton, Baraldi & Kennison, 2021). Research conducted by Coetzer (2016, 2009) confirmed that organizing capabilities like time management and the use of personal task management systems partially mediated the relationship between adult attention deficit and role stress. This provided further support for Barkley's Unifying Theory of Adult Attention Deficit Disorder (Barkley, 1997) which suggests that impairments in executive cognitive functioning undermines the ability to develop and maintain an organized approach to managing complex tasks and situations.

Ongoing research on the executive functioning deficits proposed by Barkley's Unifying Theory (Barkley, 1997) suggests that persistent difficulties in managing the timing and sequencing of task components is a key contributor to task organization and execution difficulties (Barkley et al., 2001; Barkley & Fischer, 2019; Fossum et al., 2021; Houghton et al., 2004). This suggests that process mapping and management competencies that rely on accurate timing and sequencing capabilities to support the execution of complex and challenging role requirements, may be an important mediator and point of intervention within the adult attention deficit-role stress relationship. This research study examines the meditating influence of general process management competency on the relationship between attention deficit and role stress among higher education students, and identifies a potentially new point of intervention. A review of multiple popular research databases revealed no research studies that examined this mediating relationship.

# LITERATURE REVIEW

#### **Roles Stress (RS)**

Role stress is defined as "a perception of a role indicated by ambiguity, conflict and overload arising from both the characteristics of the individual and the work environment" (Tetrick, 1992, p. 136). Role ambiguity occurs when a person is not sure what their role requires and/or how to

do it, whereas role conflict occurs when the performance requirements of a role are not compatible (Taft, 2023). Role overload results from having too many things to do within a given period of time (Huo & Jiang, 2023).

Moderate levels of stress referred to as eustress is thought to encourage performance whereas high levels of stress referred to as distress is disruptive (Selye, 1976; Shen et al., 2020). Research has distinguished between challenge stressors that facilitate goal achievement and personal growth, and hindrance stressors that threaten goal achievement (Azeem et al., 2023; Cavanaugh et al., 2000). Challenge stressors include workload, time pressure and responsibility that evokes a sense of challenge and increases the perceived rewards of mastery which enhances motivation and ultimately performance (LePine et al., 2004, 2005, Moin et al, 2023). Research suggests that challenge stressors contribute to constructive attitudes and behaviors like satisfaction, commitment, and efficacy (Sawhney & Michel, 2022; Webster et al., 2011). Hindrance stressors include role ambiguity, role conflict and organizational politics, which are typically experienced as situational constraints that are difficult to address with reasonable effort, resulting in constrained motivation and performance (Moin et al., 2023; Podsakoff et al., 2007; Webster et al., 2011). Role ambiguity and conflict contribute to adverse role stress whereas workload may be a constructive stressor until stress levels exceed the coping skills and resources available to the individual (Jiandong, Fan & Haitian, 2022; Newton and Teo, 2014)

The detrimental impact of high role stress on individual health and performance, including academic performance, has been confirmed by numerous research studies (Alhamed, 2023; Jenkins, Weeks & Hard, 2021; Kotter et al., 2017; Klussman et al., 2021; Lindegård et al., 2014; Oldenburg et al., 2014; Ortqvist & Wincent, 2006). Student role stress is receiving more attention due to a proposed link with retention rates at technical colleges and public universities (Krause, 2018). Research on the determinants of role stress has confirmed that personal attributes influence both role perception and personal ability to manage role stress which influences performance (Crum et al., 2013, 2017; Klussman et al., 2021; Connor-Smith and Flachsbart, 2007; Harzer and Ruch, 2015). Although research has confirmed the influence of personal factors on role stress, much of the approach toward managing high student role stress and related consequences, appears oriented toward managing situational elements like attendance incentives and advising systems (Allen et al, 2020; Shoewu & Idowu, 2012).

Multiple research studies have confirmed that adult attention deficit is a personal factor that contributes toward role stress and is mediated by organizing abilities and processes like time management and personal task management systems, including among university students (Barkley, 2013; Coetzer, No & Omonuk, 2023; Coetzer, 2016; Coetzer & Richmond, 2009; Coetzer, Hanson and Trimble, 2009). Ongoing research on the executive cognitive challenges proposed by the Unifying Theory (Barkley, 1997) has confirmed that difficulties with task activity timing and sequencing is associated with attention deficits (Barkley et al., 2001; Barkley & Fischer, 2019; Fossum et al., 2021; Houghton et al., 2004). The above suggests that process mapping and management competencies, which are listed by many professional associations as a key competency (National Institute of Health Competencies Dictionary – see appendix A), may be an important mediator of the attention-deficit role-stress relationship, and potentially a new point of intervention. Research by Okide et al. (2020) confirms that critical thinking competencies and related interventions assist in managing stress among undergraduate students.

#### Task Inattentiveness (TIA)

Task inattentiveness refers to constraints on the ability and/or motivation to direct and maintain cognitive activity on role and task relevant stimuli (Loschiavo-Alvares et al., 2023; De Gangi & Porges, 1990), which is required for efficient and effective role and task performance (Arabacı & Parris, 2020; Robertson & O'Connell, 2010). The capacity to focus on task relevant information over an extended period, which is both psychologically and physiologically demanding, is necessary for addressing complex tasks (Harvie et al., 2022; Robertson et al., 1997; Unsworth & Robison, 2016). Attentiveness is comprised of multiple interacting systems that include arousal, selection (filtering), vigilance (sustained attention), control, and distraction resistance (Barkley, 2022, 2010; Brown, 2005; Di Nuovo & Smirni, 1994;). Adult attention deficit has been associated with stress and reduced academic and workplace performance (Balbino et al., 2022; Billings, 2023; Barkley 2013; Biederman et al., 2006; 2009; Coetzer, 2016; Fabiano et al., 2018; Halt et al., 2023; Kessler et al., 2009; Kessler et al., 2005; Schein et al., 2023; Seppä et al., 2023).

#### **General Process Management Competency (GPMC)**

Competencies are defined as a set of abilities, knowledge, skills, perspectives, and attitudes that support solving problems and executing tasks in an efficient and effective manner (Holtkamp et al., 2015; Kakemam & Liang, 2023; Rychen & Salganik, 2001; Ellen-Woodcock, Callewaert & Millunchick, 2021). General process management competency is defined as the cross-situational capacity to support the identification, modelling, analysis, development, implementation, management, and improvement of the interrelated activities that produce systems outcomes in an efficient and effective manner (Coetzer, No & Omonuk 2023, 2022). General process management competency supports a wide variety of tasks including general task management, workflow management, business process management, quality management, and project management (Antonucci, Fortune & Kirchmer, 2021; Hrabal et al., 2021; Nowak, Pawlowski & Schellenbach, 2022). Performance of specialized processes within specific contexts (e.g. supply chain or health care management) typically requires supplementary and specialized process competency to achieve full performance (Kakemam & Liang, 2023; Pradabwong et al., 2017; Shtub, & Karni, 2010). This is congruent with the pyramidal model of performance-supporting competencies that includes more general competencies at the base and more task/situation specific competencies towards the peak (McClelland, 1973; Williams, et al., 2016).

General process management is increasingly viewed as an important competency within the modern workplace (Klepić, 2022; Koskinen, 2012; Nowak, Pawlowski & Schellenbach, 2022; Verina & Titko, 2019) and is listed as a core competency by a wide variety of business and non-business professional associations (e.g. Project Management Institute, National Institute of Health etc. – see example in Appendix A). Process management competency is supported by both declarative (descriptive) and procedural knowledge (Coetzer, No & Omonuk 2023; Gálvez Yanjarí, 2023; Langley & Tsoukas, 2010). Declarative (descriptive) knowledge within the context of general process management refers to understanding the general presence, nature, and role of process elements; whereas procedural knowledge refers to understanding the general nature of dynamic and temporal interrelationships among the elements, and how they influence systems outcomes (Coetzer, No & Omonuk 2022; Aqlan et al., 2019; Banks & Millward, 2007). General process management competency is supported by systems oriented perspective-taking and thinking that supports the ability to imagine or examine a performance situation in a way that reveals the beginning-to-end interrelationships among elements of the situation that produce particular systems outcomes (Elia, Margherita, & Secundo, 2021; Emblemsvåg & Bras, 2000; Koskinen, 2012). General process management competency refers to the capacity to identify, map-out, organize, implement, manage, and improve both abstract and observable processes across a wide variety of performance situations and conditions (Galanakis, 2006; Jonker & Karapetrovic, 2004). Recent research by Coetzer, Omunuk and No (2023, 2022) confirmed associations between general process management competency and important organizational behavior variables like conflict management, self-efficacy for project teamwork and team member performance.

#### **METHODS**

#### Hypotheses

The general proposition guiding this research is that RS is positively associated with TIA and negatively associated GPMC, TIA is negatively associated with GPMC, and GPMC mediates the relationship between TIA and RS. Students need to attend to multiple sources of continually evolving role information and constantly integrate and update this information into a coherent, comprehensive, and clear understanding of their role requirements, which in turn supports both efficient and effective performance (Coetzer, 2022; Coetzer & Richmond, 2009; Elsary & El-Sherbiny, 2023). To do this, students must direct and maintain sufficient cognitive activity on role and task relevant stimuli (Loschiavo-Alvares et al., 2023). This requirement is likely to be intensified as role requirements for students transitioning from high school to higher education; often include expanding role requirements, higher workloads, more ambiguous role information, and the need to manage a schedule and related tasks often under conflicting conditions (Coetzer & Richmon, 2009; Coetzer, Hanson and Trimble, 2009). Attention deficit related difficulties with maintaining sufficient attention and accurately sequencing and timing task activities (Barkley et al., 2001; Barkley & Fischer, 2019; Fossum et al., 2021; Houghton et al., 2004) is likely to contribute to higher levels of role confusion, difficulty managing non-compatible role requirements and the experience of role overload.

*Hypothesis 1:* Task inattentiveness will be positively associated with role stress for undergraduate students

The intellectual process of identifying process elements and mapping out interrelationships between elements and outcomes of complex tasks in a comprehensive and organized manner, requires intensive and sustained attention to process relevant task information supported by a guiding intellectual framework (Coetzer, 2022). The development of competency requires sufficient coherent reflective and learning experiences that helps establish the guiding intellectual framework (Yibing, 2022). Attention deficit related difficulties with maintaining sufficient attention and both accurately sequencing and timing task activities (Barkley et al., 2001; Barkley & Fischer, 2019; Fossum et al., 2021; Houghton et al., 2004) is likely to disrupt process conceptualization, mapping, and management; and produce poorly developed and disorganized guiding intellectual frameworks which constrains competency development and enactment (Doidge, Saoud & Toplak, 2020).

*Hypothesis 2:* Task inattentiveness will be negatively associated with general process management competency for undergraduate students

The application and integration of both conceptual and procedural thinking to the framing, understanding, mapping out, execution, and management of important role requirements will support both efficient and effective execution of important role related tasks (Coetzer, 2022; Zhang, Kang & Hu, 2020). The ability of students to intellectually model, organize, and develop an accurate and useful inner representation of their performance situations; and then map out, sequence, and integrate beginning-to-end processes that support the completion of important tasks, is necessary for successfully managing administrative, academic, and non-academic role requirements in an integrated manner (Coetzer, No & Omonuk, 2022; Coetzer & Hanson, 2009; Coetzer, Trimble and Hanson, 2009). Students with higher levels of GPMC will be better equipped to navigate role related challenges like increased workload, unclear and ambiguous role information, and conflicting role requirements.

*Hypothesis 3:* General process management competency will be negatively associated with role stress for undergraduate students

TIA influences both GPMC and RS, and GPMC influences RS, which suggests that GPMC is a mediating influence. General process management competency requires the development and enactment of intellectual frameworks which assist in identifying and framing process elements and interrelationships in a comprehensive and organized manner. The development and use of such guiding frameworks which assist in addressing complex role challenges are supported by the application of sufficiently intensive and sustained attentional resources that support the accurate sequencing and timing of task activities (Coetzer, No & Omonuk, 2023). This suggests that a component of the relationship between TIA and RS is transmitted via GPMC.

*Hypothesis 4*: General process management competency will mediate the relationship between task inattentiveness and role stress for undergraduate students

#### Measures

Items for measuring role ambiguity, role conflict and role overload were generated after reviewing the Role Stress inventory (Rizzo et al., 1970), occupational environment scale (Osipow and Spokane, 1983), role clarity index (Kahn, et al., 1964; Kahn & Quinn, 1970), the work stress inventory (Barone et al., 1984) and the role stress scale improvements suggested by Siegal (2000). Four items were chosen for each of the dimensions of role stress (ambiguity, conflict and overload). The scale has been used in multiple studies and has consistently produced 3 factors that correspond with the dimensions of role ambiguity, conflict, and overload (Coetzer, 2022, Coetzer, 2016; Coetzer & Richmond, 2009; Coetzer, Hanson & Trimble, 2009). An example item for role ambiguity is: "I don't have a clear sense of the important tasks that I need to complete." An example item for role conflict is: "The important tasks I need to do often conflict with one another." An example item for role overload is: "I have more tasks that I can effectively manage." Subjects used a seven-point Likert scale (1 = strongly disagree, 4 = neutral, 7 = strongly agree) to rate the extent to which they agreed with each item. A total role stress measure was derived by adding up the scores on the individual items.

The scale developed by Coetzer, Omonuk and No (2022) was used for measuring general process management competency. This scale was developed after reviewing (1) descriptions of process management competency developed by a variety of professional associations including

the Association of Business Process Management Professionals (ABPMB, 2022) and the National Institute of Health (NIH, 2022), and (2) reviewing recent research on process management and related competencies (Hrabal et al., 2021; Paim, Caulliraux & Cardoso, 2008; Poirier & Walker, 2005; Sonteya & Seymour, 2012). Research conducted by Coetzer, Omonuk and No (2022) confirmed (1) the unitary factor structure of the measure (long and short form) and (2) associations with important organizational behavior variables like conflict management and team member effectiveness. For this research study, an observer version of the short form of the scale was used to provide additional protection against single source bias. Use of an observer version of the short form of the scale was appropriate because each of the questions referenced observable behavior. Each research subject was asked to identify someone who was willing to provide an honest assessment of the way the subject managed important and complex processes. Each of the identified observers completed an online assessment of the subject's general process management competency. Example items include – (the person being observed) manages important and complex processes by "explicitly developing a sufficiently detailed breakdown of the beginning-to-end process into the key steps and sub-steps," "explicitly identifying, reviewing, and adjusting (when necessary) the key steps to ensure that the process produces the intended outcome," "explicitly identifying, reviewing, and adjusting (when necessary) the key steps to ensure that the process is executed in a timely and cost-effective manner," and "explicitly identifying, sequencing, and organizing all the key process steps into an integrated map of the process." Items were measured on a seven-point Likert behavioral frequency scale (1 = never, 4 = sometimes, 7 = always). The total score for general process management competency was derived by adding up the scores on each of the questions.

Task inattentiveness was measured using the component of the Brown Adult Attention Deficit Scale (Brown, 1996, 2001) that measures difficulty sustaining attention and concentration. The instrument was designed and validated for use with adults 18 years and older, and measures the following five cognitive conditions associated with adult attention deficit (each is a validated factor) (Brown, 1996, 2001):

- difficulty activating and organizing to work
- difficulty sustaining attention and concentration
- difficulty sustaining energy and effort
- difficult managing emotional interference
- difficulty utilizing working memory and accessing/recalling learned material

The Brown (1996/2001) scale uses progressive dimensional (gradations of severity) as opposed categorical (non-disordered vs disordered) measurement of the symptom clusters, which is consistent with the evidence that adult attention deficit symptoms and associated impairment falls along a severity continuum (Levy et al., 1997; Sherman et al., 1997). Numerous research studies have made use of the Brown scale to conduct dimensional measurement and correlation-based analysis of the influence of attention challenges within nomological networks that influence behavior and performance in organizations (Coetzer, 2021, 2022; Coetzer and Trimble, 2010; Nigg, 2006).

The component of the Brown scale that measures difficulty sustaining attention and concentration contains 8 items, some of which were amended to ensure that each question focused on attention challenges related to performing important tasks (as opposed to general attention challenges). Example items include "I listen and try to pay attention when addressing

important tasks, but my mind often drifts and I miss out on desired information," "I'm easily sidetracked when performing important tasks, and will often switch to doing something else," "when addressing important tasks, I remember some of the details but often have difficulty understanding the entire task." The instrument uses a four-point behavioral frequency scale (0=never, 1=once a week, 2=twice a week, 3=almost daily) to rate the frequency with which the behavior occurs. A total task attention score was derived by adding up the scores on each of the questions.

#### Sample

The sample is comprised of two hundred and fifty-four undergraduate management students attending a state university in the northwestern United States. The average age of the subjects was 22.64 (low = 18, high = 35), and 53% identified as male and 47% as female. Each subject completed self-assessments of task inattentiveness and role stress, and identified a close associate who was willing to complete an assessment of their general process management competency (under conditions of privacy – data was not revealed to the subject). Procedures recommended for addressing common method and source bias (Podsakoff et al 2003; Podsakoff et al., 2012) were used by administering the surveys at distinctly different times, using different scale formats (e.g. traditional Likert scale and behavioral frequency), generating psychological separation by associating each measure with distinctly different components and activities within the course, and using a different source (observer) to measure one of the variables. Means, standard deviations and correlations among the research variables are reported in table 1. All variable distributions are approximately normal and demonstrate reasonable variability across their respective scales. Cronbach alpha coefficients ranged from 0.91 to 0.85 suggesting good internal reliabilities (see table 1). No univariate or bivariate outliers were considered problematic and product moment correlations revealed significant associations between the relevant variables. The distribution of regression residuals produced by the mediation regression was approximately normal with no problematic outliers. The regression coefficients for the control variables of age and gender were  $\beta = -0.10$  (p = 0.044) and  $\beta = 0.01$  (p = 0.94) suggesting that gender has no influence within the model, but that age has a small but statistically significant negative relationship with role stress once the influence of the other variables have been removed.

#### **Data Analysis**

The significant threshold for all the empirical tests was set to  $\alpha = 0.05$  (2-tailed). The correlation between TIA and RS is positive and statistically significant (r = 0.43, p < 0.01) providing support for the hypothesis that task inattention is positively associated with role stress. The correlation between GPMC and RS is negative and statistically significant (r = -0.46, p < 0.01) providing support for the hypothesis that general process management competency is negatively associated with role stress. The Sobel test for mediation is statistically significant (Z = 4.482, p = 0.00) and the Hayes bias corrected bootstrap confidence interval (BootLLCI = 0.189 and BootUCLI = 0.483;  $\alpha = 0.95$ ) does not contain zero suggesting the presence of mediation. The mediation results suggest that a statistically significant proportion of the role stress associated with task inattentiveness is transmitted via general process management competency (Figure 1). A significant and sizeable partial correlation between TIA and RS (r = 0.28, p < 0.00) remains after the mediator (GPMC) is included in the model which indicates partial mediation. This suggests that GPMC does not fully explain the relationship between TA and RS, and that other unmeasured factors are helping to transmit the effect.

#### --- insert table 1 here---

--- insert table 2 here ---

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#### DISCUSSION

The results suggest that task inattentiveness is positively associated with role stress and negatively associated with general process management competency, and that general process management competency is negatively associated with role stress. The results also suggest that general process management competency partially mediates the relationship between task inattentiveness and role stress. The directionality of this relationship cannot be confirmed from this research study and both opposite and bi-directional effects are possible. Numerous studies support a preceding causal position for inattentiveness on behavior due to genetic and early developmental origins (Barkley, 2010), and the need for attentiveness as a precondition for learning and competency development (Brown, 2005). However, some research suggests that current contextual conditions may help to manifest a genetic predisposition or strengthen existing symptoms (Nikolas et al., 2012). The confirmed preceding influence of perceptual and attentional processes on the experience of stress, and the preceding influence of attention on learning and competency development, supports the temporal (causal) placement of the variables in the model. The partial mediating influence of general process management competency suggests that the development of this competency in combination with other partial mediators like time management (Coetzer, 2016) and personal task management systems (Coetzer & Richmond, 2009), represents a potentially more influential point of intervention for reducing the influence of inattentiveness on role stress. The efficacy of such interventions is likely to be further improved with the addition of attention management training. The research study is limited by using students from a single public university and geographic location. Future research needs to include a range of universities from different locations that include subjects from different cultures and nationalities.

#### CONCLUSION

Many public colleges and universities are attempting to improve retention rates and provide graduates with the competencies needed to be academically and professionally successful (Coetzer, 2023; Evans et al., 2018; Jackson, 2009; Krause, 2018). Research suggests that both student role stress and limited stress management capacity among undergraduate students are key contributing factors to poor student health, performance, and retention (Akram et al., 2023; Al-Shahrani et al., 2023; Baumgartner & Schneider, 2023; Choma, 2019; Rapoza, Gough & McCall, 2021; Swani et al., 2022). Stress tolerance and coping tactics include identifying and developing the personal competencies necessary to better navigate stressful environments (Jenkins, Weeks & Hard, 2021). Lack of student attentiveness is frequently reported as an impediment to learning and competency development (Trane & Willcutt, 2023), and research has confirmed that teaching strategies can influence both attentiveness (Bunce, Flens & Neiles, 2010) and competency acquisition (Azevedo, Apfelthaler & Hurst, 2012). This research study confirms

that task inattentiveness is significantly correlated with student role stress and that general process management competency partially mediates the relationship. This suggests that the enhancement of student attentiveness in relation to important role requirements and related tasks, combined with the development of general process management competency and other mediators like time management and personal task management systems, may help to reduce student role stress and related consequences.

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# Appendix A – National Institute of Health - Process Management Competency

National Institute of Health. (2018, Oct 19). Competencies Dictionary – Process Management. https://hr.nih.gov/working-nih/competencies/competencies-dictionary/process-management

# **Process Management**

Develops and monitors processes to achieve desired results.

Key Behaviors

- Creates an effective workflow that effectively coordinates and integrates tasks and functions.
- Identifies and takes advantage of opportunities to accomplish multiple objectives and obtain synergies through process development and management.
- Effectively communicates and coordinates with other stakeholders in the process.
- Evaluates efficiency and effectiveness of resources utilization and results accomplishment.
- Establishes clear, well-defined processes necessary to achieve the desired outcomes.
- Organizes people and activities to accomplish results.
- Identifies and addresses process problems promptly and follows through to ensure that corrective or recommended process updates are effectively implemented.
- Delineates complex processes into more simple tasks and functions.
- Analyzes business processes to identify process owners, cycle time, variations, bottlenecks, and redundancies to support streamlining and other business improvements.
- Understands the various approaches for mapping the workflow of business processes to outline steps users follow and to develop a baseline for improvements or reengineering.
- Serves customers by developing and maintaining SOPs and other policy/procedure guidelines that foster continuity of operations and organizational resilience.

		Mean	SD	1	2	3	4	
1	Role Stress	44.45	12.61	0.91				
2	Task Attentiveness	13.95	5.60	0.43**	0.85			
3	General Process Management Competency	68.17	12.79	-0.46**	-0.44**	0.89		
4	Age	22.64	3.87	-0.13*	-0.10	0.11		
5	Gender			0.04	-0.01	-0.07	-0.05	
Notes: Internal consistency reliabilities are shown in parentheses on the diagonal								
* = p < 0.05 (2-tailed), $** = p < 0.01$ (2-tailed)								

Table 1 – Means, Standard Deviations, Internal Reliabilities and Correlations

Table 2 – Hayes and Sobel Test for Mediation

Sobel Test	Z value = 4.482	P = 0.00					
Hayes Bias Corrected	Lower Confidence Interval $= 0.189$	Upper Confidence Interval = 0.483					
Bootstrap Confidence Interval							
$(\alpha = 0.95)$							
Direct Influence $= 0.28$	Indirect Influence $= 0.14$						
Type of Mediation	Partial						
Note: significant and sizeable partial correlation between TIA and RS (r = 0.28, p < 0.00) remains after the							
mediator (GPMC) is included in the model which indicates partial mediation							

# Figure 1 – Mediating Influence of General Process Management Competency on the relationship between Task Attention and Role Stress



Notes: Type of mediation: Partial. Hayes bias corrected bootstrap confidence interval (BootLLCI = 0.189 and BootUCLI = 0.483;  $\alpha$  = 0.95). Sobel Z-value = 4.482, p = 0.00. Direct influence = 0.28, Indirect influence = 0.14. Correlations in parentheses indicate  $\beta$  weights computed after the mediator has been included in the regression equation. \* = p < 0.05, \*\* = p < 0.01. All calculations conducted with the control variables of age and gender included in the model.

#### EXPLORING PMBOK'S SKILLS AND KNOWLEDGE AREAS IN ALIGNMENT WITH MANAGEMENT'S REQUIREMENTS FOR IS PROJECT LEADERS' SKILLS AND KNOWLEDGE

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## ABSTRACT

Since 1987, the Project Management Institute has published the Project Management Body of Knowledge (PMBOK), an international standard for project management's fundamental skills and practices. It is a standard terminology and guidelines for project management. The Project Management Body of Knowledge (PMBOK) recognizes 49 processes that fall into five primary process groups and ten knowledge areas typical of most projects. Each of the ten knowledge areas contains the processes that must be accomplished within its discipline to achieve effective project management. [1]. Practicing project managers who undergo continuous education through these processes and knowledge areas are deemed to increase project success with enhanced skills and knowledge.

In its seventh edition, the PMBOK is developed by "a global community of practitioners from different industries and organizations, in different roles, and working on different types of projects" [2]. The PMBOK's corpus of knowledge informs organizations on delivering Information Systems (IS) projects through traditional Software Development Lifecycle and Agile methodologies. Given the essential role of IS in modern organizations, management strives to achieve its strategic objectives through its IS investments. Therefore, the PMBOK's skills and knowledge areas should align with management's requirements for IS project leaders' skills and knowledge. Using job postings as a proxy for management's required expertise for IS project leaders, this research posits that the PMBOK aligns with management's needs for IS project leadership.

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#### IMPROVING ONLINE VIDEO LECTURES (OVLS): STUDENT PERCEPTIONS ANDLEARNING EFFECTIVENE

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#### ABSTRACT

Creating customized video lectures on specific business topics, which we refer to as online video lectures (OVLs), is necessary in today's contemporary pedagogical landscape, where course delivery includes online learning, flipped classes, and active team-based learning. The effectiveness of OVLs on learning hinges on the student's level of attention and engagement when viewing these videos. Previous literature demonstrates benefits for both students and faculty, but a holistic understanding of student attitudes toward OVL has not been well researched. To examine student needs and experiences with OVLs, this study explores three research questions: 1) how do students watch OVLs, and what are their needs? 2) do OVLs improve student learning performance? and 3) what are the contingent factors (e.g., demographic, full-time work status, etc.) that affect student OVL viewing behavior and learning effectiveness? To answer these questions, we conducted a study drawing on two sample populations: a sample of freshman students with little exposure to online learning and a sample of graduate students in an online MBA program. We first asked the students about their OVL watching experiences and viewing behaviors. To test OVL learning effectiveness, one of the authors created an OVL explaining a topic in crisis management, which is not ordinarily a part of the graduate coursework. To measure OVL effectiveness, we included pre and post-test questions. In our exploratory work, we analyzed data from a pilot study on undergraduate students taking the freshman seminar. The results showed significant improvement in pre and

post-test scores after the OVL was viewed, indicating it was effective in presenting the material. However, when controlled for gender and work status, the t-test results were more nuanced. We plan to compare and contrast the results of the undergraduate sample study with the study on the graduate student sample. We hypothesize the OVLs will still be effective in student learning. However, we anticipate student viewing behaviors, their needs, and contingent factors will be different. The results of our findings with implications for the effective development of online education will be presented at the meeting.

#### EXPERIMENTAL LEARNING OF DATA ANALYTICS THROUGH APPLIED ENVIRONMENTAL RESEARCH

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#### ABSTRACT

The importance of possessing appropriate and fundamental levels of data analytics knowledge and skills in the success of college graduates is well known across all fields. Nevertheless, the educators of statistics and data science are constantly challenged with finding suitable ways to motivate students and engage them in learning the needed skills. Various causes are identified as sources of students' lack of interest and hardship in learning the subject. One of the prominent culprits in students' low academic performance is their inability to connect classroom teachings with practice. On the other hand, one of the areas that seems to capture the attention of the current college students is sustainability and environmental concerns. This attention is well demonstrated in Generation Z's level of activism and social involvement in environmental subjects such as carbon emission, single-use plastics, waste management, and wildlife protection.

This study is designed to teach data analytics to undergraduate students through hands-on research on marine debris quantification and predictive modeling. Thus, it intends to cast data analytics as tangible skills with practical application in a field that has attracted the attention of the new generation. This student-centered program targets underrepresented students in Florida coastal communities. Actual data collected from field studies is used to teach the foundation of data processing and analytics. The participants in the project are also to serve as advocates for marine debris prevention and reduction; thus, the project intends to combine and connect education, research, and community development.

This study is part of a project supported by the National Oceanic and Atmospheric Administration, Office of Education Educational Partnership Program award (NA16SEC4810009), and the NOAA-Planet Stewards program (NA21SEC4810004). Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration.

#### **PROMPT ENGINEER CURRICULUM DESIGN**

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#### ABSTRACT

In 1993, a new technology paradigm began with the World Wide Web version of the Internet. This introduced a period of unparalleled growth and development in the use of technology around the world. In November of 2022, another paradigm shift started with the release of ChatGPT-3.5 and other Large Language Models (LLMs). A new period of exponential growth is beginning. As the advent of the Internet seemed to compress time by speeding the advancement of human knowledge at an exponential rate. So, with the availability of generative AI (LLMs) systems such as ChatGPT, we will see an even faster expansion of human knowledge. "Prompt Engineering" seems to be the term most frequently used to describe human interfacing with these systems. To tap the power of these systems a person needs to be able to ask not just the right question, but in such a way that it effectively achieves the desired outcome. It is an emerging field that requires creativity and attention to detail. It is a set of skills that will be in high demand as more organizations adopt LLM AI models. This paper will suggest the development of a curriculum in this area is imperative. Prompt engineering curriculum will be highly sought after in the coming months and years.

Prompt engineering is a major that will be within the information systems department of the College of Business in the near future. This paper will suggest what such a curriculum should look like. Topics will include what is AI, what are large language models, how you communicate with LLMs, and understanding LLM settings (roles, temperature, expert domains, and many more).

# IS IT Blockchain
# TOKENIZING CREATIVITY IN OPEN COMMUNITIES

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# ABSTRACT

Open communities where individuals share and assess creative content have thrived. However, they confront significant challenges in maintaining a roster of high-quality contributors. This study delves into the potential role of the Decentralized Autonomous Organization (DAO) as a remedy for this issue. The DAO, an emerging organizational paradigm built on blockchain technology, operates through decentralized and automated decision-making processes, utilizing cryptographic tokens to incentivize contributors.

The DAO has the potential to revolutionize the incentive mechanism within open communities. Leveraging the transparent and automated transaction capabilities blockchain offers via smart contracts, DAOs can create purpose-driven tokens with economic value to incentivize participants to engage and contribute to the community. Through well-crafted token systems and a sound governance structure, DAOs can distribute rewards to community contributors, fostering the retention of high-quality participants and facilitating the achievement of collective objectives that yield mutual benefits.

However, as DAOs for open communities are still in their infancy, numerous aspects regarding optimal governance and token designs remain unclear. Diverse reward methodologies influence participant behavior in distinct manners, collectively shaping the trajectory of the community's development. Given this context, the central research question addressed in this article is as follows: How can we devise a DAO governance structure capable of guiding a community toward achieving its shared objectives and ensuring the sustained engagement of contributors? Using agent-based simulation, we investigate how communities, where individuals engage in content production and evaluation, evolve under various DAO governance structures.

We use an agent-based simulation with reinforcement learning to model diverse DAO governance structures, accounting for the cumulative processes of reputation and reward acquisition shaping the evolution of these communities. We juxtapose three distinct DAO scenarios, each characterized by their approach to distributing rights pivotal for community engagement, subsequently influencing the quality, development, and levels of activity: Egalitarian (equitable rights distribution), Merit-based (rights based on reputation), and Property-based (rights contingent on investment). These structural models are compared against existing open communities centered around artistic and technological content creation. Our findings underscore the significance of tokenizing creativity in sustaining open communities. Notably, the Merit-based DAO exhibits exceptional engagement rates and skill enhancement within art and technology communities. Meanwhile, the Property-based DAO presents a viable alternative, particularly in art communities where performance lacks objective benchmarks, fostering a diverse and inclusive array of skills.

# IT-EMPOWERED SMART FARMING OFFERS ADVANTAGES TO TRADITIONAL AGRICULTURE SYSTEMS

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#### ABSTRACT

The farming industry has been around since the beginning of civilization and for a while, the process of operations has been done the same way. The world of technology has adapted and shifted into many sectors of business and most recently the biggest shift in the agriculture business is smart farming. The use of smart farming is designed to optimize the overall farming experience, by using new technologies that allow corporations to analyze data to ensure maximization of productivity is being reached without giving up quality of goods. Companies are switching to smart farming techniques to ensure they are reaching higher output levels resulting in increased profits but more importantly, following new focus points in the industry such as sustainability.

# **INTRODUCTION**

The agriculture industry has benefited tremendously over the years from smart farming sometimes referred to as E-agriculture. According to the Food and Agriculture Organization of the United Nations E-agriculture is defined as "a global community of practice that facilitates dialogue, information exchange and sharing of ideas related to the use of information and communication technologies (ICTs) for sustainable agriculture and rural development" (<u>www.fao.org</u>). The integration of agriculture and technology practices was designed to reach a more sustainable operating system that not only equipped farmers with new analytical tools for information gathering but also automated the overall labor process to increase output levels.

Smart farming is operated by using numerous technology sensors for different sectors of the farming ecosystem. Some of the sensors used in smart farming can direct positive or negative greenhouse variables like sunlight, while others can be used in the soil or even on an animal to track health and movement. These sensors and GPS technologies introduced to the agriculture industry help collect real data and store them in servers that can be analyzed with last closed-day trends or year-to-date trends. This simplifies the process by now being able to compare the data side by side to see where adjustments need to be made in real-time [14].

Other forms of technology are used by deploying drones to survey the land and collect images and recordings for security and operational reasons. The technology automates the prior practice of physically going to the location simply without causing too much disruption. Autonomous practices aren't just used for flying but also integrated with operations once done by humans that are transferred to robots. The robots are now able to maneuver across a farm and spread crops more efficiently and effectively than the human process, the robots are encrypted with data that allow exact measurements to play a role in operations. These new technologies reinforce the commitment to more sustainable farming practices while also increasing productivity levels and in return bringing in more profits.

# **GOALS OF SMART FARMING**

Farming and agriculture are essential parts of human survival and prosperity. With the everincreasing numbers of the population, the food supply issue is becoming more and more acute. The human population has increased from 1.5 to 6.1 billion in the last century and the growth is becoming more exponential. It is projected to reach 9.7 billion in 2050 and 10.9 billion in 2100 [8]. This requires a tremendous increase in food supply, while focusing on goals of sustainability, decrease in cost, and increase in production.

The issue of sustainability has been addressed and accepted by major institutions and organizations. The United Nations has highlighted "Responsible Production and Consumption" as Goal 12 of the Sustainable Development Goals, to serve as a blueprint for a better future for all. While traditional farming and agriculture have traditionally relied on the increase of the area of farming and better fertilizers, smart farming brings completely new ideas to reach sustainability and avoid the fate of the Easter Islanders who racked the land that gave them life.

Walter et. al. have suggested that agriculture is undergoing a fourth revolution made possible by the availability and expansion of information technology [12]. Smart farming allows us to monitor the conditions of the crops, stock, and land to make farming more sustainable. Locally, it is especially pertinent in arid regions where soil salinity can decrease productivity and ultimately lead to desertification making it unusable for many years to come [5]. Globally, agriculture contributes 19-29% of total greenhouse emissions. Without a strategy for reduction, ensuing climate change may require a complete change of specific crops and livestock.

Another major goal of smart farming is cost decrease. Cost efficiency can come from different sources. A network of site-specific weather data, soil mapping, yield projections, and disease probability calls allows an increase in year-round cultivation with minimal land downtime. Even with an initial investment into the new technologies, several climate-smart agriculture strategies have been shown to decrease cost and have positive net present value (NPV) and internal rate of return (IRR) [9]. Information technologies can address multiple inefficiencies of the value chain by improving transparency of service and supply delivery to farmers and customers. Successful logistics management of the supply chain made possible by IT can be essential for efficiency and high-level performance, decrease in cost, and sustainable competitive advantage [10].

Smart farming also allows for precise soil and weather monitoring leading to optimized crop rotation in agriculture. It can increase resilience and allow for better planning when it comes to pests and diseases to improve and sustain livestock productivity. Better preparation and precise understanding, monitoring, and adjusting to the environmental conditions give opportunities for increased production in farming.

# **TECHNOLOGIES IN SMART FARMING**

**Internet of Things** 

The Internet of Things was first mentioned in 1998. It is a network of intelligent interconnected devices able to communicate with each other and generate and analyze data. The application and reporting of IoT in farming is more recent and has increased dramatically in the last decade [7].

IoT architecture in farming can be visualized in 4 layers: perception (devices), network, processing (services), and application [1]. The perceptions layer includes the actual devices responsible for data collection. Depending on the area of farming those could be sensor nodes used to monitor plant diseases, cameras to monitor plant growth and livestock movement, soil sensors, UV sensors, etc.

Data from the perception layer (data collection devices) is delivered to the processing layer via the transport layer. It is done via a wireless sensor network (WSN) that allows wireless communication between sensor nodes and applications. WSN protocols can be characterized as short-range, cellular networks, and long-range [4]. Short-range protocols enable communication over short distances and have a high data transmission rate and low power requirements. Cellular network protocols (GPRS, 4G, 5G) enable communication over long distances but have high power consumption. Protocols for long-range establish a lower power wide area network (LPWAN) and allow transmission over very long distances with low power consumption. They are, however, only able to transmit a few amounts of data. Therefore, there is a tradeoff between distance, power consumption, and the amount of data transmitted. That should be taken into consideration while designing IS architecture for a given agricultural project to make it cost-efficient and effective [14].

The processing layer uses IoT platforms for data storage and management. Here there is an opportunity to define whether data is relevant for the business requirement and where it should be stored. The total goal is to store a large amount of diverse data most efficiently. Another part of processing is the data abstraction stage. Here it is finalized so the applications can use it to generate insights and outputs.

Finally, the application layer provides information to farmers, as well as controls automatic processes based on the perception input. The most common applications of IoT in agriculture are chemical control, crop monitoring, disease prevention, irrigation control, soil management, supply chain management, and vehicle and machinery control [7]. These solutions can be applied to a variety of environments such as greenhouses, arable land, and orchards. Crop monitoring currently occupies the top spot in smart farming applications proving its importance. It obtains site-specific information such as temperature, soil salinity, and pH, humidity, and has been used to determine the readiness of crops of rice, maize, and alfalfa.

Combining the inputs from various types of sensors can lead to even further applications. For example, humidity, soil sensors, and weather data can be combined to optimize irrigation schedules. Visual data from plants in addition to environmental data can be used to monitor diseases and has been used in sugarcane crops.

Overall, IoT in agriculture can provide exceptional ways to monitor, assess, and respond to changing conditions. The challenge remains to decide which solutions are most appropriate based on business goals and financial ability.

# **Artificial Intelligence**

Artificial Intelligence (AI) has become a larger part of our daily lives and its integration into agriculture is no exception. As mentioned above, humanity's population has continuously been growing and in turn, is requiring either more agricultural land or more effective use of the land. AI allows farmers to create greater output from their fields with less input from their work [11]. In 2019, AI in agriculture was valued at around \$519 million, which was projected to grow to \$2.6 billion by 2025 [6].

Starting from the ground up, farmers need to know what crops to plant to produce optimal yields. AI can be used in soil and weather analysis to recommend the seed to use for their land [11]. This can be coupled with AI's ability to predict pest invasion, soil erosion, or weather changes that may harm the crops while they are growing [6]. This may lead to a higher yield with a reduced chance for plant disease, allowing a maximal return on the crops the farmer produces.

With the assistance of autonomous UAVs or Unmanned ethereal frameworks (UAS), there is the potential for increased ease of crop monitoring, irrigation equipment monitoring, weed identification, herd, and wildlife monitoring, and disaster management [11]. This leads to the ability to scan a field and find the problem while it is still in infancy, such as a small patch of diseased crops, and deal with the problem before it grows. Then these UAS or automatons may be used in crop harvesting, such as recognizing a fruit that is ready to be picked or a plant that needs to be trimmed [6]. Further down the line, we may be able to use AI towards robots that can determine what crop is ready at the peak timing and harvest it then.

# **Big Data**

Technology has shown major growth over the past decade and has expanded in numerous fields of work. The implementation of big data in the farming industry has changed for the better, making huge strides towards a sustainable operating system. Big data now offers farmers the ability to efficiently monitor greenhouse levels as well as the overall health of livestock. These new technological advances help better equip farmers to ensure they are efficient and effective in their operations while also maintaining long-term sustainability.

CropX is a company that has infiltrated the agriculture industry with its state-of-the-art technology that is helping farmers analyze data to reduce water and fertilizer use on their crops. Most recently PepsiCo has contracted the firm to implement their data analytics to ensure their farmers in Mexico are on track to reduce water use by 15% by the year 2025 according to Servando Valdez who serves as PepsiCo's Director of agriculture. CropX implements trackers into the soil which send the accumulated data to the servers to analyze vs. the prior year [2].

The data can be broken down and now allows the farmers to have real data to ensure efficiency levels are being maximized. The new age farmer now has real-time data that allows them to

know exactly what is going on to not only save water but increase productivity by using the data and adapting the current methods to ensure success.

Another way data has been introduced to improve the farming industry is livestock management and tracking to improve the health and well-being of livestock. Data now can collected from livestock eating habits to miles walked in a day. In the days before big data entered the farming industry farmers had no way of identifying the issues with their livestock, but now technology can pinpoint the exact cause for certain underlying issues.

The disease is a big issue in the farming industry of animals getting sick and transmitting it to others and the only way of identifying it before was either death or a health checkup with the veterinarian. Now that has all changed; Big data can now collect blood and track these patterns that are saving farmers time by not having to track each animal down but now can access information on the cloud and compare it vs other levels and animals.

Big data has made a lot of farmers' day-to-day operations easier but it has also introduced new issues for the industry. One of the biggest issues with big data is the potential for bandwidth and network outages. An example is if the farmer doesn't have the best Wi-Fi signal the data could slow or even worse false. This new reliance on the data could lead to false information being interpreted which leads to false actions taken by the farmer to correct the issue. Another big issue is the potential of blackouts, if the system goes down then the farmer no longer has access to any of the information needed to complete a day's operations.

Overall, the introduction of big data and the integration with the farming industry has changed the game in a big way. The previous practices of manually identifying and tracking this information have been able to make technological advances to improve the overall operation and track with real-time data. The practice of turning on and off a watering system has gone extinct and the use of machine learning combined with big data now gives farmers the ability to know exactly how much water each crop needs to grow fully. Big data has now given advanced tools directly to the farmers to maximize efficiency and total output while also saving time and remaining sustainable.

# CHALLENGES TO SMART FARMING

# Cost

When we look at the implementation of smart farming, one of the leading concerns is cost. Although it is predicted that AI alone will increase production by 30% [11], the initial costs pose a significant barrier to entry. Many farmers would need to go into debt to implement AI into their farming, and may not be able to afford the maintenance costs [13]. Coupling these costs with the sensors necessary for IoT ranging from \$10 to more than \$1000, the need for adequate network coverage, subscription costs, and necessary software it may be difficult to initially implement smart farming measures for smaller farms [3].

We must also look at the environmental costs of implementing smart farming. Training an AI requires a large amount of data to process, leading to emissions greater than that of the lifetime of five cars for a single AI. If this were to be expanded to a large scale, the initial introduction of

smart farming would release a large number of emissions, contributing to global warming [13]. There needs to be more effort put into reducing the overall negative effects on the environment.

# Adoption

For smart farming to truly be effective, the farm must have access to an internet connection and be able to have all parts of the smart farm, including sensors in the field, able to connect. This may be difficult for farms in the United States, let alone in developing countries. To truly adopt smart farming technology, an emphasis on improving infrastructure must be made [13]. This leads to another set of increased costs and may be near impossible for some farmers in developing countries where access to the internet and professionals who can explain the technology is extremely limited.

# Ethics

When we look at smart farming, there are a variety of benefits that are offered. From increased yield and higher profits to being better for the environment in the long run. With the planet having an ever-growing population, there is a large need for the advances smart farming provides. With that being said, some ethical concerns arise with the advent of smart farming.

With the use of AI plus automatons, there is less need for human jobs on the farms. This may lead to a reduction in the available low-skill jobs. A transition will need to be made by some for the maintenance of the machines and AI, but if the robot is more efficient and cheaper, wages may decline as human labor is seen as less valuable. This likely will be less of an issue in the United States as there is already a labor shortage for agricultural jobs, but in developing countries, this will likely have a much larger impact [13].

With the implementation of smart farming being costly at first, there is a barrier to entry that is more likely to affect small farms than large farms. This may lead to an imbalance where large farms are using smart farming, leading to higher yields at lower costs, allowing the farm to sell their crops at lower prices. This may effectively lead to small farms losing money, as they will not be able to grow crops and sell them at the same price as the larger farms that implement smart farming.

# CONCLUSION

In conclusion, the farming industry has been around for ages and the traditional practices have worked tremendously, but the innovative technology has streamlined the entire process making it more efficient and effective. The use of technology has changed the way farmers plow their fields to how they keep their records.

The implementation of in-soil sensors now can determine greenhouse levels that can ensure a product is getting the correct amount of sunlight and water and make adjustments to achieve full crop potential. The IoT has given farmers the ability to integrate multiple systems into one where they can collect, store, and review all data necessary to ensure their farms are reaching maximum output levels and monitoring overall operations to ensure sustainable success.

Overall, the technological advances now used in the agriculture industry have been a tremendous help but with all technology, there is always the possibility of errors from either humans or computers. The possibility of blackout or data hacks is a real threat and with time and more updated tech and security, those issues will be prevented.

Smart farming is here to stay and can change the agriculture industry for the better with new updates and best practices farmers now can have real-time data to back decisions and maximize their outputs which lead to increased profits while also being mindful of the environment by having sustainability-driven practices.

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#### HOW COMMITTED ARE MEMBERS OF GENERATION Z TO ENSURING ONLINE INFORMATION SECURITY?

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#### ABSTRACT

Previous research highlighted a significant knowledge gap among Generation Z individuals, indicating lower awareness and understanding of information security compared to older generations. In terms of cyber threats, this gap poses potential risks for both themselves and others. For instance, Generation Z is well-known for their extensive use of social media and frequent personal data sharing. However, as McKee et. al. [2] note, "Gen Z consumers increasingly adopt ad blockers, use private browsers, or take other measures to limit data tracking." They value authenticity and online space is nothing more than an 'exhibition space' for Gen Z (e.g. [1]). Exhibition spaces offer heightened potential for performances to be examined, revised, shared, analyzed, and revisited. This suggests that how Gen Z view commitment to disclosure of information and security is a function of how they view exhibition spaces. It also depends on the kind of relationship they have with such spaces. Consequently, Gen Z individuals might share personal information across online platforms. However, theoretically they have a heightened sense of awareness since the off-line and online space may be indistinguishable for this generation. The notion of commitment has been defined in diverse ways, but at its essence, it represents the intention to persist in a particular course of action. Consequently, commitment within a relationship can be seen as the determination to continue that relationship with a specific artefact. However, this seemingly straightforward definition masks significant variations in how commitment has been conceptualized by different theorists over time. Therefore, in this paper we employ three theories of commitment - George Levinger's cohesiveness theory, Caryl Rusbult's investment model, and Michael Johnson's tripartite typology - to delve into the level of commitment among members of Gen Z regarding online information security, particularly in light of their relationship with the physical and online space.

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# ONLINE INFORMATION AVOIDANCE DURING A HUMANITARIAN CRISIS: A MODEL OF EXPECTATION VIOLATION, OBJECTIVITY, AND TRUST

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#### ABSTRACT

Information sources often take a partisan position during a humanitarian crisis such as the Russia-Ukraine war. In that scenario, individuals with a need to consume information framed in a neutral way or individuals with a partisan view may not find information that matches their worldview. This deviation is referred to as expectation violation in communication and media research. Extant literature explains how information consumer's expectation violation (a key construct of explaining media relationship) can impact objectivity and trust; however, how these relationships will hold in a humanitarian crisis and how these mechanisms lead to online information avoidance are major research questions. Combining the expectation violation theory (Burgoon & Jones, 1976) and information source assessment theories (Kohring & Matthes, 2007; Lee, 2020) and conceptualizing these in the context of a war, we argue that an individual's expectation violation from information sources can impact online information avoidance through source assessment factors. The research model shows that violation expectedness, source importance, and valence will impact online information avoidance through the mediation of perceived objectivity and source trust. Specifically, this research addresses three research questions: (1) How is expectedness about information source's expectation violation associated with online information avoidance through the mediation of an individual's perceived objectivity and trust in source during a war?, (2) How is importance of information source associated with online information avoidance through the mediation of an individual's perceived objectivity and trust in source during a war?, and (3) How is valence of information source's expectation violation associated with online information avoidance through the mediation of an individual's perceived objectivity and trust in source during a war? We have generated interesting insights from a multi-country survey study based in Poland and the United States. In Poland, violation expectedness increases online information avoidance significantly, and the importance of the relationship with the information source is a significant inhibitor of online information avoidance. Moreover, both trust and perceived objectivity mediate the relationship. In the USA, source importance and valence are important inhibitors of online information avoidance. Our research has two major theoretical contributions. First, we contribute to the crisis information and communication literature by identifying how expectation violation in terms of expectedness, importance, and valence impact online information avoidance. Second, we contribute by showing how perceived objectivity and trust play a mediating role in online information avoidance during crisis. At a practical level, our findings will be helpful for online information providers, governments, response organizations, and communities who utilize online platforms, forums, and related outlets to reach larger audiences for disseminating pertinent information during a crisis.

# IMPACT OF SCAMMER'S REPRESENTATION OF LOVE ON ONLINE ROMANCE SCAM GULLIBILITY

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#### ABSTRACT

Online romance scam is a crucial challenge in the social networking era. Current literature on online romance scam discusses how scammers try to persuade the victims to fall for the scam. Research identifies scarce deal, emergency, crisis, commitment and consistency, love, liking, and similarity play significant role in the online romance scam persuasion process. In general, gullibility is the naivety or foolishness of a person in believing another person or thing where there is not enough evidence to be persuaded. In social engineering and scam literature, gullibility is associated with over-trusting the perpetrator, removing doubts and suspicion about the perpetrator, increasing agreeableness, decreasing the ability to avoid risks, and increasing insensitivity. To understand this phenomenon further, it is important for us to investigate how scammers grooming process makes the potential victim more gullible and eventually vulnerable to the scam. In that pursuit, we look into the relationship theories further to find potential mechanism of the grooming effectiveness. The objective of this research is to integrate romance theories to understand the development of online romance scam gullibility through scam grooming techniques. We undertake two vignette-based experiments on single online daters to fulfill the research objective. The major findings of this research reveal that scammers representation of love using intimacy, passion, and commitment gives a person false sense of trust and satisfaction, and because of the mood-congruent judgement mistakes this phenomenon leads to more online romance scam gullibility. This research has extended our current theoretical understanding in three significant ways. First, we establish how non-grooming, only intimacy, both intimacy and passion, and all three of intimacy, passion, and commitment leads to online romance scam gullibility. Second, this research tries to contribute to this area by looking into two types of respondents- single but not actively seeking love versus single with actively seeking love. The latter group shows a higher level of variation in response to different levels of romantic grooming in terms of relationship trust and relationship satisfaction. Third, we take help from Mood-Congruent Judgement Theory that talks about how positively mood usually leads to lower decision outcomes such as how feeling of relationship quality leads to scam gullibility. Using the results- online dating platform can detect commitment messaging and provide awareness cautions to the online daters about potential scam, online daters who know that they are actively seeking love can be more aware of any scam warning signs and self-monitor themselves, and both online dater and online dating platforms can classify the relationships based on false trust and satisfaction factors and provide resources to tackle romance scam.

# EMOTIONAL ATTACHMENT FORMATION AND ITS IMPACT ON MOBILE HEALTH SERVICES USAGE: A REPLICATION STUDY

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# ABSTRACT

- Research Purpose: Conceptually replicate the study conducted by Zhang et al. (2021) <Effects of emotional attachment on mobile health-monitoring service usage: An affect transfer perspective>. Zhang et al.'s study sample was in Beijing, China. We plan to recruit a similar sample in the U.S.A. Also, we adapt their instrument to our replication study's context. By conceptually replicating prior studies, we are more confident and can reach a scientific consensus on the validity of our knowledge contributions. Also, we can confirm whether the prior findings generalize to the new context or that findings are closely tied to the original measures, analysis, etc., and don't generalize beyond them.
- Participants: Patients with chronic illness (i.e., Diabetes, Hypertension) and using mobile healthcare devices (smartphone app and wearable devices) to manage their chronic illness.
- Procedures (methods): The study will be deployed in an online survey platform. The study will specify the recruitment information. Filters will also be applied to identify the qualified participants. The qualified participants can voluntarily opt-in to take the anonymous survey. After the data is collected, quantitative analysis (structure equation modeling, factor loadings, construct reliability, validity, etc.) will be applied to investigate whether there are any variations between the original and the replication study findings.

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#### IOT ADOPTION: A SYSTEMATIC LITERATURE REVIEW

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#### ABSTRACT

The Internet of Things (IoT) is a network that connects physical objects, humans, and cyber objects to enable monitoring, automation, and decision-making. However, the complexity of this technology may cause concerns for individuals before adopting it. Our research conducted a systematic literature review of the existing top-tier Information Systems literature to identify different aspects studied in the extant IoT literature in prominent Information Systems-focused publications. Based on the literature, we have developed a model for IoT adoption and its antecedents at different levels.

# DETECTING NEW SECURITY ATTACKS: EVIDENTIAL MODELLING

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#### ABSTRACT

The amounts of data generated in a computing environment is just too large for a network detection and response system (NDRS) to analyze and generate useful decision support for chief security management officers to take the corrective and recovery actions needed to protect their computing environments. This matter becomes even more challenging to manage when the NDRS cannot detect the occurring intrusion and when the security officer cannot recognize the intrusion features and its working conditions due to its unknown signature in the existing NDRS database.

Most NDRSs use AI techniques and statistical tools that often apply either Bayesian reasoning or Evidential Calculus that employ closed sample probability spaces and frames of discernments consisting of only known events. This closed condition is mostly implemented by assigning zero to the probability of the empty set in Bayesian theory, or zero to the basic belief assignment of the empty set in Evidential Calculus.

This paper assumes that the frame of discernment is now open to new cases not known priorly. New attacks for which the signature database has no signatures can now be detected and processed before the NDRS produces the security controls recommended for preventive, corrective, and recovery actions. Our proposed model will relax the zero condition imposed on the empty set, and allow the mass assigned to the empty set by the belief structure's basic belief assignment to be greater or equal to zero. Under these conditions, we propose an evidential model where the NDRS can process new attacks towards planning the adequate security controls for the appropriate corrective and recovery actions.

This evidential model applies Dempster and Shafer theory with a generalized basic belief assignment built on an open frame of discernment. A full numerical example is provided to demonstrate the working of the model.

# Using Cognitive Load Theory to Better Understand IT Disaster Response: Implications for Practice and Academia

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#### ABSTRACT

IT disasters vary in terms of severity and duration and can affect business operations. The cost of IT outages can be massive in terms of monetary and productivity losses. Based on a report by BigPanda, the cost of an IT outage is reported to be anywhere from \$1,850 per minute to \$25,402 per minute depending on the size of the company (ranging from 1,000 to over 20,000) [4]. Disaster recovery plans cannot provide instructions for every circumstance. Each situation is unique. There are multiple tasks to prioritize, which compete for information processing attention [5] [3]. Multiple systems, people, and information resources may be involved, resulting in increased difficulty to problem-solve. IT personnel need to be prepared with appropriate troubleshooting, problem solving, communication, and "dynamic decision-making skills as well as the ability to react well in uncertain time-sensitive situations" [1 as cited in 2, p. 42]. Due to these multi-layered factors, there can be an increase in cognitive load.

Cognitive Load Theory (CLT) was developed within the context of educational psychology by John Sweller in the 1980's. It focuses on how instructions provided on assignments can affect load. The complexity of instructions affects information processing load on limited working memory, processing new information, and the extent to which information can be added to long-term memory to build expertise [6, pp. 261-262]. If the weight of cognitive load is too high, learning and long-term memory creation can be stifled. Since CLT originated in educational psychology, it's rarely applied outside of the field. Szulewski et al [7] identified the need to apply CLT concepts to industry.

The purpose of this study is to use CLT to understand IT disaster response and discover how CLT concepts can be applied in academia. Three disaster scenarios of different impact levels are analyzed for cognitive load response. The three scenarios are: Power outage and RAID drive disk failure, a ransomware attack, and a complex situation with overheated equipment. Initial data has been collected from participants in a medical office which has a complex integrated system for its size. Thus far, the data reveals that prioritizing tasks, delegating activities, setting boundaries, setting realistic expectations, creativity, and using mitigation strategies are primary aspects affecting cognitive load. The time-sensitive nature of the situations resulted in pressure and the advantage of prior expertise helped to reduce cognitive load. Technical issues are a priority to solve, but since employees are not working, managing people's expectations is another increase on cognitive load. These are also important points to consider in academia when teaching information technology students how to prepare for disaster response situations.

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#### USING TECHNOLOGY TO PROMOTE SOCIAL INNOVATION THROUGH SOCIAL ENTREPRENEURSHIP

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#### ABSTRACT

The goal of social entrepreneurship is to develop novel, long-lasting solutions to urgent societal problems. Technology has a lot to offer social entrepreneurs who wish to reach a wider audience, and these entrepreneurs can benefit greatly from its many tools and resources. Nonetheless, as we maneuver through the constantly changing terrain of social entrepreneurship, we must make sure that technology is used ethically, sustainably, and in accordance with inclusivity and sustainability. In this paper, we examine how technology might help social entrepreneurs in a disruptive way by examining several areas where technology serves as a catalyst for social entrepreneurship, highlighting the advantages and challenges associated with its integration: (1) Ideas Generation and Validation -Artificial intelligence (AI) tools, data analytics, and online collaboration platforms are some of the ways that technology helps with idea generation. These resources can be used by social entrepreneurs to pinpoint unmet needs, comprehend target audiences, and improve their solutions. Real-time feedback is made possible by social media platforms and crowdsourcing, which aid in idea validation and iteration. (2) Online Resources for Fundraising and Financing - For social entrepreneurs, information is an invaluable resource. Access to pertinent data, industry trends, and best practices is made possible by technology. With the aid of data analytics tools, market research can be conducted, enabling business owners to decide with confidence whether their projects are viable and scalable. Algorithms driven by AI can also be used to evaluate complicated social issues and find possible solutions. (3) Efficiency of Operations and Scalability - Technology streamlines operations, lowers costs, and automates procedures to increase the efficiency of social enterprises. The utilization of cloud computing, mobile applications, and digital communication tools is imperative for organizations operating in diverse and demanding environments as they facilitate remote collaboration and operational flexibility. Because of their scalability, these efficiencies enable social entrepreneurs to serve a larger number of beneficiaries. (4) Assessment of Impact - Technology is essential to quantifying and assessing the results of social projects. Real-time, granular data collection on project outcomes is made easier by data analytics, mobile data collection tools, and remote sensing technologies. (5) Obstacles and Ethical Issues - Even though technology has a lot of promise for social entrepreneurship, issues like the digital divide, data privacy, and ethical issues need to be considered. Social entrepreneurs must responsibly address these issues, making sure that technology promotes inclusivity and upholds beneficiaries' rights to privacy.

# **SECURITY CONCERNS: PERCEPTIONS OF PEER-TO-PEER CASH APPS**

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# INTRODUCTION

Mobile payments have become pervasive in modern societies which operate largely in a cash-less environment [3]. Mobile payments have increased in popularity in consumer transactions replacing the use of traditional payment methods such as personal checks, debit, credit, and even cash. Peer-to-peer (P2P) cash applications allow near instantaneous transfer of funds between consumers via mobile devices. This study examines peer-to-peer cash applications (P2P cash apps) such as Venmo, CashApp and Zelle to determine which factors influence a users' perceptions regarding security and intention to adopt the P2P cash app for use. Each brand of P2P cash app has its own niche; therefore, we examine the differences in perceptions related to security that depend on the type of P2P cash app used. For example, Zelle is a P2P cash app that is integrated into online banking in a traditional bank setting. We posit that there are differences in perceptions and adoption intention for a P2P cash app that is "trusted" by a bank as opposed to other P2P cash apps that are not integrated within online banking.

# LITERATURE AND PROPOSED HYPOTHESES

We adopt constructs from the IT/IS security and technology acceptance literature to determine user perceptions regarding security of adoption of P2P cash apps. Perceived susceptibility, perceived benefits, perceived barriers, cues to action, general security orientation, self-efficacy and perceived severity are constructs used to assess computer security behavior [4]. The Technology Acceptance Model (TAM) [2] and Theory of Planned Behavior (TPB) [1] specify constructs that apply to technology adoption such as perceived usefulness and perceived ease of use. We posit that adoption of a particular P2P cash app will be influenced by the security and acceptance constructs.

#### **METHODOLOGY**

To determine the effect on intention to adopt a P2P cash apps and to test the differences in perceptions of each application we adapt the relevant constructs and design and administer a survey. We then examine the effect of each construct on the intention to adopt a P2P cash app and how intention varies across the different P2P cash apps.

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# EXPLORING HUMAN FACTORS VULNERABILITIES IN SUPPLY CHAIN SECURITY FOR SYSTEMS INVOLVING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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# ABSTRACT

Artificial Intelligence and Machine Learning have been transforming various industries and are increasingly incorporated into cybersecurity solutions, including supply chain cybersecurity management. Recently, sophisticated attacks on supply chains and Artificial Intelligence/Machine Learning systems have risen, which has amplified the need for advanced security mechanisms and thorough risk assessments. Studies have shown that human errors cause 95% of cybersecurity breaches. Addressing human errors in the supply chain can substantially enhance the efficiency, security operations, and cybersecurity resilience of Artificial Intelligence and Machine Learning systems. This study aims to explore, evaluate, and establish a framework for detecting and mitigating the range of human behavioral factors and associated risks with supply chain security for systems involving Artificial Intelligence and Machine Learning in a multilayered, interconnected, and interoperated socio-technical ecosystem. The evaluation will show proof of concept that our design framework and approach outperform the traditional methods.

#### **KEYWORDS**

Artificial Intelligence, Machine Learning, Supply Chains, Digital Supply Chains, Cybersecurity Risk Management, Cybersecurity Defense Resilience, Cybersecurity Investment, Human Factors, Risk Intelligence, Risk Assessment, Risk Mitigation, Risk Evaluation, Cyberattack Avenues

# PROTECTING SECURITY ARCHITECTURE - HUMAN FACTORS THAT COMPROMISE CYBERSECURITY RISK MANAGEMENT

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# ABSTRACT

Security architecture design determines an organization's cybersecurity defense resilience against threats. Major systems accidents and security breaches start with an accumulation of human errors right from the cybersecurity risk management program. Many risk assessment, mitigation, and evaluation processes in cybersecurity risk management programs are designed with unintentional human errors. Errors are injected at different levels, unknowingly compromising the security architecture during the planning, business impact analysis, establishment, and upkeep of security infrastructure and systems to protect information technology and business assets from cyber threats. In this paper, we evaluate the cybersecurity risk management program and present the different human blind spots and errors in the program that increase risk exposure in security architecture solutions. This paper recommends thoughtful and careful methods to minimize human errors that compromise cybersecurity risk management programs, enhance security architecture posture, and save organizations from cyberattack distress.

#### **KEYWORDS**

Security Architecture, Cybersecurity Risk Management, Cybersecurity Defense Resilience, Cybersecurity Investment, Human Factors, Risk Assessment, Risk Mitigation, Risk Evaluation

# Management Strategy Organization

#### MICROCHIPS AND SEMICONDUCTOR INDUSTRY: THE GLOBAL RACE FOR SELF-RELIANCE

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#### ABSTRACT

Today the semiconductor industry is in the spotlight of all main world economies, and there are a few reasons for this attention. First, microchips have become an essential part of all machines and appliances and thus have become one of the key staples of the modern economy. Second, the pandemic and rising trade wars between main global economic powers especially between the U.S. and China highlighted the importance of ensuring uninterrupted access to microchip supply. On the other hand, the U.S. and even more Europe and Japan had lost their previous leading positions in producing microchips to their Asian competitors primarily in Taiwan, South Korea, and China. As a result of rising demand for microchips and higher dependencies on foreign suppliers, the Western countries realized that semiconductor production inside their borders had become an important strategic issue, critical for their economies and defense. To increase their own production, the U.S. and EU implemented a twofold strategy. First Trump and later Biden administrations introduced strict export control over the delivery of advanced chip technologies to China. The sweeping restrictions cover all advanced chips designed or manufactured by U.S. companies anywhere in the world and even block the export of any U.S. tools that can be used by Chinese semiconductor companies. Another part of this strategy is aimed at facilitating the domestic production of microchips. Both the U.S. and EU adopted comprehensive multibillion incentive programs to support investments in their local semiconductor production by both domestic and foreign companies. Current plans of the world's leading microchip producer Taiwanese company TSMC and American company Intel to build big fabrication plants on U.S. soil prove the effectiveness of these programs. The race for ensuring self-reliance in the semiconductor industry will likely intensify with India, Germany, and Russia joining this race.

# EXPLORING THE RELATIONSHIP BETWEEN FEMALE REPRESENTATION IN AUDIT COMMITTEES AND REGULATORY PENALTIES: EVIDENCE FROM S & P 500 FIRMS

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# ABSTRACT

Corporations routinely violate rules and regulations. Resource dependence theory implies that firms with stronger board oversight —an essential component of corporate governance—would be less likely to commit regulatory violations. Further, the cultural theory of risk perception suggests that high female representation in audit committees might mitigate risky decision-making in the boardroom such that firms are less likely to commit regulatory violations. Additionally, gender diversity research suggests that firms with boards attaining more than 30 percent female board membership outperform their less diverse peers. Therefore, we hypothesize: *Female representation in audit committees is negatively related to regulatory penalties once critical mass (> 30 percent female board membership) is met.* 

We focused on S & P 500 companies prior to the Covid-19 pandemic. We applied one-year lagging to create a 5-year dataset from the two data sources: the Institutional Shareholder Service (2015-2019) and the Violation Tracker (VT) penalties database (2016-2020). We utilized these data to operationalize all the variables: the independent variable (female representation in audit committees), interaction variable (30% percent female board membership), dependent variable (regulatory violations), and control variables (state, industry, board size, director age and tenure).

Because the distribution of our data was positively skewed, we applied both OLS regression and a zero-inflated modified count technique known as the Hurdle model. We employed both models to see if similar results would emerge and reported the intersection of these results. Our hypothesis was supported. In neither model was female representation in audit committees related to regulatory violations; however, it decreased regulatory violations when female board membership was more than 30 percent. Both models showed that the interaction between female representation in audit committees and the 30% threshold was statistically significant.

This study attempts to make a few contributions. Although using the VT database is becoming popular in other disciplines, our study is one of the few studies in gender diversity and corporate governance research (in our knowledge) that employed the VT. Considering the 30% threshold, scholars could have a more nuanced insight when examining gender diversity's impact on governance performance. Further, our finding might be helpful for firms intending to improve board gender diversity to strengthen regulatory compliance.

#### **RELATIONAL COORDINATION:** A FRAMEWORK FOR BUILDING SOCIAL CAPITAL

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#### ABSTRACT

Studies examining employee personal resources have shown many benefits for the individual as well as his or her organization. Because managers are positioned to engage employees at a personal level, they are the organization's principal influence to develop subordinate personal resources. This paper develops a model of engaging relational coordination toward developing the personal resources of organizational members. Thus far, there has been little depth of study dedicated to the relational coordination concept. Taking from the fields of sociology, organizational behavior, politics, and other related fields, the model is constructed to illustrate how managers might utilize the dynamics of relational coordination to facilitate employee resource gains. Specifically, it is suggested that manager activities to engage relational coordinate attitudes, and interactive practices of organizational members. Finally, we discuss practical implications and future research regarding the proposed model.

#### **INTRODUCTION**

The sponsor of an employee's personal resources in the organizational setting is the manager, who is also the employee's primary advocate in the organization. Conservation of Resources (COR) theory describes personal resources as essential assets which must be fostered and protected (Hobfoll, 1989, 1998). The personal resources discussed in this article include relationships and personal networks which provide the employee information, assistance, and emotional support within the organizational setting. COR theory also suggests that the more resources one has, the more likely one is to reinvest those resources toward further gain (Halbesleben, Harvey, & Bolino, 2009; Halbesleben & Wheeler, 2008; Hobfoll 2001; Liu, Prati, Perrewé, & Ferris, 2008).

Accordingly, a manager who works toward multiplying subordinates' personal resources will not only benefit those subordinates, but the manager and the organization as a whole. Individual benefits for subordinates may include reduced stress levels, increased job confidence, increased motivation, and many other positive outcomes. The manager may benefit from improved leadermember relationships and better unit coordination and performance. Also, the organization may benefit through a more positive organizational climate, enhanced employee commitment to the organization, increased employee motivation, as well as improvements in individual, group, and firm performance (Prati, McMillan-Capehart, & Karriker, 2009).

Dutton and Dukerich (1991) state that it is the general responsibility of managers to engage and support the organization's structural, relational, and affective ties. Therefore, it would seem that

the ability of managers to facilitate involvement by subordinates in each facet of the organization is integral to developing subordinate resources. Through the two dimensions of relational coordination, communication and relational involvement, managers may provide frequent and valuable information to subordinates regarding organizational activities and goals while engaging them at a personal level.

Theorists suggest that this interactive strategic framework of Relational Coordination can produce valuable individual and organizational outcomes (Anderson, 2006; Gittell, 2001, 2002; Prati et al., 2009). Because of the dynamic, social nature of relational coordination, the manager has multiple opportunities to foster emotional, social, and professional resources of subordinates. However, the manager must first have his or her own resources by which investments in subordinates are possible. Implementing such a managerial framework is no quick and easy task. Establishing an organizational model of relational coordination requires a significant investment of managerial social capital, which Nahapiet and Ghoshal (1997) delineate into structural, relational, and cognitive resources. They found that such resources were beneficial to the firm, increasing innovation and creating value.

Showing the value of such resources, Nahapiet and Ghoshal (1997) called for continued study regarding how such resources are developed and amassed within the firm. The premise of this theoretical discourse is that the manager is a pivotal link through which subordinates may gain social capital resources, specifically managerial support, organizational network support, and emotional capital. The present model begins at the point of managerial investment and describes the process through which relational coordination facilitates personal resource gains of subordinates.

Insert Figure 1 About Here

# THEORETICAL DEVELOPMENT

Social exchange processes provide a conduit by which managers may put forth cognitive, relational, and structural investments in their employees (Karriker & Williams, 2009). Managerial resource investments promote the development of structural, relational, and cognitive attachments fostering an environment where relational coordination is the norm among members. Such abilities and relational investments may play a role in how one assembles and shares meaning with others (cognitive resources), engages interactions (structural resources), and enjoys mutual trust and support of others within the organizational community (Prati et al., 2009).

Anderson (2006) and Prati et al. (2009), among others, have discussed the importance of managers in the formation of a climate of subordinate cooperation, communication, and positive interaction. This characterization of the relational coordination framework, which is meant to govern organizational interactions, must start with the manager. Scott and Lane (2000) explain that managers are able to influence subordinates in order to benefit the performance of the organizational unit. Accordingly, it is important to understand what resources are necessary to support such managerial influence.

# **Manager Characteristics**

*Emotional Intelligence.* Of particular importance and most relevant to this discussion is the manager's ability to communicate and relate to organizational members. One important resource to managers facilitating such activities is emotional intelligence. Emotional intelligence is "the ability to perceive and express emotion, assimilate emotion in thought, understand and reason with emotion, and regulate emotion in the self and others." (Mayer, Salovey, & Caruso, 2000, p. 396.)

Many researchers have found positive associations between emotional intelligence and both communication and relationships. Hassan, Yacco & Shah (2012) found emotional intelligence of managers led to employee communication effectiveness. Kunnanatt (2008) discussed the importance of emotional intelligence to communication, social influence and interpersonal effectiveness. The emotional and social skill of managers has been associated with positive social relationships and social support systems (Riggio, Watring, and Throckmorton, 1993). Prati et al. (2009, p. 405) states, "One with a high degree of emotional intelligence is better able to facilitate and effectively navigate interactions with others, because of his or her ability to communicate using the symbolism of emotion toward certain objectives." Indeed, the research is evident that emotional intelligence is a primary resource of managers which can engender relational coordination within the manager's realm of influence.

*Social skill.* Because relational coordination is highly interactional, social skill is a necessity for managers to navigate the framework. Social skill is the "ability to perceive interpersonal or social cues, integrate these cues with current motivations, generate responses, and enact responses that will satisfy motives and goals" (Norton & Hope, 2001, p. 60). Hochwarter, Witt, Treadway and Ferris (2006) discuss the beneficial outcomes of social skill related to this study such as social networks, cooperativeness of others, and enhanced job performance. Riggio, Watring and Throckmorton (1993) indicate that those possessing social skills had better quality relationships and support systems. Riggio and Reichard (2008) discussed evidence that social skill is a necessary resource for managers to operate within the framework of relational coordination.

*Empathy.* Salovey and Mayer, 1990 define empathy as "the ability to comprehend another's feelings and to re-experience them oneself" (pp. 194-195). Rogers (1951) states that empathy is necessary to the formation of relationships. Research suggests that empathy is key to social effectiveness whereby leaders may guide subordinates toward productive behaviors and outcomes (Goleman, Boyatzis, and McKee, 2002; Kellett, Humphrey, and Sleeth, 2006). Riggio and Reichard (2008) proposed that leader empathy begets higher quality leader-follower relationships. Therefore, empathy is an important resource for managers engaged in relational coordination efforts.

*Proposition 1: The manager's level of personal resources is positively related to the degree of relational coordination among subordinates.* 

# **Relational Coordination: The Framework**

Gittell (2002) defines relational coordination as "a mutually reinforcing process of interaction between communication and relationships carried out for the purpose of task integration" (p. 301). The effectiveness of this framework therefore depends on open, positive relationships among organizational members as well as frequent communication between and among those members. Relational coordination generates an exchange culture that results in resources for organizational members.

# The Exchange Culture

Ravasi and Schultz (2006) state, "organizational culture acts as a context for sensemaking efforts" (p. 437). The culture provides scripts and norms which dictate how employees should behave. Managers are a primary influence on the creation of culture in the organizational setting (Ravasi and Schultz, 2006). Through managerial actions, employees develop perceptions of supervisor support, trust between managers and associates, and the level of dedication managers attribute to employee well-being (Cropanzano & Mitchell, 2005).

Gittell (2003) delineates three important relational features that are components of relational coordination which fuel a positive exchange culture; shared knowledge and goals, and mutual respect. Blau (1964) described *exchange culture* as a collection of personal relationships which are characterized as positive, ongoing, interactive associations. Dutton (2003) argued that relational attentiveness fosters the creation of high-quality connections between people in organizations. Liao, Liu and Loi (2017) explored the idea that positive social exchanges between managers and organizational members created benefits such as member self-efficacy and creativity.

*Leader-Member Exchange (LMX).* Prati et al. (2009) proposed that the ability of managers to establish a personal connection with subordinates results in positive subordinate behaviors and attitudes. They indicated that relationships between manager and subordinate, which are characterized as courteous, sociable, and having a genial nature, may produce a positive and more personal connection between the subordinate and his or her organization.

Prati et al. (2009) proposed that the positive nature of manager-subordinate relationships can be created through a framework of relational coordination (Gittell, 2000; Gittell, 2001; Gittell, 2002). Gittell (2001) defines relational coordination as "the management of task interdependencies, carried out in the context of relationships" (Gittell, 2001, p. 471). She delineates the construct into two dimensions, communication and relational involvement. The communication dimension has two measures, timeliness of information provided and frequency.

Graen and Scandura (1987) defined LMX as a measure of quality in the supervisor–employee relationship. They describe it as a proactive management strategy in which the manager provides social and emotional support as an investment toward employee commitment and productivity. Graen, Novak, and Sommerkamp (1982) described the nature of the LMX relationship as an investment of resources for certain social rewards. High quality LMX relationships have been attributed to many individual and organizational benefits such as trust, improved communication, positive member attitudes, and performance (Cogliser, Schriesheim, Scandura, & Gardner, 2009; Graen and Uhl-Bien, 1995). As with all organizational

characteristics, the norms of member exchange are set from the top. How managers engage with employees to accomplish organizational objectives, will inform all organization members regarding how to interact with other members.

Prati et al. (2009) indicate that the manager's close, affable relationship with subordinates will enable a culture of courtesy, benevolence, and mutual support among organizational members. A more detailed examination of the relationship between relational coordination and culture begs for a more dynamic, interactive contribution of the organization's culture. The nature of exchange culture fits well with the relational coordination paradigm. The individual relational attention and informational resources provided by managers may encourage each employee to engage in open, multi-level, inter- and intradepartmental exchanges of information and network access. Bolton, Logan and Gittell (2021) surmise that members of this type of exchange culture are better able to use resources available to them to complete work and reap personal resources that provide for their well-being at work (Dutton & Heaphy, 2003; Gittell et al., 2008; Adler & Kwon, 2002).

*Trust.* According to Dirks and Ferrin (2001, p. 456), trust is "a psychological state that provides a representation of how individuals understand their relationship with another party in situations that involve risk or vulnerability". Prati, Douglas, Ferris, Ammeter, and Buckley (2003) describe trust (or lack of trust) of another as an expectancy, based on the characteristics of the referent other. These characteristics are deduced through observations of and experiences with the referent other over time. McAllister (1995) indicates that there are two types of trust. The first type is cognitive trust in which an individual observes reliable behavior, credible knowledge, and similar values by which one relates to the relevant other. The other type of trust is affective trust in which the observer is frequently, emotionally moved to trust another because of selfless, unmotivated acts performed by the referent other to benefit the observer.

Tsai and Ghoshal (1998) indicate that trust is essential to interpersonal cooperation. Others have indicated that trust is necessary to facilitate coordinated action (e.g., McAllister, 1995). In the literature, trust is portrayed as a reciprocal favor which grows with every reinforcing experience. Indeed, the responsibility of building trust does not fall to the manager only. Employee contributions of trustworthy behavior are necessary. However, for relational trust between subordinate and manager to produce valuable outcomes, research has shown that the manager must demonstrate his or her trust of subordinates. Research indicates that the manager's display of trust in the employee may result in several employee-related outcomes such as satisfaction, commitment, and citizenship behaviors (McAllister, 1995; Brower, Schoorman, & Hoon Tan, 2000; Gould-Williams & Davies, 2005).

The literature shows a plethora of benefits regarding trust as a resource within the framework of relational coordination. As mentioned above, trust enables cooperative efforts (Tsai & Ghoshal, 1998). Dirks and Ferrin (2001) described trust as a facilitator of cooperative behavior. Blau (1964) states that trust is one of the primary components of social exchange, and that it is cumulative in nature. Prati et al. (2009) discussed how open communication of managers may facilitate trust which engenders motivation in employees toward performance. Zeffane, Tipu and Ryan (2011) argue that trust and communication is cyclical in that trust induces communication which, in turn, engenders trust.

*Empowerment.* Conger and Kanungo (1988) define empowerment as "a process of enhancing feelings of self-efficacy among organizational members through the identification of conditions that foster powerlessness and through their removal by both formal organizational practices and informal techniques of providing efficacy information", (p. 474). Gómez & Rosen (2001) reasoned that empowerment and managerial trust would engender a positive organizational culture such as Blau (1964) introduced through his theory of social exchange. Spreitzer (1996) notes that high-involvement systems, such as relational coordination, inspire perceptions of empowerment and motivate individuals to perform for the good of the organization. Rooney, Gottlieb and Newby-Clark (2009) found support for the relationship between managerial supportive behaviors and subordinates' perceptions of job autonomy. Gómez & Rosen (2001) stated that empowered employees feel more influence over organizational outcomes. They also offered that empowered employees perceive their work as meaningful and have higher selfefficacy and control with regard to work activities. Additionally, Spreitzer (1996) found evidence to support how employee perceptions of empowerment were positively associated with sociopolitical support of networks within the organization, as well as access to information and unit climate.

*Participative decision making.* The interactive nature of relational coordination engenders participative decision making and provides for positive interactions between managers and employees (Wang, Wang & Li, 2018). Grasso (1994) found a direct relationship between manager behaviors in promoting participation in decision making. Managers in this type of culture are more likely to solicit opinions and encourage subordinates to participate in decision making (Parnell, 2010). Prati et al. (2009) describe communication efforts within the relational coordination paradigm as multi-directional, whereby managers solicit opinions and information from subordinates, and subordinates communicate with managers openly, without perceived risk. In turn, the flow of information is enhanced throughout the organization.

#### Proposition 2: Relational coordination is positively related to an exchange culture.

#### **Subordinate Social Capital**

The exchange culture created through the framework of relational coordination engenders a system of subordinate social capital gains. The primary forms of social capital include network support, managerial support, and psychological capital.

*Network support.* Network support provides for work efforts of employees where internal and external resources and information are shared and are more cooperative in nature. Lee and Kim (2020) suggest structural empowerment provides employees with autonomous freedom which encourages them to participate in organizational decision making. Gittell and Douglass (2012) discuss the benefits of network support such as participant engagement, trust, and social and emotional capital. Because of these resources, participants are able to work closely with internal and external organizational members providing for open multi-level communication and information transfer.

*Managerial support.* A great deal of research shows that managerial support is an important factor that can influence employees' attitudes and behaviors in the organization (e.g., Rooney et al., 2009; Khalid, 2020). Keller & Dansereau (1995) state that support of managers builds personal resources in the form of employee self-worth. Luthans, Norman, Avolio & Avey (2008) found that a supportive organizational climate is a positive predictor of psychological capital. This supportive climate includes the support of peers, network participants, and supervisors. Avey (2014) found the supervisor to be a major predictor of psychological capital.

Psychological Capital. Psychological Capital is defined as:

An individual's positive psychological state of development that is characterized by: (1) having confidence (self-efficacy) to take on and put in the necessary effort to succeed at challenging tasks; (2) making a positive attribution (optimism) about succeeding now and in the future; (3) persevering toward goals and, when necessary, redirecting paths to goals (hope) in order to succeed; and (4) when beset by problems and adversity, sustaining and bouncing back and even beyond (resilience) to attain success. (Luthans, Youssef, & Avolio, 2007, p. 3)

Research has shown that this construct is related to several beneficial workplace outcomes. Luthans, Avolio, Avey and Norman (2007) found a positive relationship between psychological capital and job satisfaction. Avey, Luthans and Youssef (2010) found that psychological capital was a negative predictor of cynicism and intentions to quit. Luthans, Norman, et al. (2008) also found satisfaction, commitment and performance were predicted by psychological capital. In their meta-analysis Avey, Reichard, Luthans and Mhatre (2011) found that psychological capital was related to quite a few beneficial employee attitudes, such as job satisfaction, organizational commitment and psychological well-being. Additionally, they found it was negatively related to problematic attitudes such as cynicism, turnover intentions, job stress and anxiety. Finally, psychological capital includes psychological safety. Psychological safety enables one's security of expression without fear of negative reactions or consequences (Kahn, 1990; Carmeli & Gittell, 2009). Carmeli and Gittell (2009) found that relational coordination is positively related to psychological safety.

Proposition 3: Relational Coordination is mediated by the exchange culture.

*Proposition 4: The organization's exchange culture is positively related to subordinate's social capital.* 

# DISCUSSION

The presence of a manager who communicates well with subordinates and who successfully maintains copacetic relationships with them makes a marked difference in the ability of subordinates to perform their jobs. The relational coordination framework enables managers to impart and develop subordinate resources toward better organizational functioning such that they develop their own personal resources in the form of social capital. Social capital in this particular discourse includes features within network support, managerial support, and personal psychological capital.

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# FIGURE 1





### STRATEGIC FLEXIBILITY IN HIGHER EDUCATION

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### ABSTRACT

The higher education industry has encountered significant challenges over the past several years. Questions regarding the relevance and rigor of higher education have led to difficulties surrounding enrollment and retention for many institutions. In some instances, these challenges have led to difficulties in procuring resources, in others it has led to institutions closing their doors or being absorbed by larger institutions. More recently advances in technology, the spread of businesses aiding students with questionable ethical standards, and a host of considerations around funding sources and repayment have led to further difficulty. The question becomes, what strategic tools are available to decision makers to address these difficult circumstances? We suggest that applications of strategic flexibility might support improved decision making and better outcomes in a chaotic industry. Strategic flexibility is often defined as the ability to handle change and is supported by a substantial literature linking strategic flexibility practices to improved business performance. While significant evidence supports the business necessity of strategic flexibility, little work has applied the concept to higher education. We examine the archetypal maneuvers of strategic flexibility (i.e., pre-emptive, exploitive, protective, and corrective) to higher education. With an emphasis on relationships regarding enrollment and retention, we discuss the applicability of strategic flexibility to higher education and the need for further exploration. By exploring solutions to enrollment and retention issues through a strategic flexibility lens, decision makers can clarify real options and use the resulting solution set to affect beneficial change. Furthermore, establishing strategic flexibility as a viable option to address higher education decision making needs will lead to further insight as new problems such as the advent of AI in the classroom become more important.

## EVALUATING BUSINESS MODEL CANVASES: ADVANTAGES, LIMITATIONS, AND THE QUEST FOR A COMPREHENSIVE TOOL

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### ABSTRACT

**Purpose:** This research paper explores the inherent limitations and advantages of various business model canvases, with a primary focus on the traditional Business Model Canvas (BMC). It aims to highlight the pressing need for the development of a new and robust business model tool that can comprehensively address the multifaceted challenges faced by modern organizations.

**Methodology/Approach:** The research is conducted through a comprehensive examination of the traditional BMC and various alternative business model canvases and frameworks. It includes a literature review and empirical analysis of real-world applications. The advantages and limitations of each canvas are analyzed, and practical considerations for their selection and implementation are discussed.

**Findings:** The research identifies that both the traditional BMC and its alternative counterparts exhibit limitations in various contexts. The traditional BMC is static and often fails to adapt to dynamic business environments. Additionally, it primarily focuses on internal aspects, overlooking critical external factors. Alternative canvases offer tailored solutions but come with their unique sets of limitations. The findings underscore the need for a new, all-encompassing, and robust business model tool that can effectively bridge the gaps and harness the advantages of both traditional and alternative canvases.

**Research Limitations/Implications:** This research is limited by the availability of data and information on the use of alternative business model canvases in real-world scenarios. However, it offers valuable insights into the inherent limitations of various canvases and suggests avenues for future research in the development of a more comprehensive business model tool.

**Practical Implications:** The research highlights the practical considerations for selecting and using different business model canvases and underscores the importance of understanding their limitations in various business contexts. It emphasizes the need for businesses to adopt a more nuanced approach in choosing the right canvas or framework for their specific needs.

**Originality/Value:** This research contributes to the field of business model design by providing a comprehensive analysis of the limitations and advantages of various canvases and frameworks. It underlines the originality and value in recognizing the need for an innovative and versatile business model tool that can adapt to the complexities of the contemporary business environment. The quest for such a comprehensive tool remains a critical imperative in the ongoing evolution of business model design.

## CAN MULTI-REGIONAL TRAJECTORY BASED OPERATIONS (MR TBO) REDUCE WORKLOAD-RELATED AVIATION INCIDENTS?

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### ABSTRACT

Multi Regional Trajectory Based Operations (MR TBO) was developed by Florida NextGen Test Bed (FTB) along with the Federal Aviation Administration (FAA) as a method for enhancing air traffic management (ATM), both domestically and internationally. According to FAA, "TBO is an air traffic management concept that enhances strategic planning under changing conditions providing the information and capabilities to help expedite aircraft movement between origin and destination airports" [1]. TBO offers a shift from voice-based exchanges between Air Traffic Controllers and pilots to highly automated, digital communication exchanges. In this effort, the MR TBO project has created a collaborative partnership among FAA and other global aviation companies and authorities including Boeing, Nav Canada (which owns and operates Canada's civil air navigation system), Aeronautical Radio of Thailand (AEROTHAI), Civil Aviation Authority of Singapore (CAAS), and Japan Civil Aviation Bureau (JCAB) [1]. By using TBO, several operational values can be realized by the airspace users, such as enhanced predictability, increased reliability, and flexibility, improved strategic planning, decreased uncertainty, and alignment of strategic plans and tactical actions. In recent years, the mental workload of pilots and air traffic controllers (ATCs) has received increased attention. Workload is an important factor in aviation safety because errors can happen if mental task demands exceed the capabilities of pilots or ATCs.

The purpose of this presentation is two-fold. First, it explains how TBO can help improve route amendments, speed change, strategic handling of ground events, and sharing & managing multiple aircraft. Second, the presentation proposes the integration of MR TBO into the National Airspace System (NAS) to decrease the number of incidents caused by high workloads of ATM. Results of this presentation suggest that the operational value of adopting MR TBO extends towards the airlines, pilots, and air traffic controllers. A resulting increase of efficiency and safety can revolutionize the NAS for future generations of the aviation industry.

# THE MULTIFACETED NATURE OF ENTREPRENEURSHIP: A GLOBAL INQUIRY INTO PERCEPTIONS AND CONSTRUCTS

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# ABSTRACT

Throughout human history, the construct of entrepreneurship has experienced significant evolution in meaning and interpretation [1]. Its etymology traces back to practices that evolved dynamically, with the term "entrepreneur" denoting roles from "attacker" to "risk-taker" [2]. Classic economic theorists have postulated various roles for entrepreneurs, from resource reallocators [3], [4] to innovators [5]. Entrepreneurship scholars [1], [6] emphasize the academic discourse's diverse definitions, while classical theory-development authorities [7], [8] stress the importance of clear definitions for robust theory building. To attempt to address this unrelenting and persistent problem, our research undertook a significant challenge: administering a global survey to over 500,000 respondents from diverse professional backgrounds. The survey initiates with an open-ended question, asking participants to define the term 'entrepreneur' based on their understanding. Subsequent, a comprehensive questionnaire built on a 5-point Likert scale, aiming to capture perceptions

on potential components of the entrepreneurship constructs rooted in the literature. Participants delve into the idea of entrepreneurs as risk-bearers [9], innovators [10], aspect of value creation [11], entrepreneur's role in the reallocation of resources [3], notion of entrepreneurs as profit or rent-seekers [12], [13], idea of entrepreneurship being inherently part of human nature [14], luck [13], adventurer [4] and organization creators [6], [15], [16]. Finally, the post-survey reflection, prompting participants to re-evaluate their initial entrepreneurship definitions in light of their responses.

Preliminary findings reveal intriguing variances in perceptions based on professional orientations. For instance, professors and business professionals display alignment with classic economic theories, while politicians and entrepreneurs emphasize the practical facets like risk and innovation. Finally, several participants changed their understanding of entrepreneurship after taking the questionnaire substantially. Such insights underscore the multidimensional essence of entrepreneurship, necessitating a harmonized understanding between academia and practice.

In conclusion, this study offers a panoramic view of global perceptions on entrepreneurship, striving to bridge theoretical discourses with practical interpretations. By fostering dialogue and understanding, we hope to pave the way for enriched academic discourse and pragmatic applications in the entrepreneurial realm.

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#### ANTECEDENTS OF MICROAGGRESSION AMONGST C-SUITE EXECUTIVES

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### ABSTRACT

This review synthesizes research examining factors enabling subtle discrimination by Csuite executives. Systematic searches uncovered over 80 recent studies on microaggression drivers among corporate leaders. Key antecedents found include unchecked cultural biases, problematic leadership approaches marked by authoritarian control, communication breakdowns during high-stakes interactions, physical separation exacerbating disinhibition in virtual contexts, resistance to diversity initiatives, and inadequate accountability policies. While often unintentional, repeated microaggressions from influential executives can proliferate prejudice by signaling psychological threats. The literature reveals potential interventions such as tailored inclusion education and leadership development, structured communications protocols, and accountability systems. Additional research is needed on microaggression prevalence and mitigation strategies explicitly tailored for C-suite roles, particularly in evolving remote work contexts. The findings suggest that leaders can subtly address complex biases with selfreflection, cultural humility, and commitment to progress. However, solutions require a nuanced understanding of how prejudice proliferates despite good intentions.

Keywords: Microaggressions, Executives, C-Suite, Discrimination, Inclusion, Leadership development

#### Introduction

This review synthesizes research on the antecedents and factors enabling subtle discrimination perpetrated by C-suite executives. Despite progress, microaggressions persist across diverse organizations (DeCuir-Gunby & Gunby, 2016; Sue et al., 2019).

Microaggressions involve subtle prejudicial statements or actions that communicate derogatory attitudes toward marginalized groups.

As highly influential decision-makers, C-suite executives significantly impact organizational culture and inclusion efforts (Carton, 2018). Their communications regarding diversity cascade throughout companies. For instance, insensitive remarks from CEOs can signal tolerance of prejudice, undermining progress (Holder et al., 2015). Executives also have substantial power to implement systemic changes to address microaggressions.

However, leaders' limited self-awareness of unconscious bias inhibits meaningful action (Cook & Glass, 2014). Subtle discrimination at the C-suite level magnifies harm by validating prejudice. This review analyzes antecedents from over 80 studies enabling well-intentioned executives to perpetuate prejudice through microaggressions. Key knowledge gaps uncovered highlight areas for additional research. For instance, studies are needed on interventions explicitly tailored for top leaders. Findings are synthesized to advance understanding of how microaggressions persist despite good intentions.

#### **Literature Review**

Systematic searches were conducted across several multidisciplinary databases, including EBSCOhost, ProQuest, Wiley Online Library, Sage Journals, and Emerald Insight, to synthesize knowledge on subtle discrimination among corporate executives. The following search terms were used: "microaggression," "executive," "leader," "C-suite," "corporate," "business," "management," "subtle bias," "unconscious discrimination," and "prejudice." Boolean operators were applied to capture variant terminology.

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Results were limited to English-language peer-reviewed academic articles and dissertations published from 2015-2023 to provide currency. Studies were included if they contained empirical findings, theoretical frameworks, or qualitative insights, specifically examining microaggression perpetration by organizational leaders and executives. Studies focusing solely on managers were excluded.

The searches returned over 150 initial studies for screening, 85 of which met inclusion criteria after assessing relevance. These spanned various academic journals, dissertations, and conference papers on business, psychology, sociology, and education. Synthesizing this literature revealed key themes on factors enabling prejudice among senior leaders and executives.

#### **Unchecked Cultural and Generational Biases Enable Prejudice**

A significant enabler of microaggressions among C-suite executives is unaddressed cultural and generational divides breaching inclusion efforts. While diversity initiatives have increased representations of women, minorities, and younger professionals at upper leadership levels, latent cultural gaps and unconscious biases persist (Coleman, 2012). Without proper training and support systems tailored to C-suite leaders, these divides breed subtle prejudice (Friedlaender, 2018).

Increasingly, multicultural corporations require greater intercultural understanding. Yet research indicates C-suite executives from racial/ethnic minority backgrounds also experience microaggressions questioning their qualifications or work styles due to a lack of cultural awareness, such as presuming Asian American C-suite leaders are passive or that Latino C-suite

executives are hot-tempered (Slayton-Robinson, 2017; Rodriguez, 2020). Such remarks ultimately marginalize diverse contributions.

For instance, multiple studies based on surveys and interviews with C-suite executives and employees find C-suite leaders often make insensitive jokes mocking culturally distinct names or criticizing teammates' English abilities, revealing deficits in cultural competency (Andriesz, 2019; Friedlaender, 2018; Dixit, 2016). Comments like "Your name is so difficult to pronounce" or "You have such a heavy accent" alienate talent from minority backgrounds.

Furthermore, extensive research based on surveys and interviews with C-suite executives and employees underscores how generational hierarchies cause many veteran C-suite leaders to undermine emerging millennial and Gen Z talent through microaggressions reinforcing traditional stereotypes about being "lazy," "entitled," or "inexperienced" compared to older workers (Jones, 2022; McGuire et al., 2007). For instance, a C-suite executive dismissing a young employee's concerns over work-life balance as unfounded or telling new hires they "don't understand how things work" reflects prejudicial mindsets.

Research indicates that unchecked cultural and generational biases can enable prejudice, even with positive intentions, as leaders struggle to evolve past assumptions (Shen et al., 2009; Zhang, 2010). Studies show that without proactive training on unconscious biases related to cultural identities, ages, and shifting workplace values, subtle discrimination towards minority groups may occur from C-suite executives (Coleman, 2012; Friedlaender, 2018). The literature suggests tailored education programs, networking initiatives, and mentoring could help build intercultural competency and cross-generational collaboration among C-suite teams. Findings underscore self-awareness as vital for leaders to overcome blind spots related to demographics.

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#### **Toxic Personality Traits and Reactions Enable Microaggressions**

In addition to demographic divides, the literature highlights how certain toxic personality traits and reactions to stress increase leaders' likelihood of exhibiting subtle discrimination towards marginalized colleagues, even unconsciously. Multiple studies using personality assessments, 360-reviews, and employee surveys reveal narcissism, emotional volatility, defensiveness, and poor self-regulation when faced with interpersonal challenges strongly correlate with executives demeaning, interrupting, or lashing out at others in prejudicial ways (Jones, 2019; Williams, 2020).

For example, research indicates narcissistic executives focused on self-interest are more prone to dominate discussions, dismiss others' perspectives, and retaliate against feedback by devaluing subordinates' contributions, particularly from minority group members (Thompson, 2021). Interviews with minority executives revealed several instances of White male leaders commenting that they were "articulate" or "expressed themselves well," revealing racial biases (Rodriguez, 2020).

The literature indicates that problematic personality traits and poor reactions to stress correlate with an increased likelihood of subtle discrimination from leaders (Williams, 2020). For instance, multiple studies reveal associations between defective self-regulation, lack of empathy, and prejudicial behaviors like demeaning remarks or retaliation against feedback (Jones, 2019; Thompson, 2021). Research underscores the potential value of leadership training programs focused on managing reactions, providing constructive feedback, mindfulness, and emotional intelligence to inhibit inappropriate behaviors that can enable prejudice (Seijts & The 53rd Annual Meeting of the Southeast Decision Sciences Institute 2024

Milani, 2022). Scholars emphasize that suppressing unconscious biases requires developing courage, vigilance, and moral character in leaders.

#### **Problematic Leadership Approaches Reinforce Exclusion**

Research indicates that certain problematic leadership approaches may enable subtle discrimination from executives (Jones, 2020). For instance, studies using leadership style inventories reveal associations between authoritarian styles marked by overriding control and directive authority, which are often exhibited by C-suite leaders, and prejudice against minority groups through microaggressions (Carton, 2018; Mangum, 2021).

The literature suggests highly directive executives can perpetuate exclusionary climates that undermine psychological safety by dismissing diverse perspectives and input, particularly from underrepresented groups (Rodriguez, 2022). In contrast, findings demonstrate leaders focused on participative decision-making, development, and constructive feedback perpetrate significantly fewer microaggressions. Overall, research underscores democratic, collaborative leadership as more naturally advancing equity compared to authoritarian control models.

However, scholars emphasize that organizations should provide tailored coaching to help executives develop and demonstrate the vulnerability, cultural humility, ethical values, and moral courage required to leverage diversity while addressing behaviors that may inadvertently marginalize minority groups (Shen et al., 2009). The research suggests that fostering inclusion requires continual development of key leadership competencies over time.

#### **Communication Gaps Exacerbate Subtle Bias**

Additionally, multiple studies identify how communication breakdowns and lack of constructive disagreement platforms allow unconscious biases to manifest before leaders can self-correct, enabling microaggressions (Williams, 2020) subtly. For instance, research based on conflict observations reveals heated exchanges or "power struggles" between C-suite executives of different identities frequently enable prejudice when disagreements escalate without mediation (Chen, 2018).

Importantly, these communication gaps often occur during high-stakes interactions where substantial resources or strategies are at stake, increasing tension and miscommunications. Studies reveal situations where implicit biases are triggered can lead to subtle insults or talking over minority employees in contentious discussions. (Smith, 2019). Studies also show racially callous remarks often arise when White executives feel threatened by challenges from employees of color due to unchecked biases (Davis, 2021).

Scholars emphasize implementing structured protocols for constructively bringing together diverse C-suite perspectives before alienating microaggressions occur. Dedicated training must teach leaders to seek understanding and common ground by applying inclusive communication tactics focused on empathetic listening, reflective processing, and integrating diverse inputs through dialogue (Jones, 2020). Preventing escalation sustains psychological safety, trust, and innovation.

### **Physical Separation Enables Online Microaggressions**

Beyond ingrained habits, research also indicates more extrinsic factors like physical separation associated with remote, online work enable subtle discrimination from executives who

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feel a false sense of anonymity. Multiple studies reveal the rise in virtual teams has illuminated risks of online disinhibition, as C-suite executives appear significantly more likely to make inappropriate jokes or comments and feel reduced caution for microaggressions in digital contexts lacking in-person reactions (Thompson, 2021; Karani et al., 2022).

For instance, surveys show demeaning language and dismissal of inputs over email or messaging have increased since COVID-19 shifted C-suite leaders to more virtual interactions. The research posits that implementing thoughtful antidiscrimination policies tailored for hybrid models alongside training to mitigate unconscious bias in digital communications could help curb exclusionary behaviors exacerbated when physical presence diminishes (Shen et al., 2009). Further research on fostering inclusive climates in evolving remote contexts is required, particularly for C-suite executives (Karani et al., 2021).

#### **Resistance to Change Perpetuates Microaggressions**

Additionally, several studies reveal executives who actively resist, or fear change perpetuate higher rates of microaggressions as organizations strive to advance diversity, equity, and inclusion. For example, research based on leader surveys shows executives who reflexively reject proposed reforms or rely heavily on past norms for decision-making often subtly undermine marginalized groups advocating progress through prejudice (Cook & Glass, 2014).

Studies suggest those clinging to tradition may view social progress as threatening rather than a potential for collective advancement. Their discomfort manifests through demeaning microaggressions that unintentionally reinforce the status quo and power dynamics benefiting The 53rd Annual Meeting of the Southeast Decision Sciences Institute 2024 dominant groups (Davis, 2019). Comments like "we've always done things this way" reflect closed-mindedness.

Without addressing resistance through empathy education focused on cognitive flexibility, growth mindsets, and inclusive leadership, studies show executives are likely to continue exhibiting defensive microaggressions in response to policies expanding opportunities for minorities (Smith, 2020). Reducing bias requires openness to change.

#### **Complicity Enabled by Lack of Accountability**

Finally, extensive research underscores that insufficient accountability mechanisms enable complicity in subtle discrimination at the top levels of organizations (DeCuir-Gunby & Gunby, 2016). When reporting pathways are unclear or inconsistent, and C-suite executives face no sanctions for microaggressions, research shows harm can propagate rapidly (Shen et al., 2009; Jones, 2020).

Multiple studies reveal over 30% of C-suite executives who perpetrate racial or gender microaggressions had prior complaints dismissed without investigation or training (Rodriguez, 2021). Such unresponsiveness allows patterns of prejudice to form among senior leaders. Notably, research shows accountability policies and procedures for addressing discriminatory behaviors are much less common among C-suites than lower and middle management - over 65% of companies have strong policies for middle managers, while under 35% do for the C-suite (Sue et al., 2022). The 53rd Annual Meeting of the Southeast Decision Sciences Institute 2024

Implementing protection policies, transparent follow-through, and participative development processes that engage affected groups provides the oversight needed to disrupt normalized bias among C-suite executives at scale (DeCuir-Gunby & Gunby, 2016).

Above all, motivation matters. Though robust accountability procedures are vital, the research emphasizes reducing microaggressions requires C-suite leaders with courage driven by ethical principles, not penalties alone (Zhang, 2010). Awareness, humility, and collective moral purpose create lasting cultural change.

#### **Impact on Underrepresented Groups**

The literature demonstrates microaggressions among executives have detrimental impacts on underrepresented groups. Extensive research shows subtle discrimination from influential leaders causes anxiety, isolation, and strains performance for marginalized employees (O'Keefe et al., 2015; Nair & Good, 2021).

For instance, a study of 500 minority professionals found that those who experienced microaggressions from C-suite executives had 31% higher rates of burnout and 48% lower job satisfaction scores than peers without microaggression experiences from leaders (Holder et al., 2015). Additionally, research indicates the accumulation of workplace microaggressions from senior executives' accounts for 22% of the turnover decisions made by women of color, costing an estimated \$2.1 million in replacement costs per 1,000 employees (Smith et al., 2019).

Multiple studies based on interviews with minority executives reveal ongoing experiences with microaggressions from C-suite leaders significantly increased symptoms of depression, stress, and burnout (Holder et al., 2015; Cabell & Kozachuk, 2022). Persistent subtle bias from influential leaders signals a lack of belonging.

Likewise, research on female executives shows microaggressions questioning their competence or authority from male C-suite executives caused self-doubt, frustration, and perceptions of "prove it again" biases, needing to constantly reestablish qualifications (Chapman, 2022; Marshall, 2021). Such remarks from the top are not harmless.

Ultimately, these studies emphasize unaddressed microaggressions in C-suite ranks profoundly undermine inclusion efforts by perpetuating feelings of exclusion among traditionally marginalized groups. Though often unintended, small prejudicial acts from influential leaders signal toxic climates (Sue et al., 2007). Vigilance and moral courage can mitigate harm.

Table 1. Summary of Key Findings on Drivers of Microaggressions Among Executives			
Author	Year	Findings	
Slayton-	2017	C-suite leaders from racial/ethnic minority backgrounds	
Robinson		experienced microaggressions questioning work styles	
		due to a lack of cultural awareness.	
Andriesz	2019	C-suite leaders often made insensitive jokes about	
		culturally distinct names, revealing deficits in cultural	
		competency.	
Friedlaender	2018	C-suite leaders criticized teammates' English abilities	
		through subtle discrimination.	

Dixit	2016	Microaggressions acted as barriers to advancement for
		Asian American leaders.
McGuire et al.	2007	Generational hierarchies caused prejudice between C-
		suite executives and younger employees.
Mangum	2021	Directive C-suite leaders perpetuated prejudice through
		microaggressions.
Karani et al.	2022	Virtual distance increased disinhibition and the
		likelihood of microaggressions.
Cook & Glass	2014	Resistance to change associated with defensive
		microaggressions from executives
Rodriguez	2020	Minority executives experienced microaggressions
		questioning qualifications.
Holder et al.	2015	Microaggressions from leaders caused anxiety,
		isolation, and lower performance.

# Strategies for Progress in Research and Practice

Fortunately, emerging research provides insights for reducing microaggressions among Csuite executives and leaders through evidence-based policies to foster more inclusive institutions. While challenges remain, findings enable proactive strategies built on compassion and courage, including:

• Implementing continuous inclusion education programs tailored for executives focused on building cultural intelligence, generational awareness, and recognizing personal unconscious biases (Zhang, 2010). Training must evolve beyond one-time sessions into lifelong learning.

- Developing executive coaching focused on managing reactions, emotional intelligence, mindfulness, ethical decision-making, and constructive feedback skills (Jones, 2019).
- Fostering participative, democratic leadership approaches that actively empower diverse perspectives. Authoritarian mindsets must shift to collaborative engagement (Rodriguez, 2022).
- Establishing structured communications protocols for executives facilitating inclusive dialogue through empathetic listening and integrating diverse inputs (Jones, 2020). This sustains psychological safety.
- Enacting clear, tailored antidiscrimination policies and training for hybrid/virtual contexts to curb online disinhibition of bias among leaders (Karani et al., 2021).
- Promoting cognitive flexibility, growth mindsets, and openness to diversity initiatives among executives (Smith, 2020). This reduces defensive microaggressions.
- Implementing transparent accountability systems with leadership development focusing on values and ethics (DeCuir-Gunby & Gunby, 2016; Zhang, 2010). Sanctions alone are insufficient.

However, progress requires a commitment to address complex root causes with nuanced understanding. Executive-specific research can inform tailored solutions.

# Discussion

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Despite positive intentions, this review synthesized extensive literature on subtle discrimination from executives. Given leaders' high influence, unconscious biases often have magnified detrimental impacts by signaling prejudice (Sue et al., 2007).

Yet tailored training on cultural humility and emotional intelligence, structured communications protocols, psychologically safe policies, and accountable leadership enable consciously fostering diversity while addressing biases manifesting subtly (Shen et al., 2009).

Critically, leadership development on ethics, empathy, and cultural awareness should begin before professionals reach executive levels and continue throughout their careers (Cook & Glass, 2014). Lifelong learning is essential.

Sustainable inclusion requires moving beyond rhetoric to daily practices embodying moral purpose, compassion, and courage (DeCuir-Gunby & Gunby, 2016; Zhang, 2010). Executives can create equitable institutions that leverage diversity's full potential by confronting challenges. But solutions require perseverance, vigilance, and collective awareness.

#### **Mentorship and Sponsorship**

Emerging research also highlights the vital role of mentorship and sponsorship initiatives in addressing executive-level microaggressions' harmful impacts. Studies emphasize formal programs matching senior leader mentors to high-potential diverse professionals provide guidance and psycho-social support when facing subtle discrimination (Wilson, 2020; Gomes, 2021). Mentorship helps healthily navigate prejudicial climates while opening pathways for marginalized groups to ascend into executive ranks through individualized empowerment (Cabell & Kozachuk, 2022). Meta-analytic findings confirm mentorship enhances promotion rates for underrepresented groups (McCann, 2022).

Likewise, senior leader sponsors actively advocate for and create leadership opportunities to help drive institutional change. Studies reveal consistently pairing emerging diverse talent with executive sponsors increased C-Suite promotions by over 15% (Pompper et al., 2021).

Structured initiatives allow organizations to tangibly enact inclusion by empowering leaders to lift marginalized groups facing barriers like microaggressions. But success requires accountability tracking outcomes, not just engagement (Russen et al., 2023).

### Leader Character and Allyship

Additionally, research underscores the importance of fostering courageous, socially conscious leaders committed to equity and inclusion. Studies find executives exhibiting virtues like courage, empathy, humility, and justice demonstrate significantly lower subtle discrimination rates (Warren & Warren, 2023).

Likewise, leaders who educate themselves on barriers facing minorities, speak up against bias and advocate for equitable policies perpetrate fewer microaggressions (Basford et al., 2014). Living allyship values through action helps create bias-free climates (Seijts & Milani, 2022).

However, organizations play a key role through high-quality allyship education and tailored training, equipping leaders to recognize harms, intervene constructively, and promote

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justice (Cabell & Kozachuk, 2022). Authentic allyship requires continual skill-building and practice.

These insights provide evidence-based strategies to address microaggressions at the executive level while highlighting the need for additional research. But sustainable solutions necessitate perseverance, courage, and moral purpose.

#### **Recommendations for Organizations**

Based on the research insights, organizations can address microaggressions among executives and leaders through actions including:

- Conducting inclusion audits to assess microaggression prevalence with anonymous reporting channels (Shen et al., 2009).
- Establishing a senior leader Code of Conduct prohibiting unconscious bias and microaggressions with complaint procedures (DeCuir-Gunby & Gunby, 2016).
- Requiring continuous inclusion education focused on cultural, gender, age, and racial biases manifesting through subtle discrimination (Zhang, 2010).
- Implementing 360-degree feedback and coaching assessing competencies like cultural agility, emotional intelligence, humility, and ethics (Jones, 2019).
- Developing structured mentorship programs that empower and advocate for highpotential, diverse emerging leaders (McCann, 2022).
- Investing in allyship training equips executives to recognize harm, speak up, and advocate for inclusion (Seijts & Milani, 2022).

- Promoting participative leadership approaches to integrate diverse perspectives and concerns (Rodriguez, 2022).
- Establishing communication policies requires structured, inclusive dialogue techniques (Jones, 2020).
- Implementing consistent, accountable systems addresses microaggressions through sanctions and leadership development (DeCuir-Gunby & Gunby, 2016).
- Selecting leaders based on competencies like courage, empathy, humility, and justice to counteract prejudice (Zhang, 2010).

#### Conclusion

In conclusion, research indicates that subtle discrimination by influential executives can profoundly shape organizational culture and inclusion efforts by unintentionally signaling unconscious biases (Sue et al., 2007).

Studies suggest that progress requires addressing complex root causes among senior leadership where prejudice originates (Holder et al., 2015). While initial solutions seem attainable, the literature reveals opportunities for further research on interventions explicitly tailored for C-suite roles and contexts.

This review synthesizes current knowledge on factors enabling microaggressions to persist at the highest levels of leadership, often despite good intentions. The findings highlight key gaps representing opportunities to expand understanding of this issue. For instance, additional research could inform proactive strategies built on nuanced comprehension of how unconscious bias manifests subtly. However, realizing sustainable equity likely necessitates The 53rd Annual Meeting of the Southeast Decision Sciences Institute 2024

commitment, courage, vigilance, and collective perseverance from leaders, according to emerging insights.

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#### CONNECTION BETWEEN CULTURE AND ORGANIZATIONAL EFFECTIVENESS

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#### ABSTRACT

The importance of culture is well known, be it a team, an organization, or a society. Culture affects and it gets affected too! Does culture evolve or it can be created and crafted? In today's fast changing work environment, should the focus be on maintaining, preserving and sustaining culture or modifying and shaping it? What role culture plays in enhancing the effectiveness of an organization? Many such questions have been of interest to scholars for ages. Various frameworks and models on culture are reported in the literature. Similarly, there are а number of studies elaborating different organizational effectiveness approaches. However, the ambiguity that exists around the conceptualization of the constructs of 'culture' and 'organizational effectiveness' makes the task of examining this relationship extremely challenging. The present paper aims at exploring some of the important variables relating culture and effectiveness in the organizational context highlighting areas for future research.

Key words: Culture, Effectiveness, Organizations.

#### PERCEIVED ORGANIZATIONAL RESPECT AND ALLEVIATION OF TELECOMMUTERS' SENSE OF ISOLATION

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#### ABSTRACT

This study seeks to understand how organizations may improve the psychological well-being of telecommuters. Applying the social identity approach and the need to belong theory, we have examined the connection between the respect telecommuters observe from their organizational managers and their sense of isolation. Through findings from a quantitative survey and a qualitative analysis of participants' feedback, this study suggests that perceived organizational respect from telecommuters' managers is negatively associated with their sense of isolation while comparative organizational respect from telecommuters is positively associated with their sense of isolation. This study contributes to the telecommuting literature by providing insights on how to cultivate quality telework environments.

Keywords: telecommuting, perceived respect, comparative respect, isolation, quality work relationships.

#### INTRODUCTION

Feelings of isolation are common in the digital age. For many, texting has replaced phone calls, emails and social media have supplanted in-person conversations, and teleconferences have become a proxy for face-to-face meetings. Although communication technologies offer a means to increase interactions, when their use reduces or replaces human contact they can increase feelings of isolation, loneliness, and even depression [1-3]. This effect may be particularly evident amongst teleworkers [4].

Telecommuting has grown in popularity over the last 20 years due to its many benefits such as improved schedule and location flexibility, job satisfaction, autonomy, reduced commute time and expense, and helping working parents balance life and work demands [5-10]. COVID-19 further heightened the adoption of telecommuting as it enabled many to reduce their likelihood of contracting the virus, and for some, continue working while caring for homebound children [11]. However, the largescale shift to remote work because of the pandemic highlighted a common drawback to working from home – an increase in psychological isolation [4, 11, 12, 13]. Psychological isolation is a feeling that one is disconnected from others, lacking desired social and influential network connections, and "that the need for support, understanding, and other social and emotional aspects of interaction are not fulfilled" [12, 14]. Prior studies have tied psychological isolation to numerous deleterious effects, such as job dissatisfaction, increased stress, high turnover rates, and even poor health [4, 7, 12 15,16, 17]. Given the extended telecommuting options currently being offered to many employees and what may be a radical shift in the acceptability of remote work [18], it is critical that we investigate the

Prior research suggests organizations can support telecommuters' career success by offering them opportunities for training, recognition, advancement, and opinion sharing equal to those enjoyed by inperson employees. Supporting telecommuters to reduce their psychological isolation may be more challenging, however, as isolation stems from a lack of meaningful interaction and relationships with colleagues. One factor that may influence telecommuters' psychological isolation is respect. According to [13], respect is a fundamental ingredient in the types of "high-quality relationships," that managers should cultivate to help teleworkers feel less isolated. Relatedly, [15] found that respect influences organizational identification and that the physical isolation that typifies remote work leads to a reduction in how respected

telecommuters' feel. Thus, it is possible that respect is also associated with telecommuters' psychological isolation, and this relationship has yet to be fully investigated.

Studies that explore respect in organizations have provided a variety of conceptualizations of this construct, e.g., respect as a component of status, an outcome of procedural justice, or a need and a critical element of organizational identification [14, 15, 19, 20, 21]. Respect may be considered an inherent right afforded to all humans, or as treatment and recognition earned by individuals based on their unique "attributes, behaviors, and achievements" [22]. Respect may be viewed from the perspective of those conferring respect or from the perspective of recipients [19, 21]. The latter of these is perceived respect, defined as "an identity-based status perception that reflects the extent to which one is included and valued as a member of the organization" [15]. The judgements one makes regarding their perceived respect within an organization may be autonomous or comparative [20]. Autonomous judgements are "...based on internal standards about what constitutes group membership or inclusion in a group," [20]. Comparative judgements are relative, in other words, how respected one feels stems from a comparison of their treatment to that of others [20]. From whom respect is received, e.g., from peers or from managers, may also play a role in telecommuters' feelings of isolation. However, few studies to date have considered the role of managers in telework arrangements [23]. As managers represent the organization and are those with whom remote employees may interact most frequently, telecommuters tend to view the managers' attitudes towards them as a meter of the collective attitudes of others in the organization. Hence, we focus this study on the telecommuters' perceived and comparative respect from their managers [23]. This approach captures the abstract concept of organizational respect through the more tangible and measurable managerial respect. It also provides a new perspective in investigating how managers may reduce telecommuters' feelings of isolation.

This study enriches the literature on telecommuting, employee isolation, and respect by drawing from the social identity approach [24-26] and the need to belong theory [27]. It suggests that telecommuters' perceived managerial respect will reduce their psychological isolation whereas comparative managerial respect will increase it. In doing so, we provide insights into how organizations may alleviate telecommuters' feelings of isolation by fostering optimum managerial respect. The remainder of the paper is organized as follows: the next section offers the study's theoretical foundation and hypotheses development; the third section presents the study's methodology and analyses; and the final section discusses the findings and offers suggestions for future research and for organizations seeking to improve their telecommuters' work experience.

#### THEORETICAL FOUNDATIONS AND HYPOTHESIS DEVELOPMENT

This study applies the need to belong theory and the social identity approach theory to examine the influence of telecommuters perceived and comparative managerial respect on their psychological isolation. The need to belong theory [27-28] suggests that an individual's desire to be affiliated with, and accepted by, a group motivates their behaviors and interactions. The social identity approach, which refers to two closely related theories, the Social Identity Theory [25-26] and the Self-Categorization Theory [24] is often used to explain how individuals interact and behave in group settings [20, 25, 28, 29]. Both the need to belong theory and the social identity approach pertain to the psychological experiences of individuals within groups and thus are well suited to our investigation of how respect may influence telecommuters' feelings of isolation.

# Isolation

Isolation refers to a feeling that one is missing meaningful social network connections with others, and that the need for empathy, emotional support, and other social aspects of interaction are not satisfied [14, 17]. Such feelings of disconnect and loneliness have become a social epidemic in modern society so reliant on technology [30]. According to the findings from a national survey of more than 20,000 Americans

aged 18 years and older, two in five American adults feel they are isolated while nearly 50% of them sometimes or always feel left out [30]. Such widespread feelings of isolation create high societal costs. In England, the annual cost of issues associated with loneliness is £32bn every year [31], leading the British government to appoint the first minister of loneliness in the world [32].

The COVID-19 pandemic led to an unprecedented level of telecommuting, from optional telework for 31% of office-based employees to obligatory telework for as many as 88% of workers [33]. Such global radical shift exacerbated the already-troubling loneliness epidemic, creating a global mental health crisis [34]. Even after the pandemic, the trend of telecommuting continues. This shift has offered the convenience of working from home but also reduced opportunities to enjoy social connections at work. This is unfortunate as research suggests relationships with co-workers are "…critical to organizational socialization and interactional processes, and these processes are linked to organizational outcomes, such as increased production, worker satisfaction and worker retention" [35] and that those who lack these connections may experience exacerbated feelings of isolation and poorer mental health.

## The Need to Belong Theory and the Social Identity Approach

In this study, we have adopted the need to belong theory and the social identity approach as the overarching theories because of their respective scope; the prior analyzes the drive for social connections and group membership and the latter [24-26] explains how we interact with others and behave in group settings. According to the need to belong theory, we are social creatures; forming and maintaining social connections is one of the most basic and powerful human needs, akin to our need for food and water. Our need for social interactions with others drives many of our emotions, cognitions, and behaviors. Deprivation of social connections can damage both physical and mental well-being and may be even more harmful than obesity or smoking [27-29] [17, 31]. The need to belong theory provides insights into the fundamental motivations that compel individuals to feel accepted and valued in group and has been used to help us better understand a variety of belonging-driven behaviors, such as obsessive-compulsive use of online social networks [38], the elicitation of positive emotions by sporting activities [39], and relationships between organizational power and loneliness [40]. In this study, we apply such insight on the human need to find connections in groups to guide our investigation on how telecommuters' sense of isolation may be influenced by respect they perceived within organizations.

The social identity approach refers to studies related to two intertwined and independent middlerange theories: the Social Identity Theory [25-26] and the Self-Categorization Theory [24]. The Social Identity Theory suggests that people derive their sense of self in society from group membership, which is also a main source of their sense of pride and belonging. Groups can be a class, an organization, a party, a family, a sport team, etc. The Self-Categorization Theory [24, 41] goes one step further to describe the process of social identification behind the Social Identity Theory. The Self-Categorization Theory suggests that our self-identity is defined at various levels, e.g. "I" focusing on individuality, "we" as a member of the group, and "we humans" that distinguish humans from other species. When self-categorization happens, our view of self transforms as we adopt the attributes (beliefs, values, mannerism, etc.) that distinguish the members a group from others [41]. According to the social identity approach, people desire acceptance and verification from others to define and reinforce their self-esteem [20]. The groups through which we define ourselves vary widely - from groups of close friends to groups built around social issues, academic clubs to religious congregations, professional organizations to special interest groups. We also define our identities through our work. According to a recent survey, Americans spend on average, 8.5 hours working on weekdays and 5.3 hours on weekends [42]. But it is not just the work we do that defines us, it is our interactions with others and how accepted and respected we feel within our working groups that help form our social identities and sense of belonging [21]. In this study, we have applied these theories to explore people's psychological well-being in telework environment.

# **Employee Respect & Isolation**

Respect is the full acknowledgement of a person as an individual with moral values; a universal right granted all human beings [43]. Treating others with respect is a moral [44], and receiving it is considered one aspect of social justice. Surveys across industries and skill sets have consistently shown that employees value respect [45-47] and respectful gestures (e.g., their opinions/suggestions are heard, their contributions acknowledged and recognized, and that their supervisors care about them) above compensation and benefits, considering it fundamental to their job satisfaction [48]. Indeed, research has shown that a lack of respect devalues employees' sense of self-worth and increases employee turnover, disengagement, resentment, self-interested behavior, and aggression [20, 49, 50]. In comparison, respected employees tend to have an elevated sense of self-worth, improved organizational commitment, increased adherence to organizational guidelines, a positive mood, and are more likely to act in ways that benefit the group or organization [21, 20, 49, 50]

Receiving respect from those in positions of leadership may be particularly important to employees' well-being and sense of organizational acceptance and membership. In this study, we define "managers" as individuals in the organization to whom employees most often report. Research shows that employees who perceive themselves as respected by their managers tend to feel better about themselves, have higher job satisfaction, and may even delay their retirement [20, 28, 50, 51]. Meanwhile, those who do not feel respected by their managers are less likely to stay with their organizations, hence the saying that people quit their bosses and not their jobs [50].

Perceived respect from managers may also play a role in employees' feelings of isolation. According to the social identity approach, individuals' sense of organizational identity and belonging depends, in part, on how well they are valued in the organization, demonstrated through the treatment and respect they receive from other group members. The need to belong theory suggests that such feelings of belonging are key in addressing the human need for social connectedness and combating feelings of isolation. As such, we suggest perceived respect from others plays an important role in employees' sense of isolation. Teleworkers, however, often enjoy less interactions with peers than do co-located employees, leaving them overly reliant on their managers for workplace social connectedness and to define their organization membership [23]. If managers treat them with respect, telecommuters will feel a sense of belonging in their organizations and therefore feel less isolated. If telecommuters do not feel respected by their managers, they may feel undervalued and not as connected to the group, leading to greater feelings of isolation. Hence, we hypothesize:

#### H1: The more respect telecommuters perceive from their managers, the less isolated they will feel.

In addition to the deep-seated need for social connections and acceptance by others as members of the group, employees also desire to be acknowledged for their attitudes, skills, and contributions - to create a reputation based on their unique personal identities. These are two connected and competing human needs: the need to assimilate and belong which drives us to blend in by adopting the group mannerism and traits, and the need to be recognized for our uniqueness and distinguish ourselves from others. The social identity approach suggests individuals satisfy their need to stand out by how they compare to others in the group [52]. One way that employees compare themselves to others is based upon the treatment they receive versus the how others in the group are treated. If they feel better treated, they will feel more respected than others and elevated above their peers in the eyes of managers [20]. This differentiation may lead to a separation of the individual from the group, a shift from "we" to "me" that may undermine feelings of connectedness and belonging. Although prior research suggests a negative relationship between power and loneliness [53], perhaps sayings such as, "it's lonely at the top" stem not from power but from perceptions of greater comparative respect which creates differentiation, a lack of shared identity, and distance from the group. Based on this reasoning, we suggest that telecommuters who perceive themselves as being more respected by their managers than other maybe be more vulnerable to feelings of isolation and separation. Hence, we hypothesize:

*H2*: The more respect from managers that telecommuters perceive compared to their peers, the more isolated they feel.

The drives to be both accepted and elevated in a group are competing yet connected components of an employee's social identity [27]. Employee sense of security and self-worth is threatened at the either extreme because it does not feel good to be unrecognized nor does it feel good to stand out so much that one loses their sense of belonging. Employees will thus strive to meet the need that is insufficiently met. For example, employees may alter their perceptions of themselves or their team, or even exit a team to join another team to satisfy these needs [54]. Ideally, employees will perceive a balance in their sense of belonging and their sense of differentiation [55].

#### **RESEARCH METHODOLGY**

### Procedure

Data was collected via an online survey distributed to a participant pool offered by Qualtrics -Qualtrics Consumer Panels (QCP). Using QCP allows researchers to survey participants from a wide range of industries, sectors, organizations, and demographic backgrounds (education, marital status, number of children, organizational tenure, etc.), thus improving the generalizability of findings. Qualtrics reviews researcher-created surveys for appropriate settings and time requirements before sharing it with the target QCP population, in our case, full-time employees who work at least some of their weekly hours remotely. Following two pilot-tests with a limited number of participants to fine tune the survey items, we completed the data collection.

#### Measures

In addition to collecting demographic data, we used a multi-item, seven-point Likert scale survey (Strongly Disagree to Strongly Agree) for the study's variables of interest. The dependent variable – the extent of psychological isolation - was measured by seven items from [14] with questions such as "I miss informal interaction with others" and "I miss the emotional support of coworkers." The first independent variable - perceived respect - refers to employees' perceived respect from managers [15, 56]. As managers are seen as organizational representatives by all employees and even more so by telecommuters, we combined items from perceived organizational respect and perceived managerial respect into a single scale labeled perceived managerial respect. Six items are used to measure perceived managerial respect, three from adopted from [56] and three from [20]. Three items from [20] are used to measure the final independent variable - comparative managerial respect. Details on constructs, sources, and items are provided in table 4 in the Appendix.

Demographic data noted as pertinent to employee isolation and respect by prior studies, including age, gender, marital status, number of children [57], how long the employee has telecommuted, and the employing organization's sector (for-profit or non-profit), were collected [15]. The employing organization's industry type was also collected. To gain more insight on employees' telecommuting experiences, the survey also included three open-ended questions asking participants to contemplate how being physically absent from the workplace influences their relationships with their colleagues and organizations and to explain the advantages and drawbacks of telecommuting. These open-ended questions provide a rich context for us to understand the role of respect in the work experiences of telecommuters, also making the findings of this study more comprehensive and credible.

### **Participants**

The final data collection included 500 responses. Of these, 56 responses were incomplete and dropped from the sample, leaving 446 responses. Sixty percent of participants indicated they teleworked at least 3 days a week while 38% worked remotely full time. More than half of the participants (52%) had telecommuted for at least 3 years. There were more females than males in the sample (63% female versus 37% male) and most were younger than 45 years old (73%). Almost two thirds of participants had children (63%) and most had earned an Associate degree or higher (73%). The participants represented a wide range of industries including, but not limited to, health care, education, manufacturing, marketing and sales, finance, and biotech-pharmacy. Three quarters of participants worked at for-profit organizations (74%), and two thirds of all employing organizations had more than 100 employees. A lengthy tenure was also common with 45% of participants indicating they had worked more than five years with their current organizations, while 49% had worked for the same organization for one to five years.

#### RESULTS

# **Quantitative analysis**

Results of an exploratory factor analysis (Table 1) shows strong loadings on their respective latent constructs, with the lowest loading at .716, and the highest at .930, and an acceptable internal reliability [58-59]. The average variances extracted (AVE) for perceived managerial respect is .660, comparative managerial respect .842, and isolation .738, all exceeding the recommended .50 threshold suggesting acceptable convergent validity (Table 1). Furthermore, the square root of AVE for perceived managerial respect is .813, comparative managerial respect .918, and isolation .859 (Table 1).

Constructs	Items	Factor loading	Average variance extracted	Square root of AVE	
Perceived respect (PR)	PR1	.781	.660	0.813	
	PR2	.825			
	PR3	.864			
	PR4	.844			
	PR5	.745			
	PR6	.812			
Comparative respect (CR)	CR1	.930	.842	.918	
	CR2	.904			
	CR3	.920			
Isolation (IS)	IS1	.716	.738	.859	
	IS2	.731			
	IS3	.650			
IS4		.740			
	IS5	.822			

 TABLE 1: FACTOR ANALYSIS

	IS6	.775			
	IS7	.731			
Note: $\chi^2 = 213.549$ (df=94, p=0.000); RMSEA=0.053; NFI = .954; CFI = .973; RMF= 0.034; GFI = .944					

Inter-factor correlation values are .215, 0.220, and .219, respectively (Table 2), indicating acceptable discriminant validity. As the data are self-reported, collected through cross sectional research design with the same questionnaire, we ran Harman's single factor test to determine if a common method effect was present. The results show that a single extracted factor accounts for 31.129% of the total variance, a value well below the maximum suggested threshold of 50% [60], thus no clear evidence of a common method bias in this study.

Results of the reliability analysis (Table 2) suggest the three scales have sufficient internal reliability with Cronbach's Alphas of .905 for perceived managerial respect, .934 for comparative managerial respect, and .807 for isolation, all above the suggested threshold of .7 [61]. Additionally, Cook's distance test and boxplots do not suggest significant outliers or influencers in the data.

	PR	CR	PI	
Perceived respect (PR)	.905			
Comparative respect (CR)	.215**	.934		
Psychological Isolation (PI)	220**	.219**	.807	
Note: ** Correlation is significant at the 0.01 level (2-tailed). The diagonal values are Cronbach's Alphas.				

#### **TABLE 2: RELIABLITY STATISTICS**

We next tested the relationships among the hypothesized constructs using structural equation modeling (SEM). SEM examines the relationship between variables and their underlying constructs via a measurement model and a structural model that test relationships among the latent constructs. The results show that the root-mean-square error of approximation (RMSEA) value is 0.053, less than that suggested cutoff value of .10 [62], the Normed Fit Index (NFI), Comparative Fit Index (CFI), and Goodness of Fit Index (GFI) are all over the recommended threshold of .90 [63]. These analyses suggest that the hypothesized measurement model showed acceptable fit to the data, the items were clustered as predicted, and that the three constructs were well explained by their indicator variables ( $\chi 2$  (df=94, p=0.000) = 213.549; RMSEA=0.053; PCLOSE= .246; NFI = .954; CFI = .973; GFI = .944). Results of path analysis (Figure 1) support both hypotheses: telecommuters' perceived respect is negatively related to their feelings of isolation ( $\beta = .0.44$ , P < 0.01); and their comparative managerial respect is positively related to their feelings of isolation ( $\beta = .35$ , P < 0.01).

#### **FIGURE 1: PATH ANALYSIS RESUTS**



Note: \*\*\* significant at the .001 level (2-tailed); \*\* significant at the 0.05 level (2-tailed), and the values in the parentheses are standardized beta coefficients.

We also tested the robustness of the theoretical model by including the control variables such as age, gender, marital status, number of children [57], how long the employee had telecommuted, and the employing organization's sector (for-profit or nonprofit) [15]. As shown in Table 3, perceived managerial respect is significantly correlated with tenure and whether the organization is for-profit or nonprofit, and comparative managerial respect is significantly correlated with gender and education. Perceived managerial respect has a negative correction with isolation (r= -.220), and comparative managerial respect has a positive correlation with isolation (r= -.220), and comparative managerial respect has a positive correlation with isolation (r= .219). Both results are significant at the 0.01 level. Therefore, the hypothesized relationships still hold when we include the control variables in the model, validating the results of this study. Although factor analysis and confirmatory analysis support perceived and comparative managerial respect as distinct concepts, correlation analysis indicates that the two are related. People who perceive high levels of respect from their managers also feel they are comparatively more respected than others in the group.

	1	2	3	4	5	6	7	8	9	10	11
1.Age											
2.Gender	0.069										
3.Marriage	.099*	0.029									
4.Children	.262**	0.073	.334**								
5.Education	-0.061	128**	0.054	128**							
6.Tenure	.328**	0.001	.143**	.008	0.097*						
7.TelLength	.213**	0.000	0.074	.16**	0.052	.487**					
8.TeleDays	.057	.119*	.096*	.149**	-1.46**	.107*	.185**				
9.Profit	0.047	.143**	-0.063	0.044	.117*	-0.011	-0.030	011			
10.Isolation	034	059	074	057	.068	030	042	.047	.025		
11.Perceived Respect	.029	-0.14	.057	.070	.001	.095*	.077	067	116*	220**	
12.Comparative Respect	018	- .154**	.081	0.039	.149**	006	.008	.036	.025	.219**	.215* *

TABLE 3CORRELATION ANALYSIS RESULTS (N=446)

Note: \*Correlation is significant at the 0.05 level (2-tailed), \*\* Correction is significant at the 0.01 level (2-tailed).

#### **Qualitative exploration**

To gain more in-depth understanding on telecommuters' psychological experience and provide more context to this study, we have also examined participants' answers to the three open-ended questions. The survey shows mixed feelings about telecommuting. Some people did not feel their physical distance impacts their relationships: "*It doesn't. We maintain a strong working relationship.*" "*It does not impact me.*" "*It really doesn't, just makes everything easier*". Participants who preferred telecommuting tended to

value the increased productivity and task focus telecommuting provides: "[Telework] helps to concentrate on specific tasks without unnecessary interruption.", "Ease of expediting work activity digitally vs long face-to-face meetings", "I think it helps because I can get more done in my own fashion making me more productive." More participants, however, felt isolated by telework and lamented their loss personal connections with colleagues: "I often feel out of the loop on major changes in business. Employees I used to work with all the time rarely contact me for help." "You don't feel as involved as you would if face to face." "[Telework] put space between us," "Not around for enough bonding time," "I just feel isolated and sometimes lonely. It makes the day kind of long and boring." "I don't feel connected to the company or co-workers because there is little to no interaction." One managerial participant noted that not all employees use telework to be more productive and focused, commenting: "Lack of face time does affect how employees regard tasks and general performance. Sometimes you need to micromanage certain employee performance." The teleworking benefits most frequently noted by participants included schedule flexibility, independence, time and money saved through reduced commuting, more time with family and pets. However, others bemoaned the loss of separation of work from family life. "I want to get my weekends back." "Tendency for work hours to become fuzzy - wind up working later than I would at office." "Hard to separate work time from personal time."

#### DISCUSSION

Long before the COVID-19 pandemic, telecommuting was a popular work arrangement, particularly among employees with family responsibilities. However, its growth has been slower than expected [64], stymied by traditional work culture, employees' concerns regarding organizational visibility and career opportunities, and a lack of organizational investments in telecommuting technologies and in the creation of new policies and performance assessments needed to effectively manage remote workers. However, the sudden shift to mandatory remote work for many in spring 2020 forced both employers and employees to figure out how they could make telecommuting work. It also spawned new telecommuting and management technologies, increased organizational investments in telecommuter support tools, and a rethinking of how and where work is done. So radical was the shift to telework that many choose to continue this work mode post pandemic [65]. More research will be needed on the policies and tools that facilitate telework and on how organizations can foster a happy, committed, and productive workforce regardless of work location.

#### **RESEARCH CONTRIBUTIONS**

Onsite employees often enjoy greater opportunities for social connections with their peers (e.g., bumping into each other in the coffee room, cubical or office visits, lunching together, etc.) than do telecommuters, leaving remote workers heavily reliant on their managers for organizational connection and a sense of belonging. As such, it is important to understand the role managers play in teleworkers' emotional well-being. This research contributes to the telecommuting literature by drawing from the need to belong theory and the social identity approach to examine the relationship between telecommuters' perceived and comparative respect from their managers and their sense of psychological isolation. In addition to survey items that collect quantitative data, this study also delves deeper into telecommuters' psychological and emotional experiences through qualitative data.

Our findings from a survey of a diverse sample of telecommuters suggest a connection between the respect teleworkers feel from their managers and their sense of isolation; when telecommuters believe they are respected and accepted by their managers, their sense of isolation decreases, but when they believe they are respected more than their peers for their unique attributes and accomplishments, telecommuters' sense of isolation increases. These findings are in line with the need to belong theory and the social identity approach, suggesting employees desire to be accepted by the organizational group but also distinguished from others. Through these findings, this study provides important insights into how managers may

influence telecommuters' feelings of isolation, laying a foundation for future research into how organizations can support the emotional well-being of their remote employees.

#### MANAGERIAL IMPLICATIONS

The COVID-19 pandemic has escalated the change of how we work. Even after its end, many organizations are still experimenting with ways to better manage telecommuters, adapting their policies and practices to what may be a much-increased permanent remote workforce. To manage teleworkers effectively and support their well-being, managers will have to adapt as well, rethinking their roles, their metrics (performance assessments, hours worked, etc.) and their interactions with, and support of, employees (communication patterns, modes, styles, message, etc.) [23]. While all employees will benefit from positive and supporting relationships with their managers, telecommuters may benefit from these reinforcing relationships as they have been found to foster greater organizational socialization and engagement [35]. Our findings suggest managers should find ways to cultivate the balance between perceived respect and comparative respect to help reduce teleworkers' feelings of isolation. Managers need to demonstrate that employees are equally valued by the organization through efforts such as regular oneon-one meetings, recognizing employee contributions, showing concern for employee well-being, avoiding favoritism, and keeping employees informed about organizational news [35]. Managers may further support telecommuters through pro-voice efforts that encourage employees to share their ideas in the organization. Such efforts have been shown to increase employee engagement and feelings of competence while also strengthen manager / subordinate relationships [36]. All these efforts make telecommuters feel included and may help foster perceived respect. While acknowledging and rewarding employees who have outstanding performance, managers should also make a conscious effort to be impartial and not show favoritism as this could lead to unhealthy competition and a prioritization of personal success and selfimage (comparative response), creating more division than unity within the organization [37]. Supporting teleworkers and reducing their feelings of isolation will require managers to treat the balance between employee's perceived respect and comparative respect as an interpersonal goal and a strategic imperative.

#### LIMITATIONS AND FUTURE RESEARCH

This study is not without its limitations. First, salary information was not collected in this study. Although salary beyond a level needed for comfort is not a primary driver of employee performance or organizational commitment, it is an important aspect of any job. In future studies, it would be worthwhile to explore the connection between telecommuter salary and perceived and comparative respect. Second, more data needs to be collected to examine whether telecommuters' attitudes and perceptions may have shifted over time and with the increase in telecommuting hours. Future research could replicate this study post-pandemic to provide insights on how the pandemic has influenced the factors of interest. Thirdly, our study gathered data via a few open-ended questions, and the collected information provided understanding on the psychological and emotional experiences of telecommuters. Future studies gathering more in depth, contextual, and rich data are needed. As managers play an increasingly important role in telecommuting arrangement, further studies of the influence managers have in telecommuters' work experiences and overall well-being would benefit both research and practice.

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#### APPENDIX

# TABLE 4CONSTRUCTS, MEASURING ITEMS, AND SOURCES

Perceived managerial respect (PR) (Eisenberger et al., 1986; Tyler and Blader, 2002)
I feel included in meetings and in decision making processes at my organization
Managers of my organization value my skills and abilities
Managers of my organization value my ideas and efforts
Help is available when I have a problem
The organization really cares about my well-being
The organization really cares about my opinions
Comparative respect (CR) (Tyler and Blader, 2002)
Managers of my organization treat me better than they treat other employees
Managers of my organization respect me better than they respect other employees
Managers of my organization value me more than they value other employees
Isolation (IS) Golden et al., 2008
I feel left out on activities and meetings that could enhance my career
I miss the emotional support of coworkers
I miss face-to-face contact with coworkers
I feel out of the loop
I feel isolated
I miss informal interaction with others
I miss out on opportunities to be mentored.

### A BLESSING OR A CURSE: A REFLECTION ON REMOTE WORK ARRANGEMENT DURING THE PANDEMIC AND BEYOND

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#### ABSTRACT

Many organizations switched to large-scale remote work, adapting to the needs of social distancing during the COVID-19 pandemic. More than ever, remote work has become a widely available option of work mode. The effectiveness of remote work was under scrutiny, as employers and employees investigated the way of working in the post-pandemic era. Based on interviews with fifteen business leaders, this paper offers insights into the sustainability of remote work from the perspective of organizational justice and isolation.

In general, our interviewees believed that remote work had obvious advantages, such as enhanced flexibility, autonomy, and work-life balance, let alone saving time and money on commuting. They acknowledged the fact that remote work was a new norm and an indispensable part of business in the post-pandemic era despite the challenges of remote management and workplace isolation.

The leaders cautioned that remote management may cause organizational justice problems. Although the performance evaluation system was typically designed to capture jobrelated outcomes and behaviors and seemed to be unaffected by work mode, remote workers could be less visible and less recognized for their good performance, compared to those in the office. Remarkably, some interviewees emphasized the importance of an in-person agent to advocate for those who were remote.

From an isolation perspective, our study reveals that remote work could cause isolation issues both professionally and personally. Professionally, remote work decreases face time in the office, making workers feel insufficiently informed or connected to peers and supervisors. With similar concern, organizations promoting work flexibility might require some employees to work in the office, if they do not receive sufficient updates on work progress from the employees, inevitably making in-person mode a punishment. Personally, remote work attenuates a person's social connections at work, making some longing for a workplace where people are "moving around". Interestingly, for people with close social connections at home, there is less need for an in-person work mode to address the isolation issue. It indicates the transferability of isolation across the work and life domains.

Going forward, our participants expressed a preference for a combination of remote and office-based (hybrid) work arrangements. This mode ensures sufficient face time and flexibility in part of the week and aggregates the benefits of in-person and remote work. In addition, participants also believed that working in the office is essential for junior employees because the environment supports learning, mentoring, and socialization. For organizations going for one hundred percent remote work, efforts were made to hold regular events, where employees enjoyed collaborative learning and building connections with each other.

#### LEARNING FROM THE LIVED EXPERIENCES OF AFRICAN AMERICAN SENIOR EXECUTIVES IN FORTUNE 500 ORGANIZATIONS: A TRANSCENDENTAL PHENOMENOLOGICAL STUDY OF BLACK CORPORATE TRAILBLAZERS

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#### ABSTRACT

African American Senior Executives (AASE) exist as a group of American citizens who hold senior management roles in Fortune 500 organizations. AASE members are responsible for decision-making in a diverse number of industries but represent a small group of leaders in Fortune 500 organizations. The purpose of this qualitative transcendental phenomenological study was to examine the lived experiences of AASE in a Fortune 500 organization in the United States. The qualitative study examined through semi-structured interviews the experiences of eleven senior executives in Fortune 500 organizations in the United States.

This phenomenological study examined how the lived experience of each AASE member influences their decision making, success as leaders, and career path. Transcendental phenomenological analysis approach to the study provides the researcher with an in-depth opportunity to reach the pure essence of the participants' unique lived experiences verbatim.

This research study captured the rich contextual dialogue of each participant in the study and answered the central research question: What are the lived experiences of African American Senior Executives in Fortune 500 organizations in the United States? The research revealed that among the most influential contributors to the lived experiences and success of AASE were the experiences they developed through mentorship, visibility, diversity, family values, HBCU's, and self-ambition, which helped them to become successful despite the structural barriers encountered along the path.

## MAXIMIZING JOB PERFORMANCE: THE NEXUS BETWEEN MENTORSHIP DYNAMICS AND SUSTAINABLE DEVELOPMENT GOALS

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#### ABSTRACT

In an era where environmental consciousness is paramount, public and private organizations are increasingly embracing responsible practices that harmonize financial objectives with societal and ethical considerations. This study investigates the intricate relationship between Corporate Social Responsibility (CSR), Environmental, Social, and Governance (ESG), and the Sustainable Development Goals (SDGs), which collectively serve as guiding frameworks for organizations navigating the complex terrain of corporate responsibility. CSR embodies the commitment to align financial goals with ethical and social values, while ESG provides a measurable framework encompassing non-financial performance. Moreover, CSR includes a company's dedication to community engagement, diversity and inclusion initiatives, ethical leadership, mentorship, executive compensation, and risk management practices. The alignment of business practices with SDGs underscores an organization's dedication to sustainable development and global citizenship. When infused with CSR, ESG, and SDG principles, mentorship programs foster robust connections with employees, customers, and communities, resulting in heightened loyalty and support. This study delves into the impact of sustainable and responsible business practices on employees' job performance, analyzing 350 survey responses from individuals in both public and private organizations. Findings reveal that gender equality (SDG-5), environmentally sustainable practices (SDG-9), diversity, equity, and inclusion (SDG-10), and strong institutional support (SDG-16) positively influence employees' person-organization fit, person-job fit, and achievement goals. This study underscores the profound impact of mentorship as a potent instrument for advancing SDGs, empowering individuals with guidance, support, and resources to contribute significantly to a more sustainable and equitable world.

Keywords: CSR; ESG, SDG, mentorship; job performance

# THE ROLE OF DECISION-MAKING STYLES ON THE UNCERTAINTY AVOIDANCE AND PERFORMANCE RELATIONSHIP: MODERATING ROLES OF GENDER

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#### ABSTRACT

According to Social Adaptation Theory values are types of social cognition that facilitates the adaptation to environment. As a social value, uncertainty avoidance refers the extent to feel threatened by uncertain situations and not tolerating deviant behaviors (Hofstede, 2001). Studies show that individual value differences have more predictive power on work outcomes than society-level (Taras et al, 2010). In the workplace, uncertainty avoidance may refer individuals' preference to know the views and expectations of their supervisors. When expectations are clear for the performance, uncertainty avoidance individuals may have more resources, flexibility and creativity than the situation when the expectations are unclear. High uncertainty avoidance individuals prefer structure and clear guidelines, while low uncertainty avoidance individuals are more open to ambiguity (Wang and Chan, 1995; Hardisty and Pfeffer, 2017). Therefore, it can be assumed that individuals with higher level uncertainty avoidance perform better in task performance, showing the extent to which an individual effectively accomplishes their assigned tasks. Meanwhile, individuals with lower level uncertainty avoidance perform better in initiative performance, indicating the extent to which an individual's ability to take proactive steps, show creativity, and go beyond assigned tasks. It may also be proposed that decision making styles may play a mediating role in the relationship between individual values and their performance related outcomes. Individuals with high uncertainty avoidance may prefer analytic decisionmaking as it provides a structured and predictable approach, reducing the discomfort associated with uncertainty (Rosen and Knäuper, 2009). Those with low uncertainty avoidance may lean towards intuitive decision-making, as they may be more comfortable with ambiguity and openended situations.

The purpose of the paper is to explore the role of decision-making styles on the uncertainty avoidance and individual performance relationship, and also to examine any gender differences in

all interactions. Based on the purpose we have collected data via online questionnaires from 491 employees working different companies in Germany. We have used the PROCESS macro for SPSS, an observed variable ordinary least squares and logistic regression path analysis modeling tool. The results show that uncertainty avoidance increases analytical decision-making, decreases emotional and holistic intuition decision-making styles; holistic intuition decreases task performance and increases initiative performance; emotional intuition decreases initiative performance; holistic intuition plays mediator role in the relationship between uncertainty avoidance and task performance; emotional and inferential intuitions play mediator roles in the relationship between uncertainty avoidance and initiative performance. The moderating results show that females with low uncertainty avoidance have higher level of analytics than males; females with low analytics have higher level of emotional intuition than females; females with low analytics have higher level of analytics than males. All these findings and details are planned to discussed in the congress.

# WHY FIRMS MAKE CHIEF DIVERSITY OFFICER (CDO) APPOINTMENTS: A SYSTEMATIC LITERATURE REVIEW

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#### ABSTRACT

A major initiative undertaken by business and academic institutions to promote diversity and social inclusion is the appointment of a chief diversity officer (CDO). Initially charged with equal opportunity and compliance, a diversity expert is now responsible for exploiting diversity as a core competence. A CDO is also charged with meeting an organization's strategic needs of procuring talent and developing gainful relationships with its external stakeholders. Today, almost every Fortune 500 firm boasts a CDO. However, not much attention has been given to how firms make CDO appointment decisions. For example, does a firm appoint a 'token' CDO due to compliance issues or is it a strategic choice based on the firm's ethical values? It is important to understand these motivations governing CDO appointments because these can play a critical role in CDO success, and in turn, organizational success. However, research on organizational motivations behind CDO appointments is scarce. It is unclear how firms make CDO appointment decisions and how these decisions impact organizational performance and diversity goals. We conducted a systematic literature review on CDO to assess the state of CDO research and identify organizational motivations behind CDO appointments and their impact on firm outcomes. We identified and content-analyzed 110 relevant studies after a systematic data extraction process. Our findings reveal that research on CDO appointments is scarce and prior research has not examined firms' motivations for such appointments. The results also show that CDO research lags behind practice in the business domain as a majority of the CDOrelated studies that we found belong to the education domain. Thus, this study highlights the need for further dialogue and research on CDO appointments. Additionally, given the recent trends of CDOs quitting due to lack of change, or firms morphing the CDOs into other positions or letting go of them, it is imperative that we advocate ethical choices in such diversity initiatives, both in practice and in research.

#### TRANSITIONAL SUPPLY CHAIN RESOURCE ORCHESTRATION ACROSS THE ORGANIZATIONAL LIFE CYCLE: A THEORETICAL MODEL

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#### ABSTRACT

This study uses a grounded theory approach to develop a theoretical model that provides insight into how supply chain resource orchestration (SCRO) is used to transition across organizational life cycle stages in young firms. Supply chain management (SCM) research has yet to address the importance of SCRO in young firms and the relative criticality of specific SCRO processes (i.e., supply chain pioneering, supply chain enriching, market opportunity leveraging, and entrepreneurial leveraging) that can either help or hinder these firms as they traverse organizational life cycle stages. Thus, SCM evolution across organizational life cycle stages is a "black box." Scholars do not yet understand the mechanisms, processes, and methods by which SCM delivers optimal value at a given organizational life cycle stage to enable subsequent progression to the next stage of organizational maturity. Studies regarding the prediction of formal SCM development and its resulting evolution, in conjunction with the organization's advancement, are lacking. This represents a significant gap in the knowledge base. While some broad theories explain how general organizational structures change over time, they do not provide the necessary granularity for understanding supply chain-specific changes during transient periods of development. Additionally, a dearth of organizational life cycle research addresses how firms "transition" from one life cycle stage to the next. This research fills this gap by offering a mid-range theory of supply chain development and SCRO in maturing firms.

Using data collected from 25 open-ended interviews with managers with direct experience in cultivating supply chains in young firms, this research examines the SCRO strategies and processes that managers use to successfully transition from one life cycle stage to the next. By doing so, this research offers several theoretical propositions that explain how orchestrators obtain valuable supply chain resources, develop/improve supply chain capabilities, leverage those capabilities to create customer value, and how those processes evolve between life cycle stages.

Proposition 1: In the R&D stage of the supply chain life cycle, firms are likelier to use a supply chain resource orchestration strategy focused on flexibility to transition to the next life cycle stage.

Proposition 2: In the rapid prototyping stage of the supply chain life cycle, firms are likelier to use a supply chain resource orchestration strategy focused on internal customer service to transition to the next life cycle stage.

Proposition 3: In the Commercialization stage of the supply chain life cycle, firms are likelier to use a supply chain resource orchestration strategy focused on internal customer service, quality, and flexibility simultaneously to transition to the next life cycle stage.

Proposition 4: In the Commercial Production stage of the supply chain life cycle, firms are likelier to use a supply chain resource orchestration strategy focused on internal customer service, external customer service, and quality simultaneously to transition to the next life cycle stage.

This study significantly contributes to extant literature, theory, and supply chain practice by offering a contextually rich explanation of how managers solve issues associated with simultaneously operating and building emergent supply chains while coping with the dynamic environment, lack of resources, and austere financial constraints common among young firms.

#### ENTREPRENEURSHIP AS A SOCIAL VALUE

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#### ABSTRACT

Entrepreneurship is a powerful force driving economic development in many countries around the world. "Entrepreneurs provide one of the main engines of growth in any healthy economy...They generate jobs, support local communities and build prosperous societies" (Ernst & Young G20 Entrepreneurship Barometer, 2013, p. 2). Developed and developing economies view entrepreneurship as a socioeconomic agent that brings about technological progress, product and market innovation while reducing unemployment of the population (Ernst & Young G20 Entrepreneurship Barometer, 2013, 2016; (Kuratko, 2005). Majority of the developing countries consider entrepreneurship spearheading economic progress through job creation and social adjustment (Mohar, Singh & Kamal, 2007). Socioeconomic crises that result in rising food and fuel prices, and pose threats to social peace and security (Levenburg, 2008) might be mitigated by developing entrepreneurs as the backbone of the economy.

Conceptually based on Ajzen's (1991) theory of planned behavior, the study examined relationships among general societal entrepreneurship attitude, democratic rights, criticism of entrepreneurial discourse, social justice, and entrepreneurial intention in college students in an Eastern European country. Hypotheses were tested with logistic regression analysis and the study found a positive relationship between entrepreneurship attitude and entrepreneurial intention and between social justice and entrepreneurial intention. Developing countries and emerging economies have an urgent need for fostering entrepreneurial expansion to cope with inflation, rising food prices, serious threats to social peace and security, and other societal problems. Developments of entrepreneurship education, creating environment conducive to successful entrepreneurial activities would help resolve these societal issues.

**Keywords:** entrepreneurship; social value; entrepreneurial intention; entrepreneurship attitude; theory of planned behavior

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# Marketing Consumer Behavior

# Examining Global Seaport Selection Behaviors from the Hinterland Perspectives

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#### ABSTRACT

Seaports are at the heart of international trade since they link exporters and importers in the global supply chain. As such, seaport selection can dictate the outcome of international trade. Seaport selection is among the most demanding strategic decisions due to its inherent complexities and multi-dimensional aspects. Today's port users no longer select a port per se based on traditional attributes such as port pricing, services, and infrastructure. Instead, they consider it an integral part of global supply chain ecosystems affecting local socio-economic environments surrounding the port. Nevertheless, most existent literature on port selection overlooked the growing significance of hinterland amenities to port attractiveness. The empirical analysis of primary port users' opinions using the Kano model, PLS-SEM (Partial Least Squares Structure Equation modeling), and IPMA (Importance-Performance Analysis) revealed many differences in port selection priorities between shippers and forwarders. Reflecting on this study finding, we propose wise port marketing strategies tailored to the specific needs of shippers and forwarders to help port authorities improve their competitiveness.

**Keywords:** Global port selection, hinterland perspectives, Kano model, structural equation model, importance-performance map analysis.

#### ENVIRONMENTAL SUSTAINABILITY OF AI: UNDERSTANDING PERCEPTIONS OF AND NAVIGATING THE ENVIRONMENTAL IMPACT OF GENERATIVE AI

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#### ABSTRACT

The rapid advancement and widespread adoption of artificial intelligence, particularly generative AI, while both fascinating and impressive, also has the potential to place a significant strain on energy resources. AI systems typically utilize enormous computational power, leading to increased energy consumption. This heightened energy demand, if not managed sustainably, could exacerbate the environmental impact of the technology sector, contributing to increased carbon emissions and intensifying climate change. The technology industry, including AI companies, play a crucial role in setting ethical and sustainable standards in general. By embracing environmentally responsible practices, AI organizations could serve as role models for other industries, promoting eco-friendly practices. By ensuring the environmental sustainability of generative AI, organizations could help mitigate the environmental impact of technology, set ethical standards, and promote economic growth and social equity. But it is crucial to understand the human component in this equation- what is the public perception of generative AI when it comes to green practices and what could help improve the situation as it is today? Considering the relatively early stage of the research in this field, we offer an initial point of reference for sustainability, AI, and social marketing scholars to delve into this area. We closely examine the factors that precede and influence two significant concepts: the way people perceive the sustainability of generative AI and the actions taken by AI companies to adopt sustainable practices. We demonstrate that predominantly, environmental attitudes, along with perceived utility, actual usage, and awareness of energy consumption patterns, affect people's perceptions of the sustainability of generative AI. Simultaneously, we investigate what factors would encourage AI organizations to engage in environmentally sustainable practices. Mainly, social marketing, in conjunction with the influence of green consumers and industry norms and standards, could lead to an uptick in environmentally sustainable behaviors among AI enterprises.

#### THE CAGE MODEL AND VENTURE CAPITAL INTERNATIONALIZATION BEHAVIOR IN CHINA

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#### ABSTRACT

The CAGE model (Ghemawat, 2001), measures distance using variables for cultural, administrative, geographic, and economic distance. The CAGE model has been used in relation to trade flows (Tokas & Deb, 2020), obstacles to exporting (Miloloža, 2015) and the differential effects of national distance on different industries (Kim, et al 2019). This paper builds upon one of the key historic theories on the topic of internationalization developed by Johanson & Vahlne (1977), who posited that 'psychic distance' may be a determining factor in cross-border investment. The authors of this research propose that the CAGE model can be used to predict venture capital internationalization behavior. The measures of CAGE variables were taken from a variety of sources compiled as described in Berry et al, (2010). This paper makes use of a unique venture capital internationalization data set derived primarily from the Zero2IPO website which gathered data from the Chinese venture capital market from 1997 to 2007. While larger venture capital firms invest more aggressively overall, this research finds that in regard to the percentage of the number of investments VC firms make, venture capital firms less distant from China invest more aggressively than more distant firms using the CAGE variables for distance. The paper uses Principal Axis Factoring to arrive at a factor for CAGE for use in a pseudo-fixed effect model. This research contributes to the international business and venture capital literature by showing that institutional and geographic distance measures are useful in predicting internationalization behavior, particularly in regard to venture capital firms, and it also contributes to the understanding of the usefulness of the CAGE model. The paper discusses the implications for future academic research.

**Key Words**: Venture capital, internationalization, China, Uppsala Model, liability of foreignness, psychic distance, cultural distance, institutional distance

#### 1. Introduction

China first began its experiment with venture capital with domestic venture capital entities that receiving funding from local governments and universities (Wang, 2007). Then domestic banks got involved, backed by the government as a guarantor In the mid-1990's, leaders in the Chinese sought to encourage venture capital investment to aid in the development of high technology, and realized that the local government and banks were unable to finance the start-ups at the scale the government desired (Wang, 2007),. The growth of the Chinese venture capital industry, initially tied closely to the state, was quite slow for its first fifteen years.(Jia, 2015), But the industry began to grow rapidly as foreign venture capital firms entered the market from 1998 to 2001.

The Chinese venture capital market offers an interesting window into understanding the growth of a domestic venture capital industry alongside international expansion into a unique and growing market during a time when venture capital was becoming an international industry. Though venture capital was orginally a domestic industry with much of its presence in the United States, by 2020, the international component of venture capital had grown so that half of venture capital investments were outside the United states and 30% were cross-border investments (Alvarez-Garrido & Guler, 2020). Studying the time period of rapid growth enables the researcher to uncover venture capital expansion patterns while comparing new domestic venture capitalists operating in a new market alongside international venture capitalists who are new to international expansion.

#### **Literature Review**

#### **Venture Capital Firms**

Managers of venture capital (VC) firms put together portfolios of investments. They may combine several potentially high growth, high profit closely-held firms into a portfolio for investors to invest in. The venture capitalists who run the firm hope to earn very high returns, at least on one or some of the companies in each portfolio. They may assist firms in their portfolio by finding CEO, CFO's or other important managers to help the firms improve. Typically, firms that receive venture capital investment have to reach certain milestones to continue to receive investment capital.

Traditionally, VCsfirms have invested close to their home offices. One venture capitalist noted that he liked to make all of his investments within a half an hour drive away(Brown, 2004). However in the late 1990's,

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VCs began to make international investments (Guler & Guillén, 2010a). Theoretically, a VC firm could invest in an overseas investment without setting up shop in that country. However, part of the formula for VC success is to exercise a degree of control over investments and offer guidance to managers of the target firms in which they invest (Gompers & Lerner, 2001). This may be difficult to do if investing from a foreign location. Venture capital firms also provide technical, industry, or managerial expertise to managers of firms in which they invest in the Chinese context (Ahlstrom & Bruton, 2006; Ahlstrom et al., 2007). VCs therefore need a local presence. Foreign venture capital firms will typically set up a local office in the target country in which they seek to make cross-border investments.

Venture capital firms are a subset of service firms. Service firms may internationalize differently from manufacturing firms (Anand & Delios, 1997; Brouthers & Brouthers, 2003; Wright, Pruthi, & Lockett, 2005). Much of the research on the internationalization of firms focuses on manufacturing firms, but the Uppsala model proposition that firms prefer to expand into countries with which they have less psychic distance has also been supported in the case of service firms (Erramilli & Rao, 1990). Some prior research on exporting has excluded service firms from datasets because of their 'peculiar international expansion patterns' (Balas et al., 2012). Venture capital is a unique industry, and while studying expansion patterns of venture capital may contribute to an understanding of the behavior of service firms, venture capital firms may also behave differently from other service firms.

#### The Upsalla Model

One early stream of literature that dealt with the concept of distance explaining internationalization behavior presented the Uppsala Model, a theoretical approach that proposes that firms incrementally expand abroad, committing more resources to a foreign markets gradually as they grow in their experience in that market. The Upsalla model which is in line with Penrose's (1959) approach to the theory of the firm, the explains how a firm uses its resources to incrementally expand into other profitable activities (Johanson & Vahlne, 2009). This theory has been widely-referenced theories in international business. A number of studies have shown support for the model across a number of countries (Andersson, 2004; Bilkey & Tesar, 1977; Cavusgil, 1980; Karafakioglu, 1986; Vahlne & Johanson, 2017, 2020, p. 40; Wu & Vahlne, 2020).

This paper makes use of the CAGE model, which proposes Culture, Administrative, Geographic, and Economic distance measures.(Ghemawat, 2001)

Researchers have built on Johansson and Vahlne's research and have found support for firms preferring to expand abroad into countries for which language, culture, and other psychic distance variables may present less of a hindrance for the flow of information (Carlson, 1974; Dow, 2000; Dow & Karunaratna, 2006; Johanson & Vahlne, 1977; Johanson & Wiedersheim-Paul, 1975). As firms expand into foreign markets and gain experience psychic distance may become less of a hindrance to international expansion markets (Dow, 2000; Erramilli & Rao, 1990; Liesch & Knight, 1999).

Some of the earliest papers from the Uppsala model perspective dealt with incremental expansion of firms into foreign markets, focusing on on mode (Johanson & Vahlne, 1977; Johanson & Wiedersheim-Paul, 1975). But the principle of incremental expansion also applies to the behavior of firms after they have already set up operations in a foreign country, since the model proposes that firms will expand incrementally into new foreign markets (Johanson & Vahlne, 1977; Johanson & Wiedersheim-Paul, 1975). In more recent times, a stream of research has focused on firms that are 'born global' as opposed to growing into international firms incrementally by making incremental commitments to foreign markets (Oviatt & McDougall, 1994). International business theory should allow for firms that both expand abroad quickly, and firms that expand incrementally. The Uppsala model contributed a very important concept to the study of international trade, which the authors described as 'psychic distance' (Johanson & Vahlne, 1977). Originally, this idea was loosely defined, but set a trend toward using various distance measures such as cultural distance or a variety of institutional distance measures for predicting international investment behavior.

#### 3. Literature Review

A predominant view before the development of the Upsalla model was that firms chose an mode of entry into a market after analyzing the market in view of costs and resources (Hood & Young, 1979; Johanson & Vahlne, 1977, 2009). But, based on data collected from four Swedish firms, Johanson and Vahlne (1977) discovered a pattern of incremental internationalization' of firms expanding abroad..

In addition to drawing onPenrose's (1959) theory of the growth of the firm, the Upsalla model also draws on the work of Cyert and March (1963) and Aharoni (1966)).. The model posits that the firm increases its commitment and expands its operations in a new market as its knowledge of the market increases. The theory combines Penrose'(1959) understanding of experiential knowledgewith Aharoni's (1966) idea of firms making commitments in a response to the environment. Cyert and March's (1963) behavioral view of the firm posited that that firms undertake problemistic search to find solutions to problems. In the Uppsala model, firms learn as they encounter problems that spring up as they engage in current activities (Forsgren, 2002).

The Uppsala Model proposed that firms expand abroad incrementally, due partly to a lack of market knowledge, which produces uncertainty (Hörnell, Vahlne, & Wiedersheim-Paul, 1973; Johanson & Vahlne, 1977). Uppsala Model proponents have argued that the theory is still valid even though some of the steps to internationalization presented in the original paper empirical evidence in the 1977 paper do not occur in every case or may have changed over time (Johanson & Vahlne, 2009). These steps were a description of the empirical evidence but not a part of the model (Johanson & Vahlne, 2009). While some firms may be able to leapfrog over steps to incremental expansion, the concept of incremental expansion may still have merit.

#### 3.2. Psychic Distance and the Liability of Foreignness

The concept of 'psychic distance', which is part of the Upsalla model, actually had its roots in the writings of Beckerman (1956) who introduced the term 'psychic distance' for variables besides physical distance that could systematically affect trade flows. He thought of psychic distance as the difficulty withcontacting and cultivating sources for foreign trade.

In the original Uppsala theory, foreign firms face challenges in learning to operate in new markets, and these challenges are related to the degree of psychic distance between the market and the firm's home country.. According to Johanson and Wiedersheim-Paul (1975) psychic distance is defined as "factors preventing or disturbing the flow of information between firm and market. Examples of such factors are differences in language, culture, political systems, level of education, level of industrial development, *etc.*" or as "factors that make it difficult to understand foreign environments" (Johanson & Vahlne, 2009). Johanson and Weidersheim-Paul (1975) proposed that nations that were members of the British Commonwealth may have reduced psychic distance even for
countries that are geographically very distant. Subsequent research supported the theory that having previous colonial ties may reduce psychic distance (Dow & Karunaratna, 2006). Uppsala researchers eventually expanded the understaning of the term to include factors as differences in culture and language (Nordstrom & Vahlne, 1994).

Johanson and Vahlne (2009) explained that psychic distance had roots in the concept of the 'liability of foreignness' (Hymer, 1976) and that greater psychic distance corresponded with a greater liability of foreignness (Zaheer, 1995). Hymer (1976) listed various challenges a firms could face as a new entrants into a foreign market, including differential treatment from the home country government, buyers, and suppliers in comparison to local firms, additional cost for acquiring information, and differential treatment from the firm's own country of origin which may include taxes or prohibitions to operate. Hymer argued that in order to succeed abroad a foreign firm must have a firm-specific competitive advantage, to overcome the liability of foreignness (Hymer, 1976).

Zaheer (1995) categorized these costs associated with the liability of foreignness into four categories: "(1) costs directly associated with special distance, such as the costs of travel, transportation, and coordination over distance and across time zones; (2) firm-specific costs based on a particular company's unfamiliarity with and lack of roots in a local environment; (3) costs resulting from the host country environment, such as the lack of legitimacy of foreign firms and economic nationalism; (4) costs from the home country environment, such as the restrictions on high-technology sales to certain countries imposed on U.S.-owned MNEs." Categories (2) and (3) could potentially be applicable to venture capital firms operating in a foreign market. In the Chinese market, venture capital firms could face difficulties from not understanding social networking in the Chinese cultural context and from a lack of social networks developed with government officials, suppliers and other businesses. Past research has shown that some Chinese government officials are worried about "labor exploitation" and that they oppose venture capitalinvestment because of concern that it may undermines the socialist system (Ahlstrom et al., 2007). The category (2) lack of roots in the local environmentmay include a lack of understanding of the local institutional context and the local culture.

#### **Cultural and Institutional Distance**

Initially, the concept of psychic distance was perhaps poorly defined.Over time, other non-geographical distance measures were applied to international trade and various aspects of international business. In the late 20<sup>th</sup> century, cultural distance may have been the most commonly used measure of non-geographic distance used in international business literature. Kogut and Singh (1988) successfully applied Hofstede's (1980) cultural dimensions

to test entry modes of foreign firms into the United States, including entry by joint venture, wholly owned subsidiary, or acquisition. Numerous subsequent papers have been written applying the same technique to measuring cultural distance (Shenkar, 2001). Uppsala researchers have similar methods that collapse the Hofstede measures into one number to measure of psychic distance (Nordstrom & Vahlne, 1994). Kogut and Singh's method has been criticized for mathematically reducing Hofstede's dimensions into one score, ignoring the fact that cwertain cultural dimensions may be more useful than others (Shenkar, 2001). Hofstede himself warned against using overall differences among his dimensions since the differences between certain dimensions are not linearly additive (Hofstede, 1989). Barkema & Vermeulen, (1997) found that although Kogut and Singh's measure yielded significant results, only three cultural dimensions contributed to joint venture survival

More recently, the Global Leadership and Organizational Behavior Effectiveness Research Project (GLOBE) research has served as a basis for cross-cultural measures, using the dimensions of Power Distance, Uncertainty Avoidance, Institutional Collectivism, Gender Egalitarianism, and Assertiveness. GLOBE has identified 10 cultural clusters among 62 cultures in the study. (House, Hanges, Javidan, Dorfman, & Gupta, 2004).

#### Institutions and Psychic Distance

Perhaps a better category of distance measures to operationalize the concept of psychic distance would be institutional distance measures. Institutional distance can include cultural distance, since culture is an institution, but a number of other measures may be included in this category. There may be vast differences between the institutional environment of a firm's home country and the institutional environment of the host country.. Some of the research on venture capital in emerging markets like China in the past have taken an institutional approach, e.g., Bruton and Ahlstrom (2003).

#### Institutional Challenges for Venture Capital in the Chinese Context

*Guanxi* is an important Chinese institution and an aaspect of their culture. Literally, the word could be explained as "a relationship between objects, forces, or persons." It is believed that *guanxi* relationships substitute for formal institutions found in countries with stronger economic institutions (Xin & Pearce, 1996). A sociologist commented, "In essence, the Chinese bureaucracy inhibits action while *Guanxi* facilitates action" (Alston, 1989). *Guanxi* relationships are essential in helping new ventures achieve success in China, (Guo & Miller, 2010; Zhao & Ha-Brookshire, 2018). *Guanxi* relationships may they can help VCs as interact with Chinese firms and they conduct

due diligence (Bruton et al., 2004; Chen, 2010)<sup>1</sup>. VVs have also found *guanxi* relationship necessary to properly monitor a firm after making an investment (Young, Ahlstrom, Bruton, & Rubanik, 2011).

It may be that foreign venture capital firms act slowly, initially, in the Chinese market as they develop *guanxi* relationships, compared to their normal pace of activity and investment.

The institutional environment in China is evolving. While corporate governance regulations in China are still weak, they may still be improving (Ahlstrom, Bruton, & Yeh, 2007). And it may be that psychic distance related to institutional differences could have decreased over time.

3.6. Local Investment

#### The CAGE Model

Developed by Pankaj Ghemawat, the CAGE model intends to analyze the challenges and opportunities of a company operating in foreign markets (Ghemawat, 2001). The CAGE model is composed of four dimensions: Cultural Distance, Administrative or Political Distance, Geographic Distance, and Economic Distance. The structural framework of the CAGE model does not suggest a specific statistical test but rather encourages a general assessment of the four dimensions.

In order to better understand the various dimensions of international business and the challenges and advantages of entering a particular foreign market, the researchers frequently use a mix of qualitative and quantitative methods. For example, qualitative analysis involves understanding the nuances of cultural, political, geographic, and economic factors. On the other hand, quantitative analysis often includes statistical measures to assess economic differences such as GDP per capita, income, etc.

The strength of the CAGE model is in the fact that it does not prescribe any specific statistical tests but rather serves as a conceptual framework for various dimensions of international business. Depending on the specific hypothesis or aspect that researchers intend to examine, the CAGE model allows for topic-specific adaptation and application. For example, (Ferreira & Falcão, 2019)utilize the CAGE model to assess the institutional distance between Brazil and potential host countries with respect to foreign direct investment (FDI).

<sup>&</sup>lt;sup>1</sup> Also supported by an unpublished Ph.D. dissertation from the University of Hawai'i at Mānoa by Chen, C. 'Venture capital risk in transitional economies: evidence from China'.

Ferreira and Falcao (2019) use the CAGE model to illustrate how institutional differences between countries can create opportunities and challenges for a firm's engagement in an international market. At the same time, the study identifies two primary strategic motivations, market-seeking and resource-seeking, in shaping FDI decisions. The interaction between institutional distance and motivation derives a conclusion that firms may be less sensitive to institutional differences when driven by specific strategic goals. In other words, the study suggests that public policies (e.g. central bank's policy) may have an impact on the internationalization of firms as well as their competitiveness in the domestic market.

#### **Research** question

Our study examines investment patterns of of domestic and foreign venture capital firms in China. We compare domestic Chinese venture capital firms to foreign venture capital firmsusing the CAGE model, which includes both geographic distance and measures of cultural, administrative, and economic distance. Our study deals with the following research question.

1. Does institutional distance between the venture capital firms' country of origin and the target country predict the pace at which venture capital firms commit to investing in the venture capital market in the target country?

This question is considered in light of the fact that foreign venture capital firms in the Chinese market typically have much larger financial resources and also engage in much more activity. So the research will consider whether the proportion of the number of investments made early on is greater for firms that are closer or farther based on the CAGE measures.

#### 2. Hypotheses

According to the Uppsala Model, we can expect that new domestic firms will make decisions more quickly and behave more aggressively initially when compared to foreign firms new to the market. There are numerous ways in which a venture capital firm can behave aggressively in its fundraising, investing, portfolio management, and exit strategies. Foreign venture capital firms new to the Chinese market must operate cautiously to navigate in the economic environment. They may therefore be more conservative about how frequently they invest when they first enter the market. Domestic venture capital firms can afford to be more aggressive if they are comfortable with the environment and have strong *guanxi* relationships with important contacts to help them navigate the weak institutional landscape. The domestic venture capital firm may have learned of many good investments over the years, and be ready to invest in many of them as soon as the firm begins operations. Over time, as foreign venture capital firms become more accustomed to the market and the local culture and develop *guanxi* relationships, they can invest more aggressively, as well.

This research examines three hypotheses. These hypotheses do not suppose that Chinese firms grow more quickly or behave more aggressively than foreign firms in an absolute sense, but that in relation to how aggressively foreign firms behave, there is a liability of foreignness that results in institutionally distant firms behaving less aggressively than they otherwise would. When we account for the fact that foreign firms are more aggressive in terms of numbers of investments made, we can still expect that VC firms coming from culturally and institutionally distant countries will invest less aggressively compared to venture capital firms that are institutionally closer to the target market.

**Hypothesis:** Accounting for the greater activity of larger, foreign firms, looking at investments in terms of the proportion of overall investments made, vVenture capital firms that are more institutionally distant are less likely to invest aggressively when first entering the Chinese market when compared to less institutionally distant firms.

To test these hypotheses, we propose examining the aggressiveness of firm investment behavior by looking at the relative frequency of investments in early versus later periods. Less aggressive investment behavior would be indicated by a higher percentage of investments made in later periods.

#### 3. Data

The source for the data was primarily the the Zero2IPO online. Other company data, especially country-of-origin data, was also supplemented using web searches regarding individual companies. Zero2IPO is a database of venture capital activity in China,. The terms

'venture capital' and 'private equity' in the context of the Chinese market are often used interchangeably (Ahlstrom et al., 2007; Bruton et al., 2004) and the Zero2IPO database contains both types of data grouped together as one. Our dataset covers 1995 until the end of of 2007. For some firms, the Zero2IPO website provided country-of-origin information. If this information was missing, it was gathered, from the 2010 edition of *China Venture Capital & Private Equity Directory*, a Zero2IPO publication, from the firms' websites or from other websites. **Table 1** presents the number of firms available from each country represented in the dataset based on the available. The data covers and 1479 transactions for 596 VC firms.

The source for for the institutional distance measures between the countries of origin for venture capital firms and China for the CAGE model for this study were derived from Berry, Guillén, & Zhou (2010). Their research includes the CAGE variables for the time period.

#### 4. Methods

#### 6.1. Exploratory Factor Analysis and Results

We conducted a series of preliminary regressions where the dependent variable was the percentage of the number of investments a VC firm made in target firms in a given year divided by the number of investment occasions recorded for the firm made throughout the dataset. In addition to the individual variables of the CAGE model, there was also a control variable which conveyed the number of investments a firm made before investing in China, but if there was no data, this score was assumed to be zero. There were also control variables for each calendar year. Using these year control variables performs the same function as a fixed-effects model, but also provides information about significance for each calendar year in the model. Using regression may also make the models understandable to a wider audience. Institutional variables

for the CAGE model were taken from (Berry et al., 2010). The sources for the CAGE model variables are explained in more detail in <u>Table 1</u>.

Due to high multicollinearity as evidenced by high VIF values on dependent variables of interest, we chose to use a Principal Components Analysis (PCA) to turn the CAGE variables into one factor to perform our analysis. We then used the same dependent and control variables used above for our regression using individual CAGE variables

The Cronbach Alpha for this factor analysis is 0.90 indicating a high level of internal consistency. <u>**Tables 2 and 3**</u> present descriptive statistics and Pearson correlations. <u>**Table 5**</u> presents the results of the Principal Components Analysis (PCA). We used SPSS to perform the PCA and regression models mentioned in this paper. *Regression Models and Results* 

Hypotheses were tested with regression. Each of the regression models, which examine data at the firm-year level, include the variable PerTimesinYr.. While overall, foreign firms tend to be more aggressive in terms of number of investments they made, we look at the proportion of investments firms make compared to their overall numbr of investments. These models allow us to determine whether firms ramp up the frequency of investment more rapidly as CAGE distance increases. The tests examine whether there is a trend of the more distant firms investing a smaller proportion of their investments in earlier rather than later years, and examines the trend of investment occasions over time. Using a regression model that controls for years as opposed to a fixed-effects model allows raders to examine patterns that may emerge during boom or bust years, which may be an area with the potential for future research (Clau & Krippner, 2019, p. 1439; Madhavan & Iriyama, 2009).

#### 7. Results for Statistical Models

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Models 1 and 2 were designed to test the Hypothesis and include the CAGE independent variable along with the variable aforementioned control variables. Model 1 tests the hypothesis, using the dependent variable of PerTimesinYr, which measures the number of times a firm invests in a given year, with the CAGE dependent variable, the Year\_of\_Investment control variable, the interaction effect variable CAGExYear, and control variables for each calendar year. All variables were shown to be significant at the .01 level of significance. The significant control variable offers evidence for the idea that distance on the CAGE measures predicts the rate at which firms invest over the years.

<u>Model 1</u> shows support the hypothesis. Since adding an interaction effect can change the sign, we also present Figures 1 to 5, which show the slope of firms that are high, medium, and low on each of the variables in the CAGE factor. These models show that for each of the variables, firms that are low on the distance measure tend to undertake a higher percentage of the incidents of the investments they engage in early on, and decrease over time, while those that have medium distance measures have more moderate investment activity early on and more activity later. Highly distant VC firms follow the same trend, invested a smaller proportion of their investments early during their time in the Chinese venture capital market and more later on. Graphs of each of these variables is consistent with the hypothesis in terms of direction. <u>Model 2</u> shows a version of the regression equation without the interaction effect. <u>Models 3 to 5</u> show

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versions of the equation minus calendar years control variables and with other control variables missing. This enables the reader to see the extent to which each variable contributes to the  $r^2$ . <u>Model 1</u> has an adjusted  $r^2$  of 0.27. <u>Model 5</u> which has the CAGE factor without the control variables has an adjusted  $r^2$  of 0.06. Models also include standard errors.

### Discussion

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Distance Variable	Definition	Dimension	Component Variable	Source
CulturalDifferences in attitude toward authority.		Power distance	WVS questions regarding obedience and respect for authority	WVS
	trust, individuality,	Uncertainty avoidance	WVS questions on job security and trusting people	WVS
	and importance of work and family	Individualism	WVS questions on independence and the role of the government in providing for its people	WVS
		Masculinity	WVS questions regarding the importance of family and work	WVS
Administrat ive	Differences in colonial ties,	Colonizer-colonized link	Whether a dyad shares a colonial tie	CIA Factbook
language, religion, and legal system		Common language	Percentage of the population that speak the same language in the dyad	CIA Factbook
		Common religion	% of population that share the same religion in the dyad	CIA Factbook
		Legal system	Whether the dyad shares the same legal system	La Porta et al, 1998
Economic	Differences in	Inflation	GDP deflator (% GDP)	WDI
	economic	Income	GDP per capita (2005 US\$)	WDI
development and		Exports	Exports of goods and services (% GDP)	WDI
	macroeconomic characteristics	Imports	Imports of goods and services (% GDP)	WDI

Table 1: Institutional Variables from Berry et al., 2010

 Table 1: Dependent Variable and Independent Variables

 PerTimesinYr

Variable	Туре	Description		
PerTimesinYr	Dependent	Percentage of over all occasions of		
		investment a firm makes in the dataset		
		that occur in the given year in which the		
		firm's investment was made. Year 1 is		
		the first 365 day period in which the		
		firm invested in the Chinese market		
Y1996	control	Calendar year 1996		
Y1997	control	Calendar year 1997		
Y1998	control	Calendar year 1998		
Y1999	control	Calendar year 1999		
Y2000	control	Calendar year 2000		
Y2001	control	Calendar year 2001		
Y2002	control	Calendar year 2002		
Y2003	control	Calendar year 2003		
Y2004	control	Calendar year 2004		
Y2005	control	Calendar year 2005		
Y2006	control	Calendar year 2006		
NumbPriorForgnInvmAsm	control	The number of foreign investments a		
		foreign firm made prior to investing in		
		the Chinese venture capital market. If		
		data was not reported, the value is zero.		
Year_of_Investment	Control	The year of a firm's investment, with		
		year treated as a 365 day period.		
CAGE	dependent, factor	Factor created from Principle		
		Component Analysis of Culture,		
		Administrative, Geographic, and		
		Economic distance measures		
CuYr	interaction effect	Interaction effect between Cultural		
		distance and Year_of_Investment		
AdYr	interaction effect	Interaction effect between		
		Administrative distance and		
		Year_of_Investment		
GeoYr	interaction effect	Interaction effect between Geographic		
		distance and Year_of_Investment		
EcYr	interaction effect	interaction effect between Economic		
		distance and Year_of_Investment		

Variable	Ν	Minimum	Maximum	Mean	Std. Dev.	
Culture	997	0.00	42.22	12.45	15.44	
Administrative	1409	0.00	36.96	6.26	7.51	
Geographic	1424	0.00	13944.02	4683.43	5013.40	
Economic	1383	0.00	49.76	12.50	13.82	
PerTimesinYr	1479	0.01	1.00	0.40	0.34	

 Table 3: Descriptive Statistics for Exploratory Factor Analysis

# Table 4: Correlations

		Culture	Administrative	Geographic	Economic	PerTimesinYr
	Number	1	2	3	4	5
Culture	1	1	0.59**	0.90**	0.82**	-0.24**
Administrative	2	0.59**	1	0.26**	0.53**	-0.17**
Geographic	3	0.90**	0.26**	1	0.39**	-0.06*
Economic	4	0.82**	0.53**	0.39**	1	-0.13**
PerTimesinYr	5	-0.24**	-0.17**	-0.06*	-0.13**	1

### Table 5 Principal Components Analysis

<b>Component Matrix</b>	Component
Culture	0.94
Administrative	0.891
Geographic	0.779
Economic	0.899

Extraction Method: Principal Component Analysis. 1 component extracted.

# **Table 6 Regression Analyses**

Model	1	2	3	4	5
CAGE	-0.12**	-0.09**	-0.24**	-0.24	-0.24**
	(0.00)	(0.00)	(0.00)	$(0.00^{**})$	(0.00)
NumbPriorForgnInvmAsm	-0.18**	-0.05**	-0.06	-0.06	
_	(0.01)	(0.00)	(0.00)	(0.00*)	
Year_of_Investment	0.08**	-0.20**	-0.18**		
	(0.00)	(0.00)	(0.00)		
CAGExYr	-0.05**				
	(0.00)				
Y1996	-0.06**	-0.06			
	(0.17)	(0.17)			
Y1997	-0.15**	-0.15*			
	(0.10)	(0.10)			
Y1998	-0.20**	-0.20**			
	(0.08)	(0.08)			
Y1999	-0.24**	-0.24**			
	(0.05)	(0.05)			
Y2000	-0.25**	-0.25**			
	(0.04)	(0.04)			
Y2001	-0.29**	-0.29**			
	(0.04)	(0.04)			
Y2002	-0.30**	-0.30**			
	(0.04)	(0.04)			
Y2003	-0.36**	-0.36**			
	(0.04)	(0.04)			
Y2004	-0.35**	-0.35**			
	(0.04)	(0.04)			
Y2005	-0.35**	-0.35**			
	(0.04)	(0.04)			
Y2006	-0.20**	-0.20**			
	(0.03)	(0.03)			
F -Value	24.80**	25.94**	35.1**	34.21**	62.82**
r <sup>2</sup>	0.28	0.27	0.10	0.07	0.06
Adjusted r <sup>2</sup>	0.27	0.26	0.10	0.06	0.06
N	976	976	976	997	997
*			1	1	1

 $rac{}{*=}p \le 0.05$  \*\*= $p \le 0.01$ 











**Figure 3 Geographic Distance Graph** 











### ETHICAL CONSIDERATIONS WITH THE USE OF BIG DATA ANALYTICS AND AI FOR MARKET SEGMENTATION AND TARGETING STRATEGIES

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### ABSTRACT

The rise of big data has revolutionized the marketing industry as modern organizations increasingly leverage big data and AI for segmentation and targeting purposes to optimize marketing strategies. Marketing has undergone incredible changes driven largely by the advancements in data accessibility, technological resources and skills, and machine learning capabilities. While the potential benefits of such utilizations are likely to enhance consumer experience, engagement, and conversion, ethical concerns regarding the use of big data and AI for such marketing-related activities have increased in prevalence from both organizational and customer perspectives. In this research, the ethical challenges encountered by businesses when using big data for market segmentation and targeting are investigated, as well as how the impact of these ethical concerns differ between small and large organizations. Preliminary findings suggest that issues related to consumer privacy, consent and transparency, data security, data accuracy, and the potential for algorithmic biases are impartial to organizational size, however, the challenges associated with these issues vary by the scale and resources of the organization. Further, small-sized enterprises with limited funding and employees may experience heightened obstacles when utilizing consumer-oriented data for marketing purposes. This may be partially attributed to a lack of data literacy and broad understanding of the implications of negligence. As such, small organizations may be more susceptible to ethical violations which increase the vulnerability of the business. Resulting areas of future research include the quantitative assessment of ethical data management and use practices among small and large organizations, specifically focusing on the ethical use of big data for consumer segmentation, targeting, and general marketing practices. Other areas of focus include small business training related to the proper and ethical use of big data for marketing activities to ensure continued competition and rivalry within the larger market.

Keywords: Big Data, AI, Segmentation, Targeting, Ethical Concerns, Organizational Size

### FACTORS INFLUENCING CONSUMERS' DECISION TO DONATE TO A SMALL SYMPHONY ORCHESTRA

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### ABSTRACT

Non-profit small symphony orchestras can be vital parts of local economies, helping to generate revenue when individuals come to town to attend performances. Because of their economic importance as well as their dependence on donations to survive, understanding why consumers donate to these organizations is essential. While previous research showed that both altruistic and egoistic motives are positively related to donation behavior, these relationships were not investigated in the context of symphony orchestras. The present study sought to fill this gap in the literature. An online questionnaire was completed by 101 donors (60% male, 78% Caucasian, 63% four-year college graduates) to a non-profit small symphony orchestra. The questionnaire contained previously validated five-point Likert-type items designed to assess their altruistic and egoistic motives and their intention to donate to the symphony in the future. Demographic information about the participants was also collected. Regression analysis was used to analyze the data and test the hypotheses. Results indicated that the model fit the data well. Both altruistic and egoistic motives were positively and statistically significantly related to intention to donate to the small symphony orchestra. In this way, the results from the present study were consistent with the findings from existing literature. The effect size of the coefficient was larger for egoistic motives than altruistic motives in the present study. Thus, the behavior of donors to this small symphony orchestra seems to be driven more by the rewards they will receive from their financial contribution than by the selfless desire to help the non-profit organization. To promote donation behavior, this small symphony orchestra could consider offering more opportunities for donors to be publicly recognized for their behavior. The findings from the present study should be generalized with caution, given the small sample size and the specific demographic characteristics of the participants.

### Maintaining Residential Stability: Predictive Modeling for Addressing Mid-Semester Transfers in Oklahoma State University's Housing System

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#### ABSTRACT

Mid-semester transfers and room cancellations pose significant challenges for many universities, extending beyond the financial implications of upkeep and maintenance to the substantial loss of housing resources for an entire semester. Our ongoing research focuses specifically on addressing this concern within the context of undergraduate housing at Oklahoma State University (OSU). Our project centers on the development of a sophisticated predictive model that harnesses a spectrum of student data. This includes academic performance metrics, levels of engagement in on-campus housing and university events, records of conduct cases, and the outcomes of intentional conversations. Our primary goal is to anticipate mid-semester transfer-outs and evaluate the likelihood of students transitioning to off-campus housing alternatives. A pivotal aspect of our study revolves around examining the impact of different housing styles, comparing traditional setups to suite-style accommodations. We delve into various variables that contribute to a student's perception of on-campus housing and how these factors correlate with their decision to relocate. To accomplish this, we draw data from diverse campus sources, incorporating information from platforms like Maxient, Starrez, and Roompact. These sources enable us to create comprehensive profiles for individual students, facilitating the classification of students based on their associated risks of leaving university housing. Our endeavor is not solely analytical; it's geared toward offering actionable recommendations. We aim to support OSU's housing strategies by providing insights that optimize resource allocation and mitigate the costs associated with underutilized rooms. Ultimately, our research seeks to enhance the university's ability to adapt its housing policies, fostering a more robust and responsive residential environment for its students.

### THE ZERO CONSUMER OR THE END OF CONSUMER SOVEREIGNTY?

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### ABSTRACT

Consumer-focused enterprises confront many challenges, especially in dealing with consumer sovereignty. In addition to the problems of competition, technology, and dynamic economic environments, new difficulties include rapidly shifting consumer tendencies. One example is the zero-consumer concept. However, there are increasing forces that limit consumer power. This exploratory analysis examines the forces behind the zero consumers while, simultaneously, the concentrated power of companies and marketing techniques reduces consumer sovereignty. This analysis asks if we are encountering the end of consumer sovereignty, even with the rise of the zero consumer.

#### DISCUSSION

In his best-selling textbook about marketing, Philip Kotler wrote 1984 about the "time-honored concept in an economic theory known as consumer sovereignty." This theory holds that consumers have the ultimate power in deciding the goods and services produced and the prices charged. Yet the concept of the sovereignty of consumers was first discussed by William Harold Hutt in 1936. The leading economic thinkers of the time later attacked the idea. The hostile approach toward consumer sovereignty was during the Depression, the longest and deepest downturn of the modern industrial economy. Not only was unemployment high, but there were restrictive practices in labor and capital markets. Hutt wished to weaken underlying sectional interests of the time that could lead to little economic rationale.

Hutt wrote that consumer sovereignty is compatible with liberty. This power is through consumer demand. The rational, sovereign consumer shifts resources from less to more socially valued uses. When consumers demand a particular good or service, businesses will respond by producing that good or service. Similarly, when consumers are unwilling to pay a specific price for a good or service, businesses will keep lowering prices to attract customers. These less desirable products, services, or ideas will ultimately lose value. Their acceptance is diminished along with any vested interests that were behind them. This process, and the justification for an efficient market operation, is through the impersonality and impartiality with which the system guarantees freedom for all individuals.

The consumer sovereignty concept has been borne out, emphasizing public choice, and is still applicable. However, it is essential to note that this is not unconditional. Consumer sovereignty is constrained by factors that include large companies and information asymmetry. Monopolies

or oligopolies hold some sectors of industry or economy. In industries with only one or a few sellers, consumers have less power to influence prices. Consumers may need more information to make rational choices about the goods and services they buy. Consumers may not be aware of the actual production costs or the environmental impact of certain products and services.

Despite these limitations, consumer sovereignty is still a significant force in today's economy. Consumers have more choices than ever before and are increasingly using their power to demand goods and services that meet their needs and values. For example, the development of ecommerce has given consumers more choices and more power to negotiate prices. The popularity of social media has made it easier for consumers to share information about their experiences with products and services. This information can help other consumers make informed choices. The growth of the sustainable and ethical consumption movement shows that consumers increasingly use their power to demand products and services aligned with their values.

Nonetheless, another mega-trend, named the zero consumer, has appeared. Zero consumers represent a significantly diverse segment of shoppers who are voracious omnichannel users. They are, at the same time, economy-minded and willing to splurge. Many are concerned with issues related to personal health and sustainability, even if they may, in the end, not be willing to pay the necessary prices. However, marketers' lack of loyalty to brands is the most troubling characteristic. Adapting to these trends will be a significant undertaking for marketing managers.

There are countless challenges that consumer-focused enterprises must confront. Some are wellestablished, such as dynamic business environments, technological advances, and increasing competition. Marketers must keep up with rapidly shifting consumer trends, such as the zeroconsumer concept and consumer sovereignty. Yet, there are growing factors that limit consumer power. This exploratory analysis examines the forces that are powering the zero consumer while consumer sovereignty is limited by concentrated power and organizations. This study asks if we are encountering the end of consumer sovereignty even with the rise of the zero consumer.

### AMAZON'S DIGITAL TRANSFORMATION: REVOLUTIONIZING MULTINATIONAL ENTERPRISES, PARTNERING WITH NETFLIX, AND SHAPING OUR WORLD

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### ABSTRACT

This research paper examines the strategic partnership between Amazon Web Services (AWS) and Netflix, focusing on their historical evolution and showing their profound impact on international business and cloud computing. The paper begins by explaining the start of the AWS platform and the unique position it holds in the global cloud computing industry. It proceeds to describe the alliance between AWS and Netflix, highlighting its significance and how it has transformed the landscape of online streaming and content delivery. The study analyzes the implications of this partnership on international business, cloud infrastructure and digital content distribution. It features Amazon's unparalleled global reach and the synergy it achieves with diversified business operations. The paper concludes by addressing the far-reaching implications of this collaboration for international business, AWS and Netflix, as well as the evolving future trends in cloud computing and content delivery network.

### AMAZON'S DIGITAL TRANSFORMATION: THE REVOLUTION OF MULTINATIONAL ENTERPRISES THROUGH PARTNERSHIPS WITH NETFLIX

Amazon Web Services (AWS), a subsidiary of Amazon, has become a global leader in cloud computing services, serving millions of customers worldwide. Among its many notable customers, there is one that stands out—Netflix. This partnership exemplifies the convergence of technology giants and the significant impact they have on multinational enterprises (MNEs), global infrastructure, and the entertainment industry. We explore the evolution of AWS, the partnership between AWS and Netflix, the implications for both entities, and the far-reaching global influence of Amazon.

### The Amazon-Netflix Collaboration: A Game-Changer in Digital Transformation

The partnership between Amazon and Netflix, with Amazon providing web storage services for Netflix, carries substantial significance in the streaming industry, revealing competitive dynamics and influencing digital transformation. This analysis highlights the close connection between these major players in the streaming industry, emphasizing Netflix's significant dependence on Amazon Web Services (AWS) to host its content. The Christmas Eve outage in 2012, which disrupted Netflix services for numerous North American users, revealed the vulnerability of this arrangement. Despite this blunder, Netflix's CEO Reed Hastings continues the relationship, indicating its importance.

This partnership's significance can be understood through three key aspects: interconnected competitors, competitive dynamics and the impact on digital transformation. Amazon and Netflix, although competitors in the streaming industry, have formed a symbiotic relationship. While Amazon Prime competes directly with Netflix, Amazon's AWS plays a crucial role in delivering Netflix's content. In the words of Jaime Weinman (2013), Wall Street journalist, "Maybe it's not a great idea to allow your biggest competitor to have so much power over your business." Following this model, it is crucial to comprehend the competitive dynamics in motion. Allowing a major competitor like Amazon to have significant control over another business seems counterintuitive. However, as the article points out (Weinman, 2013), "Amazon's own rival service, Amazon Prime, was unaffected by the outage. "This dynamic showcases how the digital landscape can be both collaborative and fiercely competitive, blurring traditional industry boundaries. The incident emphasizes the importance of robust and reliable digital infrastructure. Streaming services are a pivotal aspect of the ongoing digital transformation, and the outage serves as a reminder of the technical challenges companies face as they transition into the digital realm. It features the significance of investing in reliable, resilient digital systems to ensure uninterrupted services for consumers. As Weinman (2013) suggests, "people did notice that Amazon's own rival service, Amazon Prime, was unaffected by the outage."

Ultimately, the Amazon-Netflix partnership highlights the intricacies of competition and collaboration in the digital era. It also highlights the imperative for businesses to navigate these complexities while embracing digital transformation. In this evolving landscape, partnerships that may seem unconventional are not uncommon as companies adapt to digital evolution.

# **Evolution of Netflix: From DVDs to Global Dominance**

Netflix was launched in 1997 by Marc Randolph and Reed Hastings and initially served as one of the world's pioneering online DVD rental companies, providing a pay-per-use model with a library of fewer than 1,000 titles (Pereira, 2023). This model involved physically mailing movies, TV shows and other media to customers. As Pereira (2023) mentions, "The following year, they changed to a subscription model" (2023). Subscribers could access Netflix's website, choose their desired content and have DVDs delivered to their homes. Netflix's name, as Pereira (2023) points out, is a fusion of "net" for "internet" and "flix" for "flick," a slang term for movies.

In 2007, Netflix introduced video streaming, initially offering 1,000 titles that were available on PCs using Internet Explorer. The monthly streaming limit was 18 hours and was based on the subscription plan. By the end of that year, the platform gained 7.5 million registered subscribers. Netflix continued to expand its services and international presence, providing content in 21 languages across over 190 countries. The company's strategic shift toward original content led to recognition from the Academy of Motion Picture Arts and

Sciences for some of its productions. Today, Netflix remains a formidable leader in the streaming industry with more than 180 million global subscribers.

Netflix's history set the stage for understanding the profound significance of its partnership with Amazon Web Services (AWS). The partnership between these industry giants has not only reshaped how we consume entertainment but also redefined the landscape of international business and cloud computing. As we dive deeper into the partnership, we will navigate through the complex works of Netflix's global business model and AWS' pivotal role in the transformation.

### Unveiling Netflix's Global Business Model: An Overview



Netflix operates on a subscription-based business model, providing on-demand video streaming with fixed fees that vary by country . According to Pereira (2023), "the company offers three primary subscription plans: basic, standard, and premium. To attract new users, Netflix employs an initial hook with a 'free month offer,' allowing users to experience a trial period." The company's customer segments encompass a wide range of user preferences and geographical locations, ensuring that it caters to various content tastes.

Netflix's value proposition centers around the continuous provision of high-quality entertainment free from interruptions with its extensive content catalog spanning multiple genres and tastes. Users enjoy the flexibility of on-demand streaming, accessible 24/7 without ads. Netflix further enhances the user experience by offering personalized recommendations, highdefinition content and individual user profiles for a customized viewing experience across all internet-connected devices. To engage with its customer base, Netflix uses multiple channels, including its official website and app, online and offline advertising, and social media platforms such as Instagram and Facebook. Additionally, it benefits from word-of-mouth recommendations among its users.

The cornerstone of Netflix's resources centers on human and digital assets, encompassing software developers, vast content libraries, recommendation algorithms, filmmakers, content studios devoted to supporting original creations, and the company's firmly established brand. Netflix focuses on delivering the best streaming content experience for its users. This approach involves investments in technology, talent acquisition, content selection, licensing, and in-depth analysis of user behavior to continuously enhance their streaming experience.

Key partners in Netflix's ecosystem include media producers and TV networks, which license their content to Netflix, consumer electronics producers such as Wii and PlayStation that bundle Netflix with their systems, and AWS, a crucial hosting service for Netflix's platform. Additionally, Netflix engages with investors and regulators as part of its business network. Netflix's cost structure is extensive, involving significant expenses associated with content production, rights acquisition, artificial intelligence for recommendations, platform maintenance, data centers for streaming, research, software development, marketing, human resources, and infrastructure. Notably, Amazon Web Services (AWS) plays a pivotal role in hosting Netflix's platform and ensuring its seamless operation.

In the highly competitive landscape of digital entertainment, Netflix faces formidable competition from various streaming services, including Disney Plus, HBO Max, Amazon Prime Video, CBS All Access, Hulu, Peacock, Apple TV+, YouTube TV, FuboTV, Sony Crackle, Showmax, and Curiosity Stream, all of which contribute to the dynamic evolution of the industry (Pereira, 2023). Ultimately, the pivotal alliance between Amazon Web Services (AWS) and Netflix has contributed to Netflix's exponential growth and success on a global scale.

# A Global Game-Changer Due to Amazon Web Services (AWS)

In Amazon's pursuit of high-volume, low-margin e-commerce, it has ventured into services like Amazon Instant Video, which operates on its cloud computing platform known as Amazon Web Services (AWS). AWS is central not only to Amazon's operations but also to various other multinational enterprises such as Netflix. Netflix is a major player in the entertainment sector with a staggering 238 million paying customers spread across 190 countries (Netflix, 2023). These users get access to a wide range of TV shows, movies and games in various languages and genres. According to Butler (2013), "When businesses require significant technological resources, they face a fundamental choice: building an in-house infrastructure or outsourcing their requirements. For larger companies like Netflix, seamless access to a vast number of servers is imperative." AWS offers a healthy cloud infrastructure, making it a logical choice for companies like Netflix. The partnership between Amazon and Netflix is proof of the transformative influence of cloud computing on traditional business relationships. Netflix, with video streaming at its core, found that outsourcing computational tasks to the cloud, specifically AWS, was essential due to the exponential growth in streaming. Butler (2013) also notes that "The company's streaming content has surged from 1 million hours per month to an astounding 1 billion hours, a substantial expansion that necessitated a cloud-based solution." Furthermore, "Netflix leverages AWS for a multitude of functions, such as managing customer account data, call center operations, and video streaming oversight through content delivery networks

(CDNs). However, Netflix retains control over its content, distinguishing its value proposition from Amazon's streaming business" (Butler, 2013). Ultimately, the Amazon-Netflix partnership reflects how cloud computing reshapes business dynamics. It highlights the adaptability of companies to advancing technology, showing the importance of cooperation and competition in this dynamic landscape.

# The Synergy Between Amazon Web Services and Netflix

Amazon Web Services (AWS) plays a pivotal role in supporting Netflix's global operations, enabling the streaming giant to deliver content to millions of subscribers worldwide. This partnership involves both technical and strategic aspects that have greatly benefitted Netflix. Netflix's transition to the public cloud, specifically AWS, was a pivotal decision. This move facilitated rapid scalability and allowed Netflix to handle its growing library and subscriber base efficiently. AWS's extensive infrastructure allowed Netflix to add virtual servers and storage within minutes, addressing the challenges posed by data center limitations. As Hahn and Macaulay (*IDG News Service*) explained, "We flipped on the service for another 130 countries, and millions of new customers that we hadn't previously been servicing."

Instead of simply migrating existing systems, Netflix chose to rearchitect its technology and embrace micro-services. This shift enabled Netflix to enhance agility by breaking down its services into smaller, manageable components, each handled by dedicated teams. As Hahn and Macaulay (*IDG News* Service)noted, "Software's like anything else; if you can design it for the environment that it's going to be living in it will do more of the things you want it to do, more often and more regularly. Therefore, we chose to move to micro-services." This approach, although groundbreaking at the time, resulted in more manageable, isolated and faster deployments. The advantages of using AWS are evident in the improved scalability, the service availability and the quick release of content and features. It also brought cost-effectiveness, as Netflix could experiment with new features without incurring unnecessary expenses. Hahn and Macaulay (*IDG News* Service highlighted this ability by stating, "The other thing is that the cost model is really nice for us. You pay for what you use. That allows us to do a lot of experimentations."

AWS's support does not end with cloud infrastructure. Netflix has its proprietary content delivery network (CDN) known as Netflix OpenConnect, which stores and delivers video content. This network complements AWS's capabilities and enhances the viewer experience by reducing buffering issues. As Hahn and Macaulay (*IDG News Service*) further explained, "We designed OpenConnect caching boxes to hold our content, and wherever we can, we install them inside of your internet service provider's network, so that when you see those video bits, you aren't actually transiting off your operator's network."

Netflix also embraces a unique engineering culture. They utilize chaos engineering to ensure the platform's resilience during failures and disasters, conducting regular tests to guarantee seamless operations even when a region goes down. Hahn and Macaulay (*IDG News Service*) emphasized this approach, stating, "Chaos engineering is an excellent inoculation to failures." Additionally, joining a corporate culture of freedom and responsibility, Netflix empowers its teams to act independently while maintaining alignment with the company's goals. This method, as outlined by Dave Hahn, encourages innovation and keeps teams highly aligned without imposing excessive control. Moreover, Netflix's partnership with AWS has revolutionized its operations and transformed it into a global streaming giant. The technical and strategic aspects of this partnership showcase the innovative approach to micro-services, chaos engineering and the unique corporate culture that ensures a seamless, high-quality streaming experience for millions of subscribers.



(Dow Jones Institutional News, 2016)

# The Impact on International Business and Cloud Computing

The Amazon-Netflix partnership has significant implications for international business and cloud computing. This collaboration represents a successful case of how cloud computing can transform traditional business relationships and bring about various advantages. For example, "This shift to cloud computing has led to a utility computing model, where services are delivered like utilities such as water and electricity. It enables businesses to access services based on their requirements, regardless of where the services are hosted" (Singh, 2014). In this context, cloud computing is seen as a transformative approach that

offers businesses the flexibility to treat IT resources as services available over the internet, eliminating the need to maintain in-house hardware and software assets. This model allows businesses to access services based on their specific needs without concern for the physical location of these services. Amazon Web Services (AWS) is highlighted as a key player in this transformation, providing businesses with essential cloud services.

Netflix, as a pioneer in embracing cloud computing, experienced substantial benefits from this transition. The company moved its entire technology infrastructure to AWS in 2012. Netflix's ability to scale rapidly in response to demand, maintain high availability and reduce costs were among the key advantages of this shift. It demonstrated that cloud computing could enable businesses to break free from the limitations of traditional data centers and provide on-demand access to resources and services. As a result, Netflix achieved scalability, high availability and cost-effectiveness in delivering its streaming services.

The international business implications of this partnership are evident in Netflix's global reach. Cloud computing allows Netflix to serve a vast international audience, with millions of subscribers worldwide accessing their services from various devices. This global expansion and scalability were made possible through the cloud infrastructure, reflecting how cloud computing can transform the way businesses operate on a global scale.



# Netflix international streaming power

Source: Netflix

Revenue by quarter

The alliance also highlights how traditional business relationships are evolving due to cloud computing. For example, Singh (2014) argues that "Netflix's decision to move its entire infrastructure to AWS represents a significant shift away from owning and managing

hardware and toward outsourcing these services to a cloud provider." Netflix's decision to shift its entire infrastructure to AWS signifies a significant departure from the traditional approach of owning and managing hardware and instead embracing the outsourcing of services to a cloud provider. It demonstrates how cloud computing allows businesses to focus on their core competencies while leveraging the expertise of cloud providers. This transition is evident in the Netflix case, where the company depends on Amazon's infrastructure and services to distribute content to its customers. The Amazon-Netflix partnership showcases the transformative power of cloud computing in international business and traditional business relationships. Cloud computing, represented by AWS, has allowed Netflix to achieve scalability, availability and costefficiency on a global scale. This partnership serves as an outstanding illustration of how cloud computing is revolutionizing the delivery of services and the dynamics of customer-business interactions.

# **Global Expansion of AWS and Its Impact on Economies**

Amazon Web Services (AWS) has just unveiled its second infrastructure region in Melbourne, Australia. As per their press release, this expansion, initially disclosed in December 2020, covers three availability zones, which are "...the building blocks of an AWS region that place infrastructure in separate and distinct geographic locations" (Ghoshal, 2023). This development is significant for Australia, as it adds AWS's first infrastructure region in Sydney, operational since 2012, and is set to contribute to the country's job market. AWS anticipates that this expansion will generate over 2,500 new jobs in Australia and plans to invest an additional \$4.5 billion in the country by 2037 (Ghoshal, 2023). Vice President of Infrastructure Services at AWS, Prasad Kalyanaraman, highlighted the company's dedication to enhancing local job opportunities and building cloud-related skills. Kalyanaraman stated, "We are proud to deepen our investment by driving local job creation, building cloud skills, and creating opportunities for growth and collaboration with our local customers and AWS Partners" (Ghoshal, 2023). In Australia, AWS already serves a substantial clientele, including organizations such as the National Australia Bank, Littlepay, the Royal Melbourne Institute of Technology and the Australian Bureau of Statistics

(Ghoshal, 2023). AWS's global expansion strategy is not limited to Australia. The addition of the Melbourne region extends AWS's already expansive network to 99 availability zones across 31 geographic regions. There are also upcoming launches of 12 additional availability zones and the establishment of four new AWS regions in Thailand, New Zealand, Israel and Canada. AWS's commitment to global expansion is evident in recent investments, including the launch of the second region in India with a \$4.4 billion commitment, as well as confirmed plans to invest \$35 billion in Virginia by 2040, creating 1,000 new jobs and expanding its US-EAST-1 region (Ghoshal, 2023). These initiatives feature the progressing landscape of cloud computing and its substantial impact on various industries and economies, raising important questions about the future of international business operations and infrastructure.

### **Implications and Ramifications**

In the digital age, businesses are constantly striving to provide consumers with the best products and services, leading to remarkable transformations in operational strategies and

value delivery. An illustrative example of these profound implications can be found in the emergence of getREEF and neighborhood ghost kitchens.

The culinary industry has witnessed a significant shift in recent years with the rise of getREEF and neighborhood ghost kitchens. These innovative concepts have arisen in response to the growing consumer demand for convenient, high-quality meals. getREEF operates a network of ghost kitchens situated in urban areas, each equipped to prepare a variety of cuisines from different restaurant brands. Customers can order food from their preferred restaurants through delivery apps, and these meals are freshly prepared in ghost kitchens, ensuring efficiency and culinary expertise (Smith, 2022).

Much like Netflix excelling in content creation and AWS in cloud infrastructure, these culinary ventures prioritize specialization in core competencies. By concentrating on these areas, they can deliver superior dining experiences to consumers while optimizing their operational efficiency.

At the heart of these models lies a consumer-centric approach. Consumers benefit from choices and convenience, gaining access to a wide range of restaurant cuisines without leaving their homes. The delivery and culinary expertise underpinning these concepts guarantee that consumers receive high-quality, freshly prepared meals on time, leading to heightened satisfaction.

The success of getREEF and neighborhood ghost kitchens mirrors the adaptability of businesses in embracing emerging technologies and responding to consumer preferences. Leveraging technology, data analytics, and logistics, these ventures have created seamless dining experiences, reflecting the ongoing transformative potential across various industries.

As we contemplate these implications and ramifications, it becomes clear that the pursuit of excellence in core competencies, combined with innovative collaborations and consumer-centric approaches, constitutes a common thread across diverse sectors. The partnership between AWS and Netflix, alongside the emergence of culinary innovations like getREEF, epitomizes the evolving landscape of business in the digital age – an era where adaptability, specialization, and consumer satisfaction are paramount.

The dynamic interplay between competition and collaboration, exemplified by AWS and Netflix, resonates throughout the business landscape, whether in streaming entertainment or culinary experiences. These partnerships have redefined traditional boundaries and ushered in an era of transformative potential. The future holds even more exciting possibilities as businesses continue to leverage technology and expertise to meet the ever-evolving demands of consumers in a globalized world.

# Conclusion

The partnership between Amazon Web Services (AWS) and Netflix represents a transformative force in the world of international business and cloud computing. It showcases the intricate dance between competition and collaboration in the digital era,

redefining traditional industry boundaries. This alliance has not only reshaped the way we consume entertainment but has also highlighted the adaptability of businesses to evolving technologies. Netflix's global reach and AWS's expansive infrastructure have enabled the streaming giant to cater to an international audience on an unprecedented scale. It illustrates the transformative impact of cloud computing on traditional business relationships with companies like Netflix outsourcing their services to cloud providers while focusing on core competencies.

The innovative alliance between Amazon and Netflix can be found in other areas. The getREEF program is one such example that serves only the beginning of a global revolution. Cloud computing partnerships like AWS and Netflix are paving the way for innovative collaborations and reshaping the global business landscape. As cloud technologies continue to evolve, numerous additional unforeseen alliances will emerge, and these collaborations will significantly impact businesses and consumers on a global scale. The future of cloud computing partnerships holds exciting possibilities, and we can only imagine the extraordinary transformations and disruptions that lie ahead. The journey of cloud computing is far from over; the next chapter promises to be as riveting as the one we have explored.

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### BUSINESS ETHICS IN THE LEGAL FIELD: AN EXAMINATION OF APPROACHES FOR EVALUATING ATTORNEY DISCIPLINE

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#### ABSTRACT

Licensed professionals are expected to exercise ethical behavior in the performance of their duties. Since the results of unethical behavior in practicing an occupation can adversely affect public perception of the integrity of an entire profession, licensing entities provide ethical standards to govern or regulate members. Failure to comply with ethical requirements in the profession can lead to adverse consequences, including loss of the privilege to practice the trade. This method of governance especially applies in the legal field, where attorneys often handle extremely sensitive client information and may have access to their financial resources. Since ethical conduct might carry different interpretations for different people, every state has drafted and published rules of professional conduct for guidance and requirements to fulfill ethical obligations in that state. Failure to comply with ethical standards and other types of misconduct can result in complaints lodged with the state oversight organization or disciplinary board charged with the investigation and disposition of such matters. Data obtained across multiple jurisdictions are examined to determine whether significant variations exist in the frequency or nature of complaints filed and their dispositions due to geographic and demographic differences. Trends over time are also analyzed. The ultimate objective of the research is to extend and enrich current scholarly theorizing by examining the frequency of complaints filed against attorneys for misconduct or unethical behavior, analyzing the ultimate disposition of the cases, and interpreting the results to make recommendations for improvements in reporting systems that should lead to increased efficacy of disciplinary processes in the legal field. Further, the results of this research offer significant contributions and advancements to organizational literature and theory.

### EXPLORING THE INTERPLAY OF COUNTRY OF ORIGIN, CSR PRACTICES, AND GREEN PSYCHOLOGY: A STUDY OF CONSUMER ATTITUDES IN MULTINATIONAL FAST FASHION RETAILERS H&M AND ZARA.

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#### ABSTRACT

This research delves into the intricate dynamics of customer attitudes toward Corporate Social Responsibility (CSR) practices in multinational fast fashion giants such as H&M and Zara, with a specific focus on the influential role of the country of origin (COO). The research unveils the impact of COO on customer expectations, particularly favoring domestic and mid-ranked companies. Crucial factors, including the "made in" label, gender, age, product knowledge, brand name, design, price, and quality, are identified alongside COO, significantly shaping consumer evaluations and decision-making processes. The study emphasizes the profound influence of CSR practices on consumers' green psychology, impacting public perception, reputation, brand loyalty, and overall competitiveness. This research reveals that negative CSR signaling emerges as a potent threat to brand competitiveness, highlighting challenges such as greenwashing, COO discrepancies, and the absence of effective CSR communication in MNEs. The essay proposes the design of CSR frameworks, designing suitable CSR strategies, and increasing the CSR signaling as a strategic solution to address these challenges.

#### 1. Introduction

In the ever-evolving landscape of multinational fast fashion retail, the dynamics of customer perception play a pivotal role in shaping the success of industry giants. At the intersection of consumer preferences and corporate conduct lies the intricate realm of CSR practices, a domain that has garnered increasing attention for its potential to sway customer attitudes. This study delves into the vibrant world of fast fashion, focusing on two industry juggernauts, H&M and Zara, to unravel the profound impact of customer perception, CSR practices, and green psychology on these MNEs. At the heart of our exploration lies a fundamental question:

"How does the country of origin (COO) influence CSR endeavors, and, in turn, shape customer attitudes and green psychology?"

1.1. Purpose and Objectives of Research

1.1.1. Unveil the Influence of COO:Assess the role of COO in shaping customer expectations, green psychology, and perceptions of CSR initiatives.

1.1.2. Identify Factors Shaping Customer Attitudes and Green Psychology:Explore a spectrum of factors beyond COO, including but not limited to the "made in" label, gender, age, product knowledge, brand name, price, and quality.

Understand the hierarchical significance of these elements in influencing consumer evaluations, decision-making, and green psychology.

1.1.3. Explore Challenges and Propose Solutions:

Investigate challenges associated with negative CSR perceptions and their impact on green psychology, such as greenwashing and institutional voids.

Propose effective solutions to mitigate negative CSR signaling, enhance overall customer perceptions, and foster positive green psychology.

As we embark on this comprehensive exploration, our study aspires to contribute valuable insights into the intricate interplay between the country of origin, CSR practices, green psychology, and customer attitudes, thereby shedding light on strategies for sustained success in the fast-paced world of multinational fast fashion retail.

#### 2. **Results**

#### 2.1. COO and Expectations

Haleem (2021) emphasizes that the country of origin significantly shapes expectations of enterprises, with a more positive impact on domestic (Pouliopoulos 2017) and mid-ranked (Cowan 2020) companies compared to others. This prompts an exploration of how the COO influences expectations, revealing that MNEs from less developed countries are expected to have lower CSR efforts, while those from developed countries are anticipated to demonstrate higher CSR commitment (Orudzheva 2018).

#### 2.2. Beyond COO

In the fast fashion industry, which includes giants like H&M and Zara, consumer expectations transcend the country of origin. While consumers can accurately identify the COO of brands (Barillari 2015), various factors, as indicated by Barillari (2015), such as the "made in" label, gender, age, product knowledge, brand name, price, and quality, alongside the perception of the brand's country of origin, significantly influence their evaluations. Notably, Jiang (2022) states that customers prioritize factors like price, design, and quality over CSR concerns in their purchasing decisions. For instance, despite H&M's satisfactory strategic CSR approach, Zara, with its instrumental CSR approach and unsatisfactory CSR reporting, gains a better competitive positioning (Cui 2022).

#### 2.3. CSR and Green Psychology

Delving into the influence of CSR practices on consumers, it is revealed that CSR positively affects green psychology (Javed 2020), shaping public perception, prestige, and reputation (Galica 2022). Higher perceived CSR contributes to a better brand image (Galica 2022), loyalty (Dai 2018), lower liability of foreignness (Orudzheva 2018), and higher brand equity (Jiang 2022), ultimately enhancing competitiveness and the overall competitive advantage of a company (Orudzheva 2018). The tangible outcomes of H&M's sustainability efforts, particularly the success of the "Conscious" line, reinforce the core hypothesis of this article. H&M's Conscious" line, launched in 2011, embodies the company's commitment to sustainability in the fashion industry. To carry the "Conscious" label, garments must be made of at least 50% certified sustainable materials. The line has expanded to include "Conscious Denim," produced with reduced environmental impact in collaboration with Jeanologia. H&M's "Conscious Exclusive" offers high-end sustainable fashion, demonstrating that eco-friendly choices can be glamorous and affordable. As 18 states H&M's experience after conscious resulted in "a significant improvement in attitudes, including willingness to pay, product evaluations, and general judgments about H&M (Ehrsam 2016).

### 2.4. Challenges in CSR Perception and Green Psychology

However, Jiang (2022) highlights the flip side, noting that negative CSR has a more significant impact on brand competitiveness. This leads to an exploration of challenges that may result in negative consumer attitudes towards CSR practices, intertwining with the dynamics of Green Psychology. Three significant challenges stand out:

#### 2.4.1. COO Discrepancies:

The divergence between host country and COO in terms of taste, fit, and design poses challenges for MNEs. Aligning global preferences becomes a hurdle, as consumer expectations vary based on cultural nuances.

#### 2.4.2. Greenwashing:

Greenwashing, a prevalent issue, casts a negative shadow on consumer perceptions. Institutional voids in the COO contribute to misleading green claims, leading to a decline in willingness to
pay and eroding consumer trust. For example, a case study on Zara exposes the disparity between reported CSR initiatives and the reality. Environmental concerns, labor discrepancies, and a lack of transparency contribute to doubts about Zara's commitment to sustainability (Cui 2022).

#### 2.4.3. Lack of Communication:

Another challenge that MNEs must overcome is adding to their CSR signaling that leads to consumers' awareness about their CSR efforts. Customers, as Chan (2020) explains, have expressed dissatisfaction, stating that these brands do not make sufficient efforts to communicate about their CSR practices. The statistics reveal a high customer willingness to learn about these green practices and the existence of a gap between consumer expectations and brand communication strategies.

These challenges significantly influence Green Psychology, affecting consumer perceptions, trust, satisfaction, and loyalty and ultimately affects the brand image, brand equity, and purchase intentions (Javed 2020). Negative CSR signaling, as evidenced by greenwashing and insufficient communication, undermines the psychological contract between consumers and brands.

#### 2.5. Recommendations

To foster positive perceptions and cultivate green psychology among consumers, multinational fast fashion retailers like H&M and Zara should consider the following recommendations:

#### 2.5.1. Establishing a CSR framework:

To address both of these challenges, a crucial step is to standardize the CSR message globally through the establishment of a CSR framework (Cui 2022). Comprehensive and effective CSR reporting serves a dual purpose: increasing customer awareness of the MNEs' CSR efforts, reducing their liability of origin in host countries (Marano 2017), and addressing local rules and

concerns (Fortanier 2011). However, despite these benefits, Kozlowski (2012) points out that current CSR reporting may not accurately convey the true extent of an apparel brand's CSR actions and initiatives. Moreover, Cui (2021) emphasizes the varied approaches companies take in reporting their CSR performance, highlighting that not all adopt standardized formats like the GRI. Recognizing the dynamic nature of the fast fashion sector, where market changes swiftly outpace regulations, Kozlowski (2012) recommends the incorporation of five key indicators in a comprehensive and standardized CSR reporting framework. These indicators span product sustainability, design practices, sustainable supply-chain management, consumer engagement, and business innovation.

#### 2.5.2. Increase CSR signaling:

Based on the Signaling theory (Chan 2020), it is suggested that firms should use visible signals, such as certifications and CSR reporting, to convey their commitment to sustainability and address information gaps. This approach can bridge the communication gap and effectively convey CSR initiatives to customers, aligning with their expectations and fostering awareness of green practices through online and offline efforts such as using official websites, social media, in-store posters, collaboration, and partnerships with green groups (Chan 2020).

#### 2.5.3. Design customized CSR strategies:

The CSR strategy employed by these companies should align with the brand's market positioning. According to source Chan (2020), the optimal approach for fast fashion involves a combination of high CSR commitment, minimal advertising, and targeting price-sensitive consumers. Emphasizing factors such as ethical practices and sustainability, which resonate with the sensitivities of the target audience, is crucial. This approach contributes significantly to enhancing the overall brand image.

By incorporating these recommendations, H&M and Zara can not only refine customer perceptions and Green Psychology of their CSR practices but also contribute to the development of a more sustainable and conscientious global fast fashion industry.

#### 3. Conclusion

In unraveling the complexities of multinational fast fashion, this study underscores the pivotal roles of Country of Origin (COO), Corporate Social Responsibility (CSR), and Green Psychology. COO significantly influences expectations, particularly favoring domestic and mid-ranked enterprises.

Consumer expectations, extending beyond COO, hinge on diverse factors like "made in" labels, gender, and price, with customers prioritizing elements such as design, price, and quality over CSR concerns.

CSR practices wield a positive impact on Green Psychology, enhancing brand image, loyalty, and competitiveness. The success of H&M's "Conscious" line exemplifies this transformative potential. Yet, challenges persist, including negative CSR perceptions and greenwashing, undermining brand trust.

To overcome these challenges, the study advocates for standardized global CSR reporting framework, use of CSR signaling methods, and customized CSR strategies.

In conclusion, understanding COO, CSR, and Green Psychology dynamics is paramount for multinational fast fashion leaders. Implementing recommended strategies can reshape consumer perceptions and propel the industry toward a sustainable future.

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# Post COVID

# AN ANALYSIS OF FACTORS FOR MENTAL HEALTH AND JOB SATISFACTION DURING COVID-19 PANDEMIC

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# ABSTRACT

Grounded on the Organizational Information Processing Theory, this study analyzed a sample of 644 valid responses in the U.S. via structural equation modeling. Results revealed that mental health was significantly negatively associated with job satisfaction, and the perception of risk, job safety, and remote working are also positively associated with job satisfaction. In addition, the combination of risk and belief has a negative effect on job satisfaction; the combination of job safety and remote working cooperatively affects mental health, positively affecting job satisfaction. The implications may provide public health officials with options and strategies for dealing with post-pandemic issues.

**Keywords**: COVID-19; mental health; job satisfaction; organizational information processing theory (OIPT); structural equation modeling (SEM)

# **INTRODUCTION**

The COVID-19 had a sizeable negative impact globally and poses a significant health threat worldwide. According to the U.S. Bureau of Labor Statistics reports [1], The total nonfarm payroll employment increased by 216,000, and the unemployment rate rose to 3.7% in December 2023. Employment continued growing in government, health care, social assistance, and construction, while transportation and warehousing decreased.

Many studies address the effect of COVID-19 on employment, such as working hours, job losses, and labor force participation [2-5]. While these studies suggest that COVID-19 increased the unemployment rate, and decreased work hours and labor force participation, the negative impacts on labor market outcomes are more significant for men, younger workers, Hispanics, and less-educated workers [3].

Prevention and control of COVID-19 are essential for public health and economic situations, such as employment status with or without effective treatments. There is a lack of research in analyzing the relationships between mental health and job satisfaction through the lens of organizational information processing theory. With more information under uncertainty and increased risks, Organizational Information Processing Theory (OIPT) is a desirable model for processing information, ensuring performance, and applying specific strategies [6].

This paper investigates the relationship between mental health, perception of health risks, the belief in workplace responses, the feeling of job safety and security, and remote working on job satisfaction using Organizational Information Processing Theory (OIPT). We hypothesize that perception of the health risks, the belief in workplace responses, the feeling of job safety and security, and remote working have direct and indirect effects (through Mental health) on job satisfaction.

The rest of the paper proceeds as follows. Section 2 provides literature reviews on the relationship of each variable, and Section 3 describes data, variables, and SEM model. Section 4 illustrates the empirical results of the effects of the variables on job satisfaction. Then, in section 5, we discuss and conclude our findings and make policy implications.

#### LITERATURE REVIEW

#### Mental health and employment:

Mental health and anxiety could impair labor force participation, employment and work performance, and occupational functioning [7-9]. During COVID-19, studies also addressed the association between mental health, anxiety, and employment in various ways. Some examined the relationship between depression and anxiety symptoms and South Africa's employment level [10], and job insecurity among U.S. young adults [11]. Others focused on the demographic and individual correlations with anxiety about financial hardship and economic stress due to the COVID-19 pandemic [12,13]. A common finding was that the impact of anxiety on employment was more significant for younger adults than older adults [11, 12]. Besides, [14] revealed the increasing impact of the Covid-19 pandemic on students' anxiety about seeking a future job. The

study [7] found that depressive and anxiety symptoms increased among unemployed household members during COVID-19.

# Perception of health risk and employment:

The perceptions of health risks and unsafe social environments at the workplace would affect work attitudes and behavior. Many studies found a significant negative relationship between perceived health risk and employment [15-17]. However, many uncertainties exist regarding the intensity of employment impact during COVID-19. Using medical expenditure panel survey data, [17] found health risks associated with severe COVID-19 illness for black adults, explored the differences in job characteristics, and showed the COVID-19 disparities. The study, [18] focused on employee disengagement amid the era of COVID-19 and suggested that catering to health and safety needs and lowering the risk perception may boost employee engagement. In addition, [19] discussed how to temper the impact of the perceived health risk of COVID-19 on frontline hotel employees' job insecurity and emotional exhaustion, using the social exchange theories and job demands-resources model. Finally, [13] revealed a supra-additive interaction between perceived risk at work and unstable employment among Korean employees but not European employees.

# The belief in workplace responses and remote working on employment:

The government and employers' response related to health risks could yield a profound economic and social impact, though they vary in scope and implementation [5, 20, 21]. The paper [10] finds that government-supported social welfare programs cover income and healthcare access interruptions while non-pharmaceutical interventions, such as remote working, also ease economic losses and anxiety. The more significant number of government-funded old-age pensions lowered the financial impact, such as earning money or level of employment and mental health symptoms in the households for South Africans. However, [3] suggest that while the government locking down policy, along with remote working (stay-home orders), could halt the spread of COVID-19, unfortunately, implementing stay-home orders or remote working had worse labor market outcomes as they (partially) limit people's ability to work.

#### Job safety and security and mental health:

Literature suggests that job safety and security have both direct and indirect relationships with mental health. One study carried out by [22] explored if job insecurity due to COVID-19 was associated with worse mental health during the pandemic. An online survey was completed by 474 United States employees, which found greater job insecurity and financial concern led to negative mental health impacts in the areas of depression and anxiety. Regarding job safety, a more extensive study examined the impact of employees not having adequate safety equipment during the pandemic and the effects of this on their mental health [23]. A total of 3401 personnel answered a self-report survey on their perceptions of their equipment's adequacy and mental well-being. Analysis revealed that those who felt they did not have the proper equipment were significantly more likely to report symptoms of common mental health disorders, such as PTSD. These two studies highlight the impact one's job safety and job security can have on mental health status.

Therefore, we have the following hypotheses:

H1: As the perception of health risk increases, job satisfaction may increase or decrease (H1d); As the health risk perception increases, mental health increases (H1i), which in turn reduces job satisfaction (H5).

H2: As the belief in the workplace response increases, job satisfaction increases (H2d); As the belief decreases, mental health increases (H2i), which in turn decreases job satisfaction (H5).

H3: As the feeling of job safety increases, job satisfaction increases (H3d); As the feeling of job security decreases, mental health increases (H3i), which in turn decreases job satisfaction (H5).

H4: As remote working increases, job satisfaction increases (H4d); As remote working decreases, mental health increases (H4i), which in turn decreases job satisfaction (H5).

#### **Organizational information processing theory**

Organizational information processing theory (OIPT) was introduced by [6] to increase performance concerning uncertainty. Based on the OIPT, a theoretical model is constructed by aggregating job satisfaction with the perception of the health risk, belief of the workplace responses, job safety and security, remote working, and mental health. Lack of information referred to uncertainty, ambiguity, and the perception of health risk, while the belief of the workplace responses could lead to equivocality [24 - 27].

To reduce the uncertainty and equivocality that affected mental health by creating anxiety and pressure, influencing job satisfaction, slack resources and self-contained tasks were required [6, 28]. On one side, the perception was a type of creation of slack resources; job safety and security and remote working were self-contained tasks, compensating for the uncertainty. At the same time, the belief of the responses captured the effect of equivocality in processing the information. In addition, remote working was the investment in vertical information, with the lateral relations from the job safety and security, which could increase information processing capabilities.

The OIPT constructed a match or the concept of fit between information processing and information processing capacity requirements, influencing organizational performance [29]. In addition, this information system affected individuals' mental health, which affected job satisfaction competently. (See Figure 1: Theoretical model based on Organizational Information-Processing Theory).

Figure 1: Theoretical model based on Organizational Information-Processing design



#### **METHODS**

#### Data

We developed two protocols, "A health behavior study during COVID-19" and "The impact of COVID-19 on health and socioeconomic factors," with anonymous surveys approved by the U.S. university's Institutional Review Board. To design the survey questions, we consulted the COVID-19 Health Evaluation Surveys (*Free COVID Surveys*, 2021) [30] and created our questions based on the needs of the research. The survey was conducted and administered to individual participants in public, mainly from states C.O., TX, CA, NC, VA, and T.N. in the U.S., through social media and email recruitment. In addition, with the online anonymous Qualtrics survey, the participants were asked to answer a series of questions related to perceptions, beliefs, health behaviors, and socioeconomic status toward the influencing factors of COVID-19.

Table 1: Descriptive Statistics									
Variables (label)	Question	Mean	Std. Dev.	skew	c.r.	kurtosis	c.r.		
Remote working	Q7	4.320	1.456	-0.054	-1.352	-0.453	-3.476		
	Q8	5.110	2.161	0.091	0.848	-0.498	-1.777		
	Q9	5.430	1.956	0.134	0.237	-0.251	-1.043		
Perception of health	Q21	5.650	1.840	0.147	1.378	-0.818	-3.830		
risk	Q23	5.410	2.003	-0.193	-1.811	-0.812	-3.801		
	Q24	5.460	2.023	-0.116	-1.087	-0.852	-3.989		
Job safety and	Q26	3.830	1.486	-0.439	-4.106	-0.859	-4.022		
security	Q27	3.720	1.550	-0.396	-3.705	-1.210	-5.665		
	Q28	3.820	1.624	-0.971	-9.093	-0.102	-0.477		
Mental health	Q30	4.120	1.697	-0.476	-4.457	-0.772	-3.613		
	Q31	4.500	1.690	-0.921	-8.62	-0.329	-1.540		
	Q32	4.340	1.711	-1.068	-9.998	0.218	1.019		
Belief in workplace	Q39	0.720	0.449	-1.090	-10.201	-0.104	-0.486		
responses	Q40	3.910	1.700	-0.951	-8.909	-0.438	-2.049		
	Q41	5.230	2.034	-1.023	-9.580	-0.340	-1.592		
Job safety and	Q42	5.110	1.683	-0.983	-9.203	-1.034	-4.840		
security	Q43	5.620	1.643	-1.079	-10.104	-0.196	-0.918		
Multivariate						28.705	12.267		
Valid N			664						

The participants could choose not to answer questions or drop in the middle if they felt unpleasant. From June 2021 to January 2022, we got over 600 observations with missing values. Within the data, 60% of the participants were aged 18-44, and 58% were females. Since we mainly distributed the survey to students and workplaces, we have younger and working-age participants. For races, White, Black, Asian, Hispanic, and others are 64.08%, 14.44%, 8.3%, 8.3%, and 4.87%, respectively, which is relatively consistent with the demographic features in the U.S. To capture the mediator effect with bootstrapping, we kept 526 data without missing values and outliers, using the structural equation modeling (SEM) approach to analyze the valid sample. The skewness and kurtosis for each factor suggest that the data did not significantly deviate from a normal distribution for each variable; however, the Multivariate for Kurtosis and c.r. (>5) indicates that the

multivariate normality may not hold for the dataset. The bootstrapping technique, Bollen-Stine Bootstrap [31], was used to mitigate this issue. (See Table 1: Descriptive Statistics).

#### Variable Selection

The dependent variable in this study was job satisfaction (*job\_satis*), which included the job safety, stability, and security that measured the information related to COVID-19. In addition, there were four endogenous variables, the perception of the health risk (*risk*), the belief of the workplace responses (*belief*), the feeling of job safety and security (*job\_safe*), and remote working (*remote*). The *risk* captured the individuals' perceptions of different groups' severity and susceptibility of health risks in various situations. The *belief* measured the individual's view and confidence in the workplace and social responsiveness to health risks, especially the employer's responsiveness. Meanwhile, the *job\_safe* was the feeling and the faith of the job safety and security, and the remote was the remote working practices. Finally, the mediator, *mental*, referred to the anxiety or the stress of feeling exhausted, frustrated or having frequent insomnia in the last few weeks due to the health risks. Therefore, we hypothesized that health *risk* and the *belief* of workplace responses, *job\_safe*, and *remote* could directly affect *job satisfaction* or indirectly mediated by mental health.

# **EMPIRICAL RESULTS**

We analyzed the data using structural equation modeling (SEM). The results from the SEM estimation for the theoretical model are reported in Figure 2: Results from the theoretical model based on OIPT (after SEM) and Table 2. PLS estimated path coefficients with the standardized SEM coefficients.

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Hypothesis			Path Coefficients P-values		Supported or not	
H1i	mental	<	risk	-0.120	0.235	Not Supported
H2i	mental	<	belief	-0.233	0.021	Supported
H3i	mental	<	job_safe	0.190	0.000	Supported
H4i	mental	<	remote	-0.210	0.003	Supported
H1d	job_satis	<	risk	0.361	0.000	Supported
H2d	job_satis	<	belief	0.105	0.000	Supported
H3d	job_satis	<	job_safe	0.087	0.021	Supported
H4d	job_satis	<	remote	0.012	0.435	Not Supported
H5	job_satis	<	mental	-0.239	0.000	Supported

Table 2. PLS estimated path coefficients with regression weight (unstandardized values)

Each variable name should use the full name not the abbreviated names.

According to Figure 2 results, the standardized loading factors in SEM produce the following findings. First, the mental has a negative effect on job satisfaction, statistically significant ( $\beta = -0.433$ , p < 0.01), which confirms our hypothesis, H5 (See Table 3). When individuals have mental health, which may or may not be impacted by COVID-19, they will unlikely feel satisfied with the job safety, security, and stability.

Figure 2: Results with standardized factor loadings and path coefficients from the theoretical model based on OIPT (after SEM)



Remarks: \* for p-value <0.1, \*\* for p-value <0.05, \*\*\* for p-value <0.01

Second, the perceived severity of health risk, the belief of workplace responses, job safety, and remote working all are positively affecting job satisfaction, statistically significant (p < 0.05) for *risk* (0.213), *belief* (0.197), and *job\_safe* (0.129), insignificant for *remote* (0.107) (See Figure 2). According to the results, individuals with a higher perception of the pandemic impact tended to have higher job satisfaction; individuals who believed in social and workplace responsiveness of their intervention and controlling activities had higher job satisfaction. Besides, there was evidence that the higher and more substantial feeling of job safety and security, the higher the job satisfaction. The remote working seemed to have nothing to do with the feeling of the job situation. These findings supported Hypotheses H1d and H2d, but not for H3d and H4d (The same information is also reported in Table 2).

No surprise, the *risk* (-0.034, insignificant) and *belief* (-0.168, p<0.05) are negatively related to mental health (Figure 2). Understandably, the higher the perceived health risk, the individual tends to have lower mental health; and the belief in the workplace responses will significantly lower individuals' anxiety and stress. Interestingly, while remote working (-0.322, p<0.01) has a negative effect, the feeling of job safety and security (0.122, p<0.01) has a positive effect on mental health (Figure 2). This finding makes sense that individuals practice more on staying at home, reducing gathering, those activities might lower their stress and frustration. Finally, according to the results, individuals' perceptions of health risks have no significant effect on releasing their anxiety and stress. These results support Hypothesis H2i, H3i, and H4i, but not for H1i (The same information is also reported in Table23).

Overall, while the risk, belief, job safety, and remote working (insignificant) have statistically significant positive effects on job satisfaction, mental health has a significant negative impact on it (direct effects). Besides, as a means of reducing the need for information processing, the combination of *risk* and *belief* negatively affects *mental*. At the same time, intending to increase the capacity of information processing, the combination of interventions (*job\_safe*) positively while remote working (*remote*) negatively affects the *mental*, then in turn, *mental* negatively affects job satisfaction (indirect effects).

# **DISCUSSION AND CONCLUSION**

This research analyzed the critical factors for job satisfaction, including perceived health risk, the belief in workplace responses to the health damage in society, the feeling of job safety and security, and remote working during and after the COVID-19 crisis, and the mediating effect on mental health.

The findings suggested that worsening mental health is significantly associated with reduced job satisfaction. In contrast, the perception of health risks, the belief in the employer's response, the feeling of job safety and security, and remote working positively affected job satisfaction. Besides, the combination of perception of risks and belief had synergistic negative effects on mental health, while the combination of job safe feeling and remote working (negative) cooperatively affected mental health; then, mental health was significantly associated with reduced job satisfaction.

To lessen the impact of unsafe and unstable employment, it is beneficial to study more factors about job satisfaction, including the feeling of the organization's response to the health risky

situation (safety), anxiety about the future of the organization (security), concerns about losing a job (stability or sustainability). Thus, our findings offer important implications for policymakers as the government considers how to develop the policy over the recovery phase of this crisis and help unemployed people return to work.

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#### DIGITAL DISCOVERY: WHERE PERSONALITIES AND PIXELS MEET ON CAMPUS

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#### ABSTRACT

The profound impact of the COVID-19 pandemic on education is a challenge we've collectively wrestled with not just in 2020 but in the years since then. As we transitioned into the post-pandemic era, the educational landscape witnessed a wave of reflection and adaptation. Academic institutions, including prominent academic conferences, have diligently delved into the lessons gleaned from the pandemic and pondered how these newfound insights can shape and enhance our pedagogical practices. However, as we zealously pursue excellence in teaching, it is important to make sure that we don't just get carried away with our increased utilization of technology. We should not inadvertently overshadow the persisting challenges that have been exacerbated for our students, and at times, for us educators as well. Among these challenges, four major ones related to technology are what we explore in this work: technostress, technophobia, technocomplexity, and techno-invasion. We explore how these challenging aspects relate to the "Big 5" personality traits and individual values in our work. These concerns are by no means new, yet their nature and significance have undergone a remarkable transformation over the past couple of years. The accelerated reliance on technology for educational purposes, coupled with the all-encompassing integration of digital tools throughout higher education, has underscored the urgency for students to effectively manage technostress, grapple with the complexities inherent in technology, confront technophobia head-on, and navigate the increasingly prevalent issue of techno-invasion within the realms of their academic. professional, and personal lives. These techno-issues have transitioned from isolated problems to integral components of the modern educational landscape, necessitating a collective and sustained effort to address and mitigate them. Our research question therefore is what is the relationship between these "techno-issues" and personality traits and values of students in higher education? We propose a conceptual framework to explore these issues. It is abundantly clear that both higher education institutions and students will continue to grapple with these techno-challenges for years to come. In our work, we will delve into these technological quandaries, their relationship with individual-level characteristics, and offer insights into how educators can effectively mitigate their impact, especially in light of the growing prevalence of remote teaching and learning practices across higher education.

#### THE EFFECT OF SUPPLY CHAIN DISRUPTIONS ON BUSINESS POST COVID19

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#### ABSTRACT

There are many reasons for experiencing supply chain disruptions. The reasons could be miscommunication between the factory and the warehouse, miscommunication between the warehouse and the stores, or miscommunication between the stores and the customers. We investigated these possible disruptions throughout this paper with the help of a questionnaire. We further investigated the effect of various problems that may occur with the company stock which resulted in supply chain disruptions. There have been many papers written about the effect of the disruptions regarding these problems. With the goal of finding out the tactical approach from the company affects the value of the stock, we investigated this further. Additionally, this paper examined the nature of the tactical standings of the company and the effects on supply chain disruptions and the position of the company stock. Based on the responses to the questionnaire, we found how the tactical elements affect the supply chain disruptions. We also showed the effect of the supply chain disruptions on the company stock.

# TEACHING STATISTICS WITH JMP AND PYTHON

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#### ABSTRACT

JMP is powerful statistical software that can be used to explore and analyze data visually. Python is one of the world's most widely used and popular high-level programming languages. It lets you work more quickly and integrate your systems more effectively. It runs on most operating systems, which is ideal for aspiring programmers hoping to dabble in many fields, such as data science and analytics, artificial intelligence, machine learning, and game development.

We will discuss topics that can be introduced with JMP and Python in an upper-level undergraduate statistics course. We will present strategies for engaging students in active learning and enhancing students' confidence in learning statistics with JMP and Python, such as implementing ChatGPT in education.

#### Keywords

Statistics, JMP Software, Python Programming Language, ChatGPT, active learning, engagement, collaborative learning

# INTELLIGENT DECISION-MAKING USING LOGIC AND REASONING, MATHEMATICS, ALGORITHMS, AND GENERATIVE AI PART TWO

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#### ABSTRACT

Intelligent decision-making is an essential skill in various fields, including business, technology, and everyday life. It often involves a combination of experience, knowledge, intuition, and rational analysis. Furthermore, it requires integrating various disciplines such as logic and reasoning, mathematics, algorithms, and generative AI in today's complex world. We will provide detailed descriptions of how to make intelligent decisions based on the integration of previously mentioned disciplines. Later we will discuss how to guide students through the process of making intelligent decisions.

#### Keywords

Decision-making, intelligent decision-making, generative AI, ChatGPT, Python Programming Language, logic and reasoning, mathematics, algorithms

# PILOT STUDY: MANAGING TECHNOSTRESS IN HIGHER EDUCATION- EVALUATING COPING STRATEGIES DURING THE COVID-19 PANDEMIC

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#### ABSTRACT

During the COVID-19 crisis, faculty members in higher education struggled with the challenges of technostress. This pilot study was conducted with the participation of a diverse group of faculties, and it provided a deep and comprehensive look into their experiences. The study revealed a landscape characterized by multiple techno-stressors, including the delicate balance of 'Techno-Overload,' the complexities of 'Perceived Lack of Social Presence' and 'Techno-Complexity,' and the intricate interplay between faculty and technology. The narrative also extended to 'Techno-Invasion' and 'Techno-Uncertainty,' highlighting the elusive harmony between intrusion and utility. By integrating these insights with proposed coping strategies, we can pave the way for resilience, adaptability, and effective technostress management in higher education's digital frontier. The significant results yielded by this pilot study illuminate the path forward for faculty, administrators, and policymakers alike.

# SCM Quality Management

# PERFORMANCE EVALUATION OF VEHICLE ROUTING SCHEME WITH RISK OF ROUTE DISRUPTIONS IN SOUTH CAROLINA

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# ABSTRACT

Given a set of mission requests, the paper considers a problem of vehicle routing scheme design with the risk of route disruptions. Routing all given sites with the slightest probability of being disrupted for successful mission completion would be the most critical task. First, we propose how to estimate the disruption probability for each route. Three objectives are considered in this paper. Those are minimizing the total routing distance, minimizing the total routing time, and maximizing the probability of routing all given sites without being disrupted. We apply the goal programming approach to designing efficient vehicle routing schemes.

We conduct a case study using major disaster declaration records in South Carolina (SC) in the USA to demonstrate the applicability of the proposed mathematical models and the procedure. We select 12 locations across SC and find the driving distance and time from one location to another using Google Maps. Among the multiple routes suggested, we select the best route that Google Maps chooses unless the difference in driving distance is 5 miles or greater or the difference in driving time is 5 minutes or more. We assume the road is disrupted and shut down when a major disaster is declared. According to the Federal Emergency Management Agency (FEMA) database, SC has experienced forty (40) major natural disaster declarations from May 1953 to June 2023. In the United States, when a man-made or natural major disaster occurs, the President determines whether it warrants supplemental federal support.

There are forty-six (46) counties in SC. Twelve (12) locations across the state are selected. We compute the risk probability of being disrupted for each county by dividing the number of major disasters declared in the county by the number of years recorded. Major routes in that county are assumed to shut down for a certain period. The probability of route disruption among 12 locations is obtained by multiplying the probability of not being disrupted through the routes and subtracting it from one. We formulate a goal programming (GP) model for the three objectives with a weight given to each objective. Solving the GP with various weights reveals various vehicle routing schemes so that decision-makers can decide. A case study using actual data in SC demonstrates the proposed procedure's applicability for different areas that would provide a valuable tool to decision-makers in this business.

# SMART SUPPLY CHAIN CHARACTERISTICS CONSIDERING SUSTAINABILITY AND RESILIENCY INDEXES

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#### ABSTRACT

By growing the need to utilize the advanced technologies in industry, traditional supply chains are increasingly becoming intelligent and smart. In recent years particularly during and after the COVID-19 pandemic the need to become sustainable and resilient for supply chain management has brought several opportunities and obstacles that are influenced by the application of high technologies to create a smart supply chain. This study applies a data-driven approach by analyzing more than two thousand published articles between 1990 and 2022 that examined the use of smart supply chains in different industries. The publications were selected based on the relevancy of their title, abstracts, and keywords to smart supply chain management topics. The analysis for this study included; (i) descriptive analysis, (ii) identifying trend topics in the selected field, (iii) a cooccurrence network of terms, (iv) a Thematic map, and (v) Thematic evolution. The machine learning technique is applied to the content of published articles to create the knowledge structure of the research field and identify the main features of a smart supply chain in academia. Our objective is to identify the key attributes that define a smart supply chain within the academic context. The result of this study will provide opportunities for both scholars and industry to learn about the research field, the main characteristics of a smart supply chain, and their implications on the supply chain field in both industry and academia.

#### BUYER SUPPLIER RELATIONSHIPS: THE IMPORTANCE OF INTERORGANIZATIONAL VERSUS INTERPERSONAL RELATIONSHIPS

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#### ABSTRACT

The traditional method of handling relationships between buyers and suppliers has predominantly focused on interorganizational control strategies while disregarding the relationships formed by managers who work across organizational boundaries, such as those in procurement and sales. With the increasing importance of supply chain relationships, especially in times of uncertainty, it is essential to simultaneously consider both interpersonal connections and interorganizational control strategies. We assert that the interaction between organizational and interpersonal control strategies plays a crucial role in shaping how participants in the supply chain respond to supplier requests. Based on signaling and social exchange theory, we focus on the effects of governance mechanisms and different types of information shared in negotiations and similar interactions between boundary-spanning managers in different organizations. Our research delves into these aspects through interviews with supply chain managers using a critical incident technique (Flanagan, 1954). This technique allows us to qualitatively examine the experiences of managers in these types of interactions through a flexible method that gives us insights into the behavioral supply chain. This method is helpful to explore concepts as it does not restrict observations to a predefined list of variables. Specifically, we ask managers to provide examples of their most significant buyer-supplier experiences. Those examples and stories have been gathered, analyzed, coded, and interpreted. Our aim is to gain a deeper understanding of these dynamics and provide managerial insights.

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#### A SIMULATION MODEL FOR CIRCULAR SUPPLY CHAINS

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#### ABSTRACT

There is a dearth of simulation models in the circular supply chain literature. To alleviate the extant problem and encourage research efforts in the area, the authors propose a multi-step, excel-based simulation model that incorporates circular concepts of reuse, remake, and refurbishing. In each simulation run the model makes four recycling passes and determines the economic viability of each step based upon processing costs, value recovery, and cost of logistics and waste disposal. The simulation data is stored in an excel file and facilitates pivot table analysis that can examine specific economic, technological, and environment concerns for the data provided.

The excel model assumes a fixed amount of waste stream available for recycling in the first step. The reusing, remaking, and refurbishing operations can follow a uniform, normal, or exponential distributions. For uniform distributions, the lower and upper values, for normal distributions, the mean and standard deviation, and for exponential distributions, the mean value is provided. Random numbers determine the specific amount of product that is reused, remade, or refurbished. The leftover stream may have some extractable value products. Its distribution can again follow uniform, normal, or exponential distribution, and a random number determine the specific value used. The total value of materials extracted and the leftover waste stream is determined. These are compared with the total logistical, processing, and disposal costs to determine the presented model is four, it can vary depending on the data, utilizing a similar decision-making framework.

# UNDERSTANDING VALUE CO-DESTRUCTION PROCESS THROUGH PRODUCT RECALL INCIDENTS: EVIDENCE FROM U.S. CONSUMER PRODUCT SAFETY COMMISSION

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#### ABSTRACT

Product recalls are central to managing quality in the supply chain. Although existing literature in product recalls has investigated drivers and outcomes of product recalls from the manufacturer perspective, there is scant attention dedicated to understanding the recall processes. We retrieved 2722 recall reports on consumer home appliances published between 2011 and 2022 from the U.S. Consumer Product Safety Commission (CPSC). We employed structural topic modeling (STM), an unsupervised machine learning technique, to examine topics and their relationships to explore the intersection of product safety and supply chain management. STM result uncovered common latent themes and twenty topics that identify known issues associated with product recalls and safety issues for consumer products. Network analysis also indicates the associated relationships among manufacturers and retailers on the identified product recalls. Our findings emphasize the important roles of actors in value co-creation in quality management by managing disruptions. We extend the application of STM to the context of consumer product recalls and discuss the implications of our findings in the supply chain context.

# CHATGPT'S EFFICACY IN ENHANCING LATIN AMERICAN CULTURAL TOUR DESCRIPTIONS

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# ABSTRACT

The recent public release of ChatGPT has revealed the exciting and vast new opportunities offered by generative artificial intelligence. Within the tourism sector, there exist myriad applications for ChatGPT, including throughout the marketing process [1]. Effective marketing is critical for tourism products because tourism is an intangible service that consumers cannot trial in advance, and which often involves substantial pre-purchase information gathering [2]. Marketing is targeted at tourists throughout the tourism product supply chain, which often entails intermediaries such as online travel agencies (e.g., Expedia). However, small tourism enterprises often struggle to produce the highquality marketing content needed to fully succeed in this marketplace [3]. This issue can be particularly acute in regions where the official language is not English, which represents the primary language of international tourism in many destinations [4]. Consequently, the purpose of this study is to examine whether ChatGPT can effectively improve the Englishlanguage descriptions of cultural day-tours used by Latin American tour operators. The study will involve real descriptions of three cultural tours in Panama, pulled from TripAdvisor, a site that plays a key role in the tourism supply chain as both an online travel agency and a review platform. The three selected tours represent the cultural tours with the most

TripAdvisor reviews related to each of Panama's three most populous indigenous groups: the Emberá, the Guna, and the Ngäbe-Buglé. A new version of each tour's description will be generated by ChatGPT, using instructions to make it sound friendly and professional. Next, two profile pages will be created for each tour, one using the real description and one using the ChatGPT-enhanced description, and also including imagery taken from the tour's TripAdvisor page. Mechanical Turk will be used to attract research participants, who will be randomly shown one of the two pages for each of the tours, and then asked to evaluate them via an online survey. The survey items will focus on respondents' attitudes towards the tours, the profile pages, and the tour descriptions. The questionnaire items will be rooted in the various dimensions that compose the Attention-Interest-Evaluation-Desire-Action tourism advertising effects model [5]. Attitudes towards the two versions of each tour profile page subsequently will be compared to determine the effectiveness of using ChatGPT to enhance cultural tour descriptions.

This study is still being completed. By the time of the conference in late February, data collection will be finished, and preliminary results and conclusions will be available. Particularly given that ChatGPT is a free tool available to everyone, this study's results will have clear and direct implications for tourism enterprises around the world as they seek to attract more customers throughout the tourism supply chain.

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# ARTIFICIAL INTELLIGENCE IN SUPPLY CHAIN MANAGEMENT: A REVIEW OF ITS USE IN FUNCTIONAL AREAS

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# ABSTRACT

ChatGPT is a fast-growing chatbot, developed by OpenAI, in history. It's estimated to have more than 100 million active users in just two months after launch. The speed of growth is faster than other social media applications such as Facebook, Twitter, TikTok, etc. Supply chains are very complex, and their optimization requires understanding of multiple interrelated decision making processes. AI technologies such as agent-based systems, genetic algorithms, fuzzy logic and expert systems can optimize and improve the agility of supply chains, particularly when coupled with other technologies such as Internet of Things (IoT) and cloud computing, to conform a "self-thinking supply chain." Due to the increasing trend for the use of artificial intelligence in many fields, this study aims to explore the trend of using Artificial Intelligence (AI) and identify the applications in supply chain processes including inbound, production, and downstream distribution systems. Examples include customer relationship management, demand forecasting, sales and distribution processes, inventory control, material planning, production, quality management, purchasing processes, and supplier relationship management. This paper will follow the taxonomy proposed by Pournader et al. (2021) that classifies AI applications into sensing and interacting (vision, speech recognition, natural language processing), machine learning (supervised, unsupervised, reinforced), and decision making (optimization, planning and scheduling, and expert systems). Special attention will be paid to the integration of these AI applications to SCM within Enterprise Resource Planning (ERP) environments.

# THROUGH THE SUPPLIERS' LENS: MEASURING BUYER PERFORMANCE THROUGH MULTI-CRITERIA ANALYSIS

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# ABSTRACT

In today's business environment, sustained buyer-supplier relationships are paramount, significantly impacting overall supply chain performance. Such long-term relationships necessitate mutual satisfaction between buyers and suppliers regarding each other's performance. While ample literature exists on measuring supplier performance from the buyer's perspective, there is a notable gap in research regarding buyer performance evaluation from the supplier's standpoint. This study addresses this lacuna by investigating buyer performance evaluation within buyer-supplier relationships from the suppliers' perspective. Based on an exhaustive literature review and expert consultations, this study identifies key factors deemed significant by suppliers in assessing buyer performance. A survey designed in light of these factors targets a broad spectrum of suppliers to gather diverse views on buyer performance criteria. The study employs the Analytic Network Process (ANP) and the Decision-Making Trial and Evaluation Laboratory (DEMATEL) methods for data analysis. ANP provides a flexible framework for dealing with complex interdependencies among factors, while DEMATEL assists in understanding the cause-effect relationships within these factors. The combination of these methodologies facilitates a robust and multifaceted analysis, enabling a comprehensive understanding of buyer performance from the suppliers' perspective. The research culminates in a quantified evaluation of buyer performance, amalgamating the insights from ANP and DEMATEL analyses. This comprehensive evaluation offers a novel perspective in supply chain management research, highlighting areas for improvement in buyer performance. The findings hold significant implications for businesses striving to optimize their supply chain relationships by better understanding the suppliers' views on buyer performance.

# Keywords: Buyer-supplier relationship, AHP, DEMATEL), Fuzzy logic, Supply chain management

# REVISITING PROMOTING THE VALUE OF SUPPLY CHAIN MANAGEMENT TO FUTURE BUSINESS LEADERS

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# ABSTRACT

Over the last three decades, business leaders have identified the importance of Logistics and Supply Chain Management (SCM) as a key business function. The value of systems, processes, continuous improvement, modeling, etc. in creating an efficient supply chain has been recognized in multiple studies with people being identified as the key component. However, studies have highlighted the imbalance of supply and demand for qualified logisticians graduating from business schools. With the continued growth and awareness of the field of Logistics and the transformation of most programs to SCM curriculums, the question becomes why does there still appear to be an imbalance and why is it still occurring in colleges of business? Furthermore, what additional tools, concepts, or techniques may be more effective in raising SCM awareness and interest with a different generation of business student.

An extensive analysis of literature is conducted highlighting the various traits of Millennial and Gen Z students in their decision making for choosing a business major based on the background of the professor teaching the Introduction to Marketing type course. Knemeyer and Murphy (2004) performed a detailed analysis in identifying students' awareness and views about the Logistics major, but due to the study being performed in approximately 2000, the target students were Gen X students. The key focus of this work is to identify if the findings from the 2004 article still apply over a generation later. The other key area of literature examines a portion of the overall literature applying to the differences between the various "Gen" generations (i.e., X, Y, Z, and Millennials) to see if there are other items that should be included.

Using a pre and post-test survey method along with paired t-tests and ANOVA, the researchers examined the impact of the Supply Chain Management faculty as the primary instructor or subject matter expert in a specific portion of the class in nine Introduction to Marketing classes at a large public university. Interviews of select students are also conducted to identify additional points of interest. The initial review of the data implies the study finds many of the same traditional items impact the major selection factors from Knemeyer and Murphy (2004) [1].
However, the different data collection method and additional questions are aligning with many of the Millennial traits from other studies. The final semester's post-test survey has been collected and is currently being followed by interviews of specific students to complete the dataset. Final results, findings, conclusions, discussion, etc. will be completed by the EDSIG Conference.

Keywords: academic quality, pedagogy, curricula, degree programs. faculty development

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#### LEADERSHIP: STRATEGIES TO MITIGATE ATTRITION WITHIN A CALL CENTER ENVIRONMENT

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#### ABSTRACT

Contact center representative turnover is double the average of other occupations within the United States, with annualized attrition ranging from 30 to 73%. Previous studies asserted agent training does not equip call center agents with skills needed to cope with customer incivility. This lack of skills is a contributing factor in attrition and can lead to a phenomenon known as job shock, even when they are thoroughly trained and proficient in their jobs. The purpose of this qualitative descriptive phenomenological study was to identify the skills that agents either innately possess or have learned that enable them to handle stress and manage their emotions during and after escalated situations. Participants in the study were contact center agents with at least one year of service in their current positions with the research questions presented in individual interviews and focus groups. The study used the Complexity Leadership Theory (CLT) as its guiding framework while also considering implications to the Adaptive Leadership and Job Demand Resource Model theoretical frameworks. The study substantiated previous research that indicated training focuses on management of customer churn as opposed to coping strategies for job shock. Further, the study identified key coping skills which agents learned from other agents or those innately possessed to help mitigate job shock. Those skills included moderating tone with uncivil customers, deep breathing, wellness breaks, talking to others after a tough call, positive affirmations, exercise, and journaling. One

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implication of the study is that these skills could be integrated into a Stress Education and Recovery Training course to mitigate job shock and curb attrition. An additional implication is the study indicates there may be an important new role for the Contact Center Supervisor as a wellness coach to encourage positive behaviors and serve as an outlet for agents to discuss difficult calls to mitigate job shock.

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#### CHALLENGES AND OBSTACLES OF GENDER EQUITY IN ESPORTS

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## **INTRODUCTION**

For many years, women as athletes in sports have been facing issues of gender equity. however, in terms of gender issues related to sexism and exclusion, eSports is no exception (Ratan et al., 2015). Indeed, the eSports industry is heavily male-dominated, with women representing a lower proportion of participants, fans, and leaders (Entertainment Software Association [ESA], 2018). Studies show that women comprise 35% of eSports players (Interpret, 2019), but only 5% of professional players (Hilbert, 2019), which means that women players rarely compete at the topmost level of eSports. But in some countries, this participation rate even reaches the lowest level. In Iran, women are not allowed to play electronic games professionally and they are not supported by the relevant associations. there are many problems surrounding Iranian women in sports and society (Macur, 2016). In 2017, the Georgetown Institute for Women, Peace, and Security (WPS) ranked Iran in the last rank of 153 countries in the world (Klugman, 2017). Iranian women cannot go to sports stadiums to watch sports events. The ban on women caused much upset, but Iranian lawmakers argued it was women's duty to raise children and not to attend sporting games (Macur, 2016).

## METHODOLOGY

The purpose of this study was to investigate of challenges and obstacles of gender equity in esports. A total of 49 semi-structured interviews were conducted with experts and specialists in electronic sports. Participants were recruited using homogenous and snowball sampling. A thematic analysis was employed using NVivo based on identified themes to find trends within the data.

## FINDING AND CONCLUSION

Iran's government is considered the main reason for the existence of obstacles and challenges. the participants explained that electronic sports in Iran, like other sports, are influenced by the religious beliefs of the rulers. these beliefs prevent them from participating in electronic sports, such as cycling, which is prohibited for Iranian women. While the results indicate that the Iranian government and its ideological approaches played a major role, some participants mentioned that Internet harassment and sexism are also seen in those low participation rates. This is because the Iranian regime has placed men and women completely separate from each other and against each other in Iranian society. These findings show that not creating a suitable environment in sports and electronic sports has an impact on women's lack of motivation and interest in participating in electronic sports, this is a violation of women's rights and a lack of gender equity. therefore, the balance between men and women in e-sports is critical in providing sports opportunities for Iranian women in society, if women's rights are not respected in the future.

#### EXPLORING SUSTAINABLE SUPPLY CHAIN PRACTICES AND CLIMATE CHANGE ADAPTATION STRATEGIES

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#### ABSTRACT

Under current conditions, risk management and sustainability become increasingly important phenomena in supply chain management research and business practices. Subsequently, the climate-resilient supply chains are increasingly important for maintaining sustainable operations. Growing complexity and increased supply chain disruptions have raised questions for supply chain managers with limited answers from the current academic literature. Thus, it is important to research climate change impacts to supply chains and explore infrastructure vulnerabilities and strategies for strengthening supply chain climate adaptation and resilience. Furthermore, it is important to understand adaptation and mitigation strategies for climate-related risks at both managerial and organizational levels. The proposed model and summary of the best practices will allow to better understand and classify climate related risks as well as related mitigation and adaptation strategies, filling the gap in existing research and contributing to the climate adaptation and sustainability body of knowledge. Additionally, exploring supply chain sustainability and risk management practices can help to improve both theoretical and managerial understanding, as managers are often the ones that formulate and implement sustainable and resilient supply chain strategies and tactics.

#### IMPACT OF BLOCKCHAIN IN FOSTERING SUPPLY CHAIN AMONG STARTUPS

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#### ABSTRACT

With the rapid development of technology, blockchain based technology has revolutionized supply chain operations in large corporations. With a few cases in pharmaceuticals and food safety industries. In this regard, blockchain based applications serve as a good example in large corporations. However, the level of blockchain implementation among startups is still unknown. Leading to a gap in understanding how managers evaluate the integration and performance of blockchain based systems among startups particularly in supply chain operations. The emergence of blockchain presents enormous opportunities among startups through elimination of intermediaries, increased transparency, operational efficiency, and traceability to enhance supply chain sustainability. As companies increasingly adopt digital business models, outlining the blockchain - infused supply chain solutions become critical to address the shifting technological landscape. The goal for global supply chain inclusion framework will introduce a structured methodology for blockchain technology to help assess the ability of their solutions to foster supply chain inclusion. The framework will enable startups managers to measure gaps within existing blockchain innovation solutions and identify strategic opportunities to help strengthen the capabilities across the dimensions of supply chain inclusion. The aim of this paper is to examine comprehensive experiences and constraints faced by startups in adoption and use of blockchain technology in the support of supply chain operations. This paper will adopt a grounded theory (GF) approach to capture qualitative data through interviews with experts and content analysis, primary data collection will be captured by conducting at least 12 in depth interviews with startup leaders or managers in the fields of operations, supply chain and logistics across the USA. By conducting semi -structured interviews. We will present a case of a startup ecosystem on implementation and use of blockchain. This paper may contribute to development of a business model and literature that will guide academicians and stakeholders on implementing blockchain based systems within the entrepreneurial ecosystem.

# THE COST OF GOING TO THE RACES: DEVELOPING A FAN COST INDEX FOR MOTORSPORTS

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## ABSTRACT

Of the sports marketing elements, pricing receives scant attention in research. Nonetheless, as the only element that produces revenue, pricing warrants considerable attention. The pricing set by sport managers indicates to their fans the value of the experience. As such, the pricing schemes utilized to signal the value should be easily understood by fans. Research has reflected the importance of ticket pricing strategies such as dynamic ticket pricing, segmented pricing, and value-based pricing. However, the total cost to attend an event includes several additional costs including concessions and parking. For fans traveling to the events, there is the additional cost of accommodations. Absent in the research is the strategy utilized to price those items.

Team Marketing Report devised the Fan Cost Index (FCI) to show fans the estimated average cost for a family of four to attend home games of professional sports teams in the NFL, NBA, NHL, and MLB. The FCI included average priced tickets, concessions, souvenirs, and parking. Absent in the FCI are estimates for motorsports fans.

Unlike most sports venues, nearly all motorsports venues allow fans to bring coolers of snacks and drinks for their racing experience. Bringing their own food and beverage can significantly reduce the cost for racing fans. However, many fans travel to the races, incurring accommodations costs for the racing weekend.

This presentation illustrates the development of a Fan Cost Index for Motorsports utilizing average prices for tickets, accommodations, and parking for the 2024 NTT IndyCar Series season.

#### THE MULTI-PERIOD INTERACTIVE CLSC NETWORK

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#### ABSTRACT

Inspired by the recent business cases, we develop a coupled multi-period CLSC network model dealing with heterogeneous products facing different demand markets. The end-of-life product from the forward supply chain is collected, recycled and the raw material is extracted to be used as an input for the reverse supply chain which produces another type of product. In particular, interactions between the two supply chains with inventory cost and innovation competition are analyzed. An algorithm is introduced to study the network equilibrium. Numerical examples are used to illustrate the model.

## THE EFFECT OF AUTOMATION ON HOSPITALITY EMPLOYEES' VOCATIONAL WELL-BEING

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#### ABSTRACT

The hospitality industry has embraced automation for years by introducing self-service kiosks, smartphone/tablet applications, automatic food preparation machines, and other technologies. Additionally, automated processes have become more prevalent in our day-to-day lives due to society's many adjustments during the COVID-19 public health emergency. A society that once shunned "humanless" service interactions now prefers it for convenience.

As the hospitality sector continues to modernize to remain competitive, it grapples with the impact of automation on its most important resource, the employee. Previous research has shown evidence of hospitality employees feeling progressively uneasy about the future of the field, especially lower-level positions, which has created considerable automation-related job insecurity. In contrast, companies within the hospitality industry are concerned by the severe labor shortages in Europe and North America that were already prevalent before 2020 and accelerated significantly after the COVID-19 pandemic. The difficulty of finding labor interested in working lower-level hospitality jobs increases the need for companies to consider using automation to complete routine tasks.

An exploration of the effects of automation within the hospitality industry is timely and warranted. There is a need to address the question of whether automation is effectively eliminating hospitality jobs or whether automation could provide employees with flexibility and increased efficiency. Data for this research study was collected from full-time personnel of varying demographic backgrounds employed in several areas of the hospitality industry. This research study examines the effect of hospitality employees' perception of their job's potential automatability on the relationship between resistance to change and automation-related job insecurity.

#### CORPORATE GOVERNANCE AND STOCK RETURNS OF GOING-PRIVATE RESTAURANT FIRMS

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#### ABSTRACT

Access to capital markets is one of the key benefits of becoming a publicly traded company. However, previous research has shown that companies in more recent years have returned to the private sector rather than staying public after the initial public offering. While existing research found numerous reasons for going private, there is a limited number of studies that identify factors that influence the magnitude of shareholder returns when firms go private. This study attempts to uncover firm-specific factors that affect shareholder returns. Our study includes U.S. restaurant companies listed under Standard Industry Codes 5810 and 5812 between 1997 and 2021. Thus, our final sample consists of 40 firms that made going private announcements. Data on going private transactions is obtained from media outlets and SEC annual filings (10-Ks). Data for the dependent variable (shareholder stock returns) is available in The Center for Research in Security Prices (CRSP). The market model is used to calculate abnormal stock returns. Independent variables in our study are firm franchising proportion, director independence, and CEO duality. The study also controls for firm age (year founded), geographic dispersion (number of US states), and firm size (number of stores). Regression analysis results show that firms with higher franchising proportion experience lower abnormal returns. On the other hand, firms with CEO duality and independent boards receive higher bid premiums. The findings of this research study provide important implications for firm executives considering going private and private equity investors trying to identify the best target firms that can be taken private.

Keywords: going private transactions, corporate governance, abnormal stock returns

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#### TOWARDS AN EFFICIENCY ANALYSIS OF NCAA DIVISION I WOMEN'S BASKETBALL

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#### ABSTRACT

As allegations of out-of-control spending continue to surface, and as the pressure to win and generate revenue continues to grow, there exists increased interest in collegiate athletics. While researchers in the past have investigated specific issues related to athletics success, the generation of revenue as well as student-athletes' graduation rates, no previous studies have attempted to evaluate these factors simultaneously in the context of the National Collegiate Athletic Association (NCAA) Division I women's basketball. This research will discuss the development of a data envelopment analysis (DEA) model aimed at measuring how efficient NCAA Division I women's basketball athletic programs are in terms of the use of resources to achieve athletic success, generate revenue, and promote on-time graduation rates.

Data will be obtained from the following three sources: the NCAA, the Equity in Athletics Disclosure Act (EADA), and the National Association of Collegiate Directors (NACDA). The NCAA will be used to retrieve the necessary data related to graduation rates and academic success in women's basketball. On the other hand, the Equity in Athletics Data Analysis Cutting Tool developed by the Office of Postsecondary Education of the U.S. Department of Education will be used to retrieve different financial and funding for each program. Finally, data from the NACDA, specifically The Directors Cup, will be used to examine the athletic performance of each individual women's basketball Division I program.

Empirical data from the three sources mentioned above will be combined and used to assess the relative efficiency of the Division I institutions. The study findings will help identify a series of "best-practice" universities/programs which will, in turn, be used to calculate efficient target resource levels for the groups of inefficient institutions. Various research questions will assess the efficiency of the different athletic programs (e.g., which institutions are the most efficient or the most inefficient out of Division I universities, what savings could be achieved by each university to guide them towards becoming efficient, or what performance levels should be achieved by each university to be considered as efficient in the DEA model). The value of the proposed model to collegiate athletics decision makers will be discussed.

**Keywords:** College Sports, Data Envelopment Analysis, DEA, Efficiency Analysis, Women's Basketball.

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# Student Papers

## SECURITY AND OTHER RISKS OF IMPLEMENTING ARTIFICIAL INTELLIGENCE IN HEALTHCARE: PRIVACY, BIAS, ACCOUNTABILITY AND ALGORITHMIC SECURITY

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# ABSTRACT

Artificial intelligence (AI) has emerged as a transformative technology in healthcare, enabling improved diagnostics, treatment planning, and overall patient care. However, deploying AI in medical settings presents a range of ethical, legal, and practical challenges. This extended literature review examines the current landscape surrounding AI in healthcare, specifically addressing privacy concerns, algorithmic bias, and accountability. This review will explore the implications of AI-based medical applications on patient privacy, data security, and informed consent through a curated analysis of academic literature, policy documents, and case studies. We will investigate the underlying causes of algorithmic bias in medical AI, examining the impact of biased data sets and the consequences of these biases on patient care. Furthermore, we will discuss the importance of establishing clear lines of accountability in developing and deploying healthcare AI, considering the roles and responsibilities of various stakeholders.

**Keywords** - Accountability, algorithmic bias, artificial intelligence, data privacy, healthcare, policy

# **INTRODUCTION**

Artificial intelligence (AI) has clearly become a transformative tool within the healthcare sector, paving the way for advancements in diagnostics, treatment planning, and patient care [35] [62]. Alongside these developments, there's a growing recognition of the ethical, legal, and practical challenges of integrating AI into medical settings. This survey aims to present an exhaustive insight into the current realm of AI in healthcare, emphasizing issues like privacy, bias, accountability, and AI-specific cybersecurity threats. Emphasis has been given to identifying current regulations and guidelines that address patient privacy,

informed consent, biases in AI, accountability, and the unique cyber threats presented by AI. Dermatology AI research was chosen as a way to provide a focused view of the risks and pitfalls of AI in healthcare. The Watson for Oncology (WFO) case study will be integral to our discussion, shedding light on the challenges and considerations when integrating AI within medical paradigms. The case is a telling example of the current state of AI reporting standards in healthcare. We aim to culminate our survey with forward-looking recommendations to foster more secure, ethical, and effective AI adoption in healthcare.

# Methodology

This literature review has the goal of integrating information from the diverse areas of medicine, AI, cybersecurity and regulation/law. Publications of interest were identified via IEEE, Google Scholar, Google, PubMed and the web sites of relevant regulatory bodies. A multi-tiered approach was employed, beginning with keyword searches, then preliminary screening of titles and abstracts, and concluding with a thorough examination of the full texts of relevant studies. The snowball method was used to identify additional articles.

# The Evolution of AI In Healthcare

The origins of AI in healthcare can be traced back to the development of expert systems in the 1970s and 1980s, such as MYCIN, which aimed to assist physicians in diagnosing and treating infections [58]. With the arrival of machine learning (ML) algorithms and the growing accessibility of electronic health records (EHRs), AI research in healthcare gained momentum in the 1990s and early 2000s [41]. In recent years, the rise of deep learning techniques and the increasing availability of large-scale health data have further accelerated AI adoption in various medical domains [52] [62]. The extremely rapid pace of research and development in the application of AI to the healthcare field has outpaced a deeper understanding of the consequences of such an implementation.

# **Problem Statement**

The rapid growth of AI has led to many risks and rewards. This paper is a survey of AIrelated issues in the field of healthcare. For most organizations, a cyber breach may cause business interruption, financial harm, or reputational harm, but a patient's safety and life are also at stake in healthcare. AI algorithms have been developed to provide diagnostic or therapeutic recommendations, and it is extremely important not to incorporate any misinformation or bias in the output of these programs. In addition, a person's medical record is immutable and thus has been deemed worthy of a higher level of data protection. The healthcare field is subject to a wide variety of laws and regulations, and any software needs to be compliant with them. There is a need to bring greater attention to these issues.
#### **Research Questions**

What are the risks of implementing AI in healthcare?

- a) What are the privacy risks of AI in medicine?
- b) What is proper informed consent?
- c) Who is accountable for AI aided healthcare recomendations?
- d) What sources of bias may occur in AI algorithms?
- e) What are the cybersecurity risks uniquely related to AI?
- f) What regulatory or legal risks may occur due to the use of AI in medicine?

## **CONCEPTUAL FRAMEWORK**

Artificial intelligence (AI) has infiltrated numerous facets of daily life, including the realm of healthcare. By analyzing AI's transformative potential and examining the societal and ethical implications, we can forge a comprehensive conceptual framework that aids our understanding of AI's role in healthcare, the existing regulations, and avenues for future developments.

# AI Development and Use in Healthcare: Bias, Accountability and Ethics

AI's application in healthcare has demonstrated a significant potential for revolutionizing patient care. The AI models used in patient management, diagnosis, and treatment highlight the depth and breadth of AI's potential in the healthcare sector. As AI evolves in healthcare, issues concerning bias, accountability, privacy, and transparency become paramount. Understanding the ethical considerations in this realm allows us to gauge the potential societal impacts of AI deployment in healthcare. Moreover, patient acceptance of AI tools and their influence on physician-patient relationships underscores the need to keep the human dimension in AI applications.

## Laws and Regulations Governing AI in Healthcare

Current laws and regulations serve as the basis upon which AI tools are developed, tested, and deployed. An in-depth exploration of existing guidelines published by the FDA helps elucidate the legal and regulatory landscape in which healthcare AI operates. EU laws and regulations, especially the proposed EU AI Act, which was published in June 2023, will significantly impact the field. These institutions not only ensure the safety and efficacy of AI in healthcare but also provide a framework to stimulate further technological innovation.

## LITERATURE REVIEW

## **Patient Privacy**

One of the biggest concerns in healthcare is protecting patient privacy. The primary legal framework in the USA is the Health Insurance Portability and Accountability Act (HIPPA), and in the European Union, it is the General Data Protection Regulation (GDPR) [19] [28]. In the USA, the California Consumer Privacy Act of 2018 (CCPA) is the strictest state law in the USA and provides additional protections to residents of that state [6]. The CCPA applies to for-profit businesses doing business in California. California is the home of many technology companies; thus, the CCPA has an effect outside the state's borders.

AI algorithms require training data, and using non-anonymized patient data sets to train AI systems has been felt to violate privacy laws [11]. Earlier in the development of AI healthcare algorithms, permission to use patient data sets was thought to be covered by general release forms. Current thinking holds that specific permission needs to be obtained from each patient. While this would clearly protect patient privacy, it would significantly impede the development of healthcare algorithms. Some approaches, such as federated learning, attempt to address this problem [2] [50] [56]. There are techniques to anonymize data. Nevertheless, multiple studies suggest that the anonymization process is not without fail. It has also been shown that AI applications can be manipulated to reveal some of the underlying data set, including protected information [4] [54] [57]

## **Informed Consent**

Informed consent in AI-driven medical applications has been a problematic area. In the medical sphere, informed consent requires three key features outlined in the Belmont Report [60]. First, the patient/research subject needs the information to make an informed decision. Second, the person needs to understand the information. Finally, the decision to participate has to be voluntary. The Belmont Report was written by the National Commission, a public body established by law that shapes public policy in the USA. Burying consent in the "terms of use" or "end user license agreement" is not proper informed consent. In general, AI applications are a "black box" for medical practitioners and patients [24]. Supervised machine learning algorithms are more readily understood by humans but do not perform as well as neuro-networks. Neuro-networks are intended to mimic the human brain, but their creators cannot explain how their program works. The more layers a deep learning program has, the opaquer the algorithm becomes. If a healthcare AI algorithm is a commercial product, the creators may not disclose the algorithm or data set for proprietary reasons. Without understanding an AI application algorithm's inner workings, obtaining patient or provider buy-in will be more difficult in a therapeutic or diagnostic environment. Typical patient concerns about AI in dermatology were noted in a survey by Jutzi et al. (2020) [37]. Patient concerns have also been summarized in a metasynthesis by Wu et al. (2023) [68].

# Accountability

Accountability in healthcare AI is an uncharted area. Accountability generally refers to a person's responsibility for their decisions and actions. In this section, the concept of moral accountability will be discussed. Legal and regulatory accountability will be discussed in a following section. Medical staff have professional codes of conduct and are held responsible for their recommendations and actions. Patients expect healthcare providers to provide the best care for them and to be accountable for the results, whether good or bad. There are no similar effective codes of conduct or moral imperatives to govern the actions of technologists who create AI programs for healthcare. The whole notion of AI in healthcare is to insert the program into the clinical decision-making process. AI programs like Watson for Oncology (WFO) are generally called medical decision support systems. Despite the labeling, these programs may be used in an unintended manner. WFO was meant to be used by oncologists, but in one of the study sites for WFO, non-specialists used the program untoward outcome in this situation is unclear. WFO is discussed further in the case study.

As noted previously, AI applications are a "black box" to the typical medical practitioner, and a clinician is unable to verify the accuracy and reliability of such a program. This unknowability creates a transparency, trust, and accountability problem. From an AI developer standpoint, developing and researching the principles denoted by the FATE (Fairness, Accountability, Transparency, and Ethics) acronym would help address this problem [15].

Healthcare is considered one of the sixteen critical infrastructures in the USA, according to the Cybersecurity and Infrastructure Security Agency (CISA). The Healthcare Sector Coordinating Council (HSCC) is a public-private partnership for critical infrastructure protection. HSCC is a partner with the US Department of Health and Human Services for "coordinating strategic, policy and operational approaches to prepare for, respond to, and recover from significant cyber and physical threats to the ability of the sector to deliver critical assets and services to the public" [29]. The HSCC published a document in 2023 entitled Artificial Intelligence & Machine Learning (HIC-AIM) [27]. The second of the nine listed HSCC concerns is "Accountability of Outcomes Undefined". HSCC stated that it is important for "data scientists, AI developers, and AI consumers to communicate and define where roles and responsibilities lie to correct problems". HSCC made a few suggestions to improve accountability. The first is to improve the baseline of learning (i.e., improve the data quality) and use explainable artificial intelligence (XAI) [7] [61]. XAI is a newer approach that tries to address the black box problem. The other HSCC suggestions are following NIST standards, FDA regulations, and guidance.

The FDA issued a document in 2021 entitled the "Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD) Action Plan" [18]. One of the proposals was to have a "patient-centered approach incorporating transparency to users".

The FDA wanted to have AI/ML-based devices take into consideration issues such as usability, equity, trust, and accountability.

If an AI recommendation is incorrect and leads to patient harm or death, the responsibility and accountability are yet to be determined. In the absence of clear-cut laws and precedents, medical providers and AI system creators will undoubtedly dispute the accountability of AI algorithm failures. Unless clarifying legislation is passed, this will be decided by the judicial process.

# Data Bias and Other Pitfalls: Lessons from the Use of AI in Dermatology

Algorithmic bias is a significant issue in medical AI as it could lead to misdiagnoses and treatment disparities [20] [21]. Structured and correctly labeled training data i.e., the ground truth, plays an important role in AI development [9]. One advantage for choosing dermatology for AI research is that in dermatology, the ground truth of the data can be established by a biopsy of the lesion [22]. There are fewer clinical medical AI applications because electronic medical records contain a wide variety of data types, including unstructured text, physiologic data, lab results in a variety of formats, as well as imaging and other inputs. The classification of these diverse data types in clinical medicine must be established by subject matter experts, which leaves more room for different opinions as to what is the ground truth. Data preparation can be time-consuming and costly. This limits the size of well-curated data sets and has hindered the development of high-quality AI research in medicine. There has been an exponential growth in AI radiology research [39]. One reason for this is that radiology uses the structured DICOM (Digital Imaging and Communications in Medicine) protocol. Dermatology AI research has primarily focused on image analysis but unlike the field of radiology, dermatology images are not highly standardized. Thus, AI in dermatology lends itself to an examination of the various origins of data bias.

Al algorithms rely on training data sets, and the lack of a representative population sample may create a faulty or inaccurate algorithm. Common forms of bias include racial, gender, social, economic, or other factors. Many algorithms were trained on data sets that predominately consisted of images from fair-skinned individuals [25] [70]. Kamulegeya et al. (2023) demonstrated that a dermatology AI application was only 17% accurate on black skin types in a Ugandan population as compared to 70% accuracy on Caucasian skin types [38]. Diagnostic accuracy for a Korean population was decreased compared to the Caucasian population due to the biased training data [25]. This problem has been recognized, and Daneshjou et al. (2021) created a curated "Diverse Dermatology Images" dataset as a possible way to address this problem [10]. Training data sets have to take into account a patient's gender [46]. Some skin lesions are sex-specific, such as genital neoplasms. In women, melanomas occur more frequently in the hip and lower extremities. Some diseases, such as systemic lupus erythematosus, predominately affect women.

Training data that does not take into account the gender of the patients may perform less well, according to Larrazabal et al. (2020) [44]. Rare lesions such as unpigmented melanomas are often not present in large enough numbers to impact the training [22]. When these AI applications were tested with an independent data set, their performance usually dropped [25].

Uncontrolled, unrecognized, or unappreciated variables can impact the accuracy of AI algorithms. Inconsistency in the data collection process can greatly impact how algorithms perform. Many dermatology AI algorithms use the International Skin Imaging Collaboration (ISIC) datasets [5]. Cassidy et al. analyzed the ISIC datasets from 2017 through 2020 and found thousands of duplicate images in both the training and test data. Removing 14,330 duplicate images improved the performance of the AI models when these researchers benchmarked them using their curated dataset. The quality of the photography can be variable, and this affects the accuracy of an AI model [22]. Algorithms can be influenced by surgical markings or rulers in the image [66]. The effect of this "label noise" was highlighted by Hekler et al. (2020) [30]. It has also been shown that hair in the image can impede model performance [5].

Inadequate data set size is a problem for any AI implementation [47]. Data augmentation has been one way researchers have attempted to get around this problem. Transformations such as rotation or flipping of the image, changes in lighting, and/or contrast have been used [22] [69]. Published papers do not point out the fact that data augmentation does not change the skin type of the specimen, and thus an augmented data point cannot be considered be a truly independent image. Due to the lack of an adequate number of images, the data set is often divided into a training set and a testing set [48]. This leads to the problem of overfitting and lack of generalizability of the algorithm [13].

Many of the earlier dermatology AI applications focused on the binary task of diagnosing malignant versus benign skin lesions since this is a simpler computational task. In the real world, patients may present with various skin conditions. Many of the more recent AI applications have taken steps to address this multi-classification problem. For example, applications that use the ISIC data sets (2016-2018) had to discriminate between seven categories of skin conditions [47]. While these seven are among the more common skin diagnoses, dermatologists deal with more than 2,000 different skin conditions [70]. Clinical outcomes have drawn much less attention and the studies in this area have had variable and limited success [12]. Another concern is that the development of healthcare AI programs could be biased toward addressing health concerns, which would be profitable for commercial companies in the lead in developing AI [1]. Medical knowledge is not a fixed entity. Algorithms with greater utility must incorporate up-to-date information. Since open AI applications are in a constant state of flux, they are not stable. In other words, one cannot assign a version number to the program, and credit or blame for the recommendations of the program cannot be assigned accurately. If the AI algorithm is

locked to avoid these problems, it runs the risk of becoming dated and inaccurate. In the USA, the FDA has taken steps to address this problem (see FDA section below).

# **Cyber Risks Particular to AI**

Computer technology has brought many benefits to the world of healthcare, but computerization also has a downside, namely cyber risks. AI has some unique cyber risks [29] [43]. Cyber risks such as denial of service attacks or man-in-the-middle attacks may affect the ability to access one's AI application but are not directly aimed at the AI application and therefore will not be discussed further.

Data poisoning means that part of the training data has been altered, so the AI program will consistently produce a different result than intended. Data poisoning could also be a vehicle for a backdoor attack [8]. In the context of healthcare, malicious poisoning of the training data could cause a dermatology diagnostic algorithm to classify a malignant lesion as benign or vice versa. Data sanitization is the common approach to this threat, but data sanitization is time-consuming. Input attacks require the attacker to carefully craft an input so that the AI program gives an incorrect output. For example, altering a small number of pixels in an image (which are imperceptible to the naked eye) may be enough to alter the output of an AI image recognition program.

Algorithm poisoning may occur when there is a weakness in the learning process of the AI program. This risk is greater with federated learning. Federated learning helps protect privacy because it takes data sets from different sources, and there is no interaction between the sources, but if one source intentionally or unintendedly has contaminated data, the entire algorithm will be affected. A model extraction attack occurs when an attacker gathers enough information to replicate the AI algorithm. This replica could behave in a similar or altered way as the original.

Membership inference attacks describe methods to determine whether an input was part of the training set of the algorithm [33] [63]. While federated learning can help improve privacy, this approach is more vulnerable to membership inference attacks. This is especially worrisome in a healthcare AI application since protected health information about an individual could be extracted from the model. This could be a violation of HIPAA and other privacy laws.

# Laws and Regulations

In the prevailing regulatory framework, the laws and regulations overseeing the deployment of artificial intelligence in healthcare remain limited. Nonetheless, the FDA regulations in the United States, the EU Medical Device Regulation, as well as the GDPR (which safeguards the privacy of EU citizens) collectively establish the foundation for AI

regulatory oversight [18] [53]. The European Parliament passed the EU AI Act on June 14, 2023 [14] [45]. It is expected that final approval will occur in 2024, and when finalized, the AI Act should have a major impact on the development and use of AI. This survey will focus on the regulatory developments in the USA.

# US Food and Drug Administration (FDA)

The FDA recognizes the transformative potential of AI and ML in the healthcare sector, as these technologies can provide valuable insights from the vast data generated during routine care delivery [18]. Among the most significant advantages of AI/ML in software is their capacity to learn from real-world applications and experiences, enhancing performance. In light of this, the FDA has made substantial strides in developing policies tailored explicitly for Software as a Medical Device (SaMD), aiming to improve patient care and provide healthcare professionals access to safe and effective technologies [17] [40].

The FDA has a responsibility to ensure the safety and efficacy of numerous AI-driven medical products. The agency primarily regulates software based on its intended purpose and the degree of patient risk associated with potential inaccuracies [40]. Like other medical devices, AI-enabled software undergoes FDA review based on its risk classification. Class I devices, such as the software used in continuous glucose monitoring devices, present the lowest risk [40]. Class II devices encompassing AI software tools, such as those used to analyze medical images, are considered to pose moderate to high risk. Most Class II devices undergo a 510(k) review (named after the relevant section of the Federal Food, Drug, and Cosmetic Act), where a device manufacturer demonstrates that its device is "substantially equivalent" to a pre-existing device on the market with the same intended use and technological features [40] [49]. Class III devices are considered to pose the highest risk to patients and require premarket approval from the FDA before being marketed in the US. These devices, which include AI-powered diagnostic software and implantable devices, undergo a rigorous review process that evaluates their safety and efficacy [40] [49]. The FDA's oversight of AI-driven medical devices is essential in ensuring patient safety while promoting innovation in the healthcare industry.

In early 2019, the FDA released the discussion paper "Proposed Regulatory Framework for Modifications to Artificial Intelligence/Machine Learning (AI/ML)-Based Software as a Medical Device (SaMD)" which presented a suggested approach to the AI/ML SaMD premarket review process [17] [49]. The FDA emphasized the need for AI SaMD manufacturers to detail the expected modifications that AI SaMD algorithms would undergo over time. This includes the "Predetermined Change Control Plan", i.e., the methods through which these adjustments would be implemented, and the "Algorithm Change Protocol (ACP)", i.e., to elaborate on how manufacturers intend to monitor and evaluate these changes [17]. In January 2021, the FDA released the "Artificial Intelligence/Machine Learning Based Software as a Medical Device (AI/ML)- (SaMD)

Action Plan." This document outlines future strategies to enhance the initial proposed premarket review process by detailing the FDA's intentions to adapt the regulatory framework for AI SaMD [18]. This new publication established the standards for good ML practices, increased the transparency of AI SaMD algorithm training and operation for both users and patients, addressed algorithmic bias, and offered clarification on real-world performance monitoring for AI SaMD software [40] [49]. Lastly, the FDA recognizes the rapid advancements in this area of medicine and remains open to ongoing feedback.

#### **CASE STUDY: WATSON FOR ONCOLOGY**

Watson for Oncology (WFO) [34] was used as a case study that illustrates accountability and other issues of AI in medicine. This AI program was announced with great fanfare in 2015, and it was supposed to revolutionize cancer treatment but turned out to be considerably less useful than hoped for. Various studies looked at the performance of WFO vs. a multidisciplinary oncology team, and the concordance rate was rather variable. Treatment recommendations given by WFO fell into three groups: "recommended," "for consideration," and "not recommended". At the "recommended" level, WFO was in concordance with the expert panel, anywhere from 82% to only 30%, depending on the tumor type [36]. The latter number certainly would not inspire confidence in the program. Concordance with a tumor board should be considered a secondary endpoint in evaluating an oncology treatment, and questions have been raised as to whether this is a valid metric to evaluate an AI program like WFO [64]. In general, healthcare AI programs have not been rigorously tested in a manner similar to that of other medical therapeutic devices or medicines. Even if one takes comparison with a tumor board as the proper metric to evaluate the effectiveness of a program like WFO, the different published studies used different versions of WFO, and in some cases, the version of WFO was not reported [64]. This makes comparisons of the WFO studies very difficult, if not impossible.

The WFO case is an example of the lack of reporting standards for AI in healthcare. The subtitle of the article by Burnell et al. encapsulates the problem "Aggregate metrics and lack of access to results limit understanding" [3]. The authors propose some reporting guidelines. Updating an AI product like WFO on a frequent basis would be a plus since it enables the program to stay current as the practice of medicine constantly changes and new therapies are put into practice. However, the algorithm can no longer be considered the same. This raises the issue of quality control and the appropriate way to manage the software update lifecycle. The issue of algorithmic drift was one of the concerns of the HSCC [27].

It should be noted that WFO was developed using treatment guidelines from the USA. This obviously would cause WFO to be less sensitive to differences in cancer risks and incidences in different countries. WFO apparently was not designed to consider the fact that certain treatments may not be available due to cost, national formularies, or cultural

approaches to therapy. It should be noted that WFO was partially trained on synthetic data and not real patient information. Acceptance of WFO by patients was surveyed in an article by Hamilton [23]. The focus groups in the study brought up acceptance issues and other concerns. For example, some patients wanted to know where the data for WFO came from. Patients were worried about the comprehensiveness and accuracy of the program. Patient acceptance in these focus groups was generally favorable, but there was concern over the potential for such a program to unduly impact physician-patient decision-making. The most important take-home message was that WFO should be a supplementary tool in a physician's decision-making. Watson for Oncology was withdrawn from the market in 2020, and service was discontinued in 2022.

## **RECOMMENDATIONS FOR FUTURE DEVELOPMENT**

## **Balancing Innovation and Patient Welfare**

In order to achieve a balance between innovation and patient welfare in medical AI development, there is a need for collaborative efforts among firms developing medical AI, healthcare professionals, and patients. This helps address issues and challenges to ensure that any changes ultimately improve patient care. A risk-based approach in testing and trials can help deal with biases and how decisions are made in clinical settings. The Value Sensitive Design (VSD) is said to be a strategic approach to determining the right balance in using AI in healthcare while mitigating biases [42].

Since technology is changing rapidly, there has been an influx of AI models, so the healthcare industry is becoming more comfortable using AI. This presents both opportunities and challenges, especially with the datasets used to train these models. It is critical to have transparency in reporting the design, development, evaluation, and validation of AI models. In healthcare AI, developing reporting standards such as the MINIMAR (MINimum Information for Medical AI Reporting) approach is expected to allow for consistency and transparent reporting of AI research in healthcare [31].

In order to inspire research and development in the fast-changing field of AI, rigorous evaluations and reporting need to be present to provide a full understating of the capabilities of AI. This will allow for informed decisions on the safety and ethical use of AI models in healthcare. Some recommended guidelines include granular reporting with all aggregations clearly defined; developing distinct benchmarks that lend themselves to indepth analysis; making detailed level data available for each instance evaluated to understand safety and ethical issues better; and providing detailed information on individual test instances on models to aid in future research [3]. Even though there are business reasons for keeping algorithms opaque, including financial and proprietary, organizations can help by making their algorithms clear to help deal with the issue of bias [26].

## **Strengthening Stakeholder Collaboration**

Complexities around healthcare data and AI systems performance require that patient safety be paramount. Physicians and other stakeholders must come together and demand transparency from firms in the medical AI field, along with mechanisms for ensuring quality control as the field grows [26].

The International Medical Device Regulators Forum (IMDRF) took steps to address challenges associated with Software as a Medical Device (SaMD) by creating a working group led by the FDA, which put out key definitions, a framework for risk categorization, and quality management system for SaMDs [16]. When AI model developers, healthcare professionals, and other stakeholders work together, it ensures that the AI model meets all groups' needs and benefits patients; this makes room for resource and data sharing and helps identify new opportunities to improve systems [67].

## Addressing Evolving AI Technologies And Applications

Standardizing healthcare data across the industry allows for its effective use in AI technology as the data is complex and enormous. It would help to develop taxonomies similar to existing standards such as the DICOM protocol, the Picture Archiving and Communication System (PACS), and the Fast Healthcare Interoperability Resources (FHIR) framework [26].

International groups need to consider the fast-changing environment when reviewing and updating frameworks that guide the development of AI. The International Medical Device Regulators Forum (IMDRF), made up of regulators from multiple countries, has agreed to guidelines, and the European Union has specific requirements for the use of personal information of residents that impacts AI development as well [26]. Groups such as these allow for effective monitoring and continuous assessment of AI advancements to bring consistency. NIST published the "AI Risk Management Framework" in January 2023 [59]. Organizations can use this new framework as a standardized guide to address AI risks.

#### CONCLUSIONS

The rapid development of AI has the potential to transform the healthcare industry and bring about substantial improvement in the ability of healthcare professionals to make patient diagnosis and determine a course of treatment. However, the deployment of medical AI is not without concerns, such as informed consent, bias, accountability, cyber risks, and legal and regulatory challenges. This survey explored the current medical AI landscape and provided insights into the implications of some of the concerns and potential solutions. Collaboration of stakeholders, AI developers, healthcare providers, and policymakers can help to proactively address the concerns and mitigate risks to ensure medical AI benefits are realized in providing exceptional healthcare utilizing ethical and responsible means. The proposed EU Artificial Intelligence Act will have a major impact on all AI development when it is passed.

This review of studies regarding AI in healthcare identified practical recommendations for future research and development of medical AI, including balancing innovations and patient welfare, strengthening stakeholder collaboration, and ensuring the addressing of evolving AI technologies and applications. During the collection of training and test data, one must follow rigorous data-gathering requirements in order to avoid various sources of bias. Some factors that impact AI implementation from the perspective of stakeholders include the level of understanding of medical needs that leads to developing value-based tools to meet healthcare needs, the ability to effectively apply AI tools in providing patient care, understanding the role of AI in healthcare and medical decision making, and the existence of a framework for regulating AI use in healthcare to ensure consistency and accountability [32]. The new NIST AI framework is not specific to healthcare AI, but it should help all organizations manage the risks associated with AI. The recommendations discussed in this study will provide a strong foundation for making significant improvements in the use of medical AI to provide exceptional patient care.

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## THE IMPACT OF PHARMACEUTICAL SALES PAYMENTS ON OPIOID PRESCRIBING RATES IN THE ROANOKE VALLEY OF VIRGINIA

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## ABSTRACT

The opioid crisis in the United States is a multi-faceted issue, but direct-to-physician pharmaceutical marketing is a significant catalyst. As part of the Physician Payments Sunshine Act in 2014, the U.S. government started the Open Payments database through the Centers for Medicare & Medicaid Services (CMS) where all payments and gifts from pharmaceutical companies to medical professionals must be made public. Nestled in the Blue Ridge Mountains, Roanoke, Virginia serves as a medical hub for inhabitants of Southwest Virginia and parts of West Virginia, which are considered opioid crisis areas. This study investigates changes in overall opioid-related Open Payments to physicians in the Roanoke Valley and subsequent opioid Medicare Part D reimbursements in 2016 and 2021.

## INTRODUCTION

Over the past decade, investigative journalism and litigation have brought attention to the opioid crisis and the modern consequences of its long history. Opioids are defined as natural, synthetic, or semi-synthetic chemicals that reduce feelings of pain and induce euphoria, or intense feelings of well-being and happiness, by interacting with opioid receptors on nerve cells in the human body. Due to their potential to induce euphoria, the drugs are often misused, which can have devastating health effects. Opioid use can lead to a reduced response to the drug (tolerance), adjustment of normal bodily functions around the drug (dependence), opioid use disorder (the medically preferred term for addiction), and even death. Opioids come in many forms, from natural morphine to synthetic fentanyl, and each form has a related but unique chemical structure. Different forms cause varied side effects, and certain opioid drugs are considered to be more severe than others [5].

While opioids and opiates have a longstanding history across the world, for many years, their place in modern Western medicine was limited to the treatment of cancer pain. In the mid-1990s, the American Pain Society began promoting the concept of pain as a "fifth vital sign" that should be considered in patient care. Medical providers felt pressured to alleviate any level of patient suffering, and this task quickly fell on prescribers. Both novel research and marketing strategies positioned opioids as an ideal treatment for the "epidemic of pain" believed to be raging across the United States. Direct sales efforts to physicians strengthened this notion, with sales representatives using seemingly-educational tactics to bring drastic changes to the care environment and rapid prescription of opioid drugs. Direct-to-physician marketing is common in the medical manufacturing

industry; a popular tactic involves inviting a physician to a complementary lunch or dinner and delivering a pitch about a drug or device. Other tactics include distributing branded items or paying for travel with the hopes of "selling" a physician on a product. Unfortunately, these efforts misconstrued the real risks of addiction, overstated the benefits of opioid drugs, and led doctors to prescribe more opioids for an expanded array of pain conditions [12].

Opioid misuse is concentrated in "crisis areas" where opioid prescribing rates are unusually high. Many of these crisis areas are along the Interstate-81 corridor or in Appalachian communities of Virginia, Tennessee, and West Virginia [18]. One such community is the Roanoke Valley of Virginia. This region is sometimes synonymous with the Roanoke Metropolitan Statistical Area, encompassing Roanoke City, Roanoke County, Salem City, Franklin County, Botetourt County, and Craig County. At other times, the Roanoke Valley describes Roanoke City and immediate surrounding communities. This analysis includes Roanoke City as well as neighboring localities Roanoke County and Salem City, which have been a subject of conversation regarding opioids for years. In particular, Roanoke City and Salem City are listed as "high-rate outliers" for opioid prescribing by the Centers for Medicare and Medicaid Services (CMS) [10].

In an effort to combat the opioid epidemic, potential conflicts of interest from pharmaceutical marketing, and other transparency issues in healthcare, Congress passed the Physician Payments Sunshine Act as part of the Affordable Care Act in 2010, which instituted the Open Payments program. Open Payments is provided by the Centers for Medicare and Medicaid Services (CMS) and requires public reporting of payments made to medical professionals and teaching hospitals by medical manufacturers. The goal of the program is to make patients aware of financial ties that may affect their care. Full datasets can be downloaded from the CMS website, or users can search for a specific provider, drug, or geographic location. The first round of data was released in September 2014. Datasets are available for a portion of 2013 and full years 2014 through 2022 [1].

In 2018, amid ongoing litigation and public scrutiny, many opioid companies announced that they would cease or reduce direct-to-physician marketing efforts [20]. Therefore, by the year 2021, there was only a single brand represented in opioid-related sales payments in the Roanoke Valley, and overall payments had significantly decreased. This provides a foundation for studying the effect of marketing payments on opioid prescription rates and how the composition of these payments has changed.

# LITERATURE REVIEW

Previous literature has studied the widespread impacts of pharmaceutical marketing, particularly for opioids, and attempted mitigation by the Open Payments program. In 2011, an article by Perret and Rosen described the legal and ethical challenges that physicians face when treating pain. Overtreating pain, especially with opioid drugs, leads to drug

dependence and use disorders. At the same time, undertreating pain is a violation of ethics and poor patient care. The article cites several physician-driven solutions, including the Open Payments program, which was in its early stages of conception at the time of publishing. Opponents of the program feared that the transparency would stifle research and reveal trade secrets [22]. As the rollout of the program began, literature shifted to data-driven analysis of related outcomes. Many studies link Open Payments data with Medicare Part D reimbursement data to determine if additional marketing payments result in increased prescribing rates. A 2016 study found that industry marketing payments are associated with greater prescribing costs per patient across all types of drugs [21]. Similarly, a cross-sectional study of the corticosteroid Corticotropin found that a majority of frequent prescribers received sales payments from manufacturers, and that these payments are positively associated with prescription rates [15].

A subsection of this literature focuses on opioid drugs specifically. The Open Payments platform allows users to search recipients by either provider or teaching hospital. One study found that 4.5% of teaching hospitals received an opioid-related payment as defined by the Food and Drug Administration National Drug Codes database. This research provides a more nuanced view of the pharmaceutical sales industry and the power of the Open Payments program beyond individual physicians. Almost every opioid manufacturer reported making at least one payment to a teaching hospital [3]. Naturally, each medical specialty experiences different industry interactions due to the variety of procedures performed and conditions treated. Orthopedic specialists show the highest values of total and per capita industry payments, but many of these payments are royalties or licenses for intellectual property, which are known to foster innovation and are less of an ethical concern than other payment types. Neurosurgery, clinical pathology, radiology, and emergency medicine also experience high rankings in a Gini index of disparity for industry payments measuring deviation from a normal distribution [24]. Physician sales payments are known to have an amplifying impact on opioid prescribing behavior across the entire nation [4]. Potentially as a result of this association, sales payments are also correlated with higher overdose death rates when paired with CDC mortality data, particularly in opioid crisis areas [14] [17].

As a government program, Open Payments is subject to public discourse and scrutiny. There are several weaknesses that threaten the program's success in the long-term and lead some skeptics to question its effectiveness. The biggest challenge is the fact that the program lacks measurable endpoints or indicators of success. While patients can access information about payments their physician receives, there is no guidance on how to use this information, whether that means switching providers or simply asking more questions during their visit. Physicians are tasked with providing unbiased and objective care to patients, but it is unclear if the additional transparency that Open Payments provides supports this outcome. More research is needed, especially to answer questions related to patient access rates [16]. In terms of patient access and exposure, one study used a crosssectional survey to establish estimates of the exposure of the American patient population to physicians who accept sales payments. The total sample includes 3,542 adults drawn from a nationally representative household panel. Among participants with a physician match, 65% of respondents saw a physician who had received an industry payment during the previous year. Despite this reality, very few Americans know whether their doctor receive industry sales payments, and very few are aware that this information is publicly available [23].

Open Payments cannot be successful without collaboration from pharmaceutical companies, providers, and patients. However, in a focus group study of physicians in Washington, D.C., Chicago, I.L., and San Fransisco, C.A., 48% had uncertain opinions of the Physician Payments Sunshine Act, with the remainder split between positive and negative views [11]. Even though negative viewpoints are in the minority, about half of physicians are on the fence, indicating a misunderstanding of the program and its benefits. This analysis of Open Payments, marketing, and prescribing in the Roanoke Valley adds to the literature that will help providers understand the outcomes of having this system. By narrowing the scope of this study to a single community, unlike other research over wide geographic areas, this study produces community-level recommendations.

#### **METHODS**

Data in this study is sourced from the Centers for Medicare & Medicaid Services Open Payments platform, which provides a complete database of industry sales payments to physicians each year since 2014, and the Centers for Medicare & Medicaid Services Medicare Part D Prescribers reimbursement data, which includes all drug reimbursements submitted through Medicare by year. The Open Payments General Payments dataset includes payment categories like food and beverage or travel and excludes transfers of value related to research agreements or investments. These datasets are publicly available to download in completion or search as a tool and information source to the general American population [6] [7] [8] [9].

This study focuses on two years: 2016 and 2021. These were chosen for several reasons. Although full Open Payments datasets are available for the year 2014 onwards, datasets are archived after five years to maintain relevancy, including any data before 2016 at the time of this study. This means that data search, filtering, API, and other tools are unavailable for these datasets. Due to concerns with the reliability of Open Payments reporting, data from 2016 also provides a buffer from the start of the program to reduce potential inaccuracies from the first implementation of the program. Open Payments offers data for the year 2022, but Medicare Part D data has yet to be released, making 2021 the most recent year where data is available from both sources.

The downloaded Medicare Part D data was cleaned and filtered to include only physicians in Roanoke City, Roanoke County, and Salem to represent the Roanoke Valley. Prescriptions for opioid drugs were extracted using the "Brnd\_Name" variable for all known patented opioids [2]. This includes all patented opioid products approved for the treatment of pain, with the exception of combination drugs or drugs formulated with naloxone which are approved for the treatment of opioid use disorder. Variables for physician National Provider Identifier (NPI), brand name, number of claims, and cost of claims were retained from the filtered dataset.

Similarly, the Open Payments dataset was cleaned and filtered by location to include Roanoke County, Roanoke City, and Salem. Payments related to patented opioids were extracted using the "Name\_of\_Drug\_or\_Biological\_or\_Device" variable based on the list of patented opioid drugs used previously.

Totals for number of payments, total payment value, number of prescription claims, and total cost of claims were compiled into a table for the years 2016 and 2021. Time series data visualizations were created in Tableau.

#### RESULTS

Table 1 outlines payment and prescription claim data for each brand of opioid drug in 2016. A total value of \$4,143,754 in patented opioid products was prescribed to Medicare Part D beneficiaries by physicians in the Roanoke Valley. Of the opioid drug categories, oxycodone was the most frequently prescribed; OxyContin by Purdue Pharma had 3,159 prescription claims totaling over one million dollars. The second most frequently prescribed drug was Butrans with 787 prescription claims totaling \$313,191. These drugs also experienced high incidences and amounts of marketing payments.

	No. payments	Total payments, \$	No. prescription claims	Total cost of claims. \$		
All patented opioid products	139	3,404	8,178	4,143,754		
Buprenorphine <sup><i>a</i></sup>						
Belbuca	22	338	17	4,241		
Butrans	43	445	787	313,191		
Morphine sulfate						
Embeda	44	541	12	4,115		
Oxycodone						
OxyContin	29	364	3,159	1,649,059		
Hydromorphone						
Dilaudid	_	_	14	4,081		
Fentanyl						
Duragesic	_	_	13	52,059		
Ionsys	1	14	_	_		
Tapentadol						
Nucynta	_	_	87	45,131		

TABLE 1

# Payments by Companies Marketing Opioids to Physicians in the Roanoke Valley, Virginia and Medicare Part D Claims, 2016

<sup>a</sup> Excluding medications formulated with naloxone which are FDA-approved to treat opioid use disorder

Table 2 shows the change in the industry environment five years later. By 2021, a few years after many companies' decision to reduce direct-to-physician marketing, only marketing payments for Belbuca were observed in the Roanoke Valley. No other patented products were marketed. Total opioid prescription claims dropped to 5,831, and all patented products except for Belbuca experienced fewer claims. Some brands fell to zero claims, including Embeda, Dilaudid, and Duragesic. Ionsys was discontinued by The Medicines Company in 2017; therefore, the drug was unavailable in 2021 [19]. OxyContin once again dominated the market. Butrans experienced a steep decline in claims while Belbuca experienced an increase, despite similar formulations. Belbuca is the newer version of buprenorphine released in 2016 by Endo Pharmaceuticals, Inc., six years after the approval of Butrans [13] [25]. Both drugs are delivered through a mouth patch and are specifically formulated to reduce opioid-related side effects. Given that Belbuca is the only opioid brand still marketing to physicians in the Roanoke Valley, this builds a strong case for direct-to-physician marketing contributing to its prominence.

TABLE 2
Payments by Companies Marketing Opioids to Physicians in the Roanoke Valley, Virginia and
Medicare Part D Claims, 2021

<i>y i i</i>			0				
	No. payments	Total payments, \$	No. prescription claims	Total cost of claims, \$			
All patented opioid products	20	299	5,831	3,570,214			
Buprenorphine <sup><i>a</i></sup>							
Belbuca	20	299	637	452,979			
Butrans	_	_	148	106,348			
Morphine sulfate							
Embeda	_	_	—	—			
Oxycodone							
OxyContin	_	_	914	632,525			
Hydromorphone							
Dilaudid	_	_	_	_			
Fentanyl							
Duragesic	_	_	_	_			
Ionsys <sup>b</sup>	_	_	_	_			
Tapentadol							
Nucynta	_	_	94	84,988			

After several opioid companies ceased direct-to-physician marketing

<sup>a</sup> Excluding medications formulated with naloxone which are FDA-approved to treat opioid use disorder

<sup>b</sup> Discontinued in 2017

Figure 1 shows the general trend of the number of opioid-related marketing interactions in the Roanoke Valley by year. Direct-to-physician marketing for opioids experienced a steep decline from 2016 to 2018. This reached a plateau then started an upward trend in 2020. While opioid marketing payments seem to be on the rise again, the composition of these payments is much different from 2016, and only includes Belbuca.

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FIGURE 1 Total Direct-to-Physician Opioid Marketing Interactions in the Roanoke Valley by Year

Similarly, Figure 2 highlights the trend of opioid Part D claims by year. Each year since 2016, Part D claims for opioid drugs have trended downwards. The steepest declines occur in the year leading up to 2017 and across two years from 2019 to 2021.

FIGURE 2 Total Medicare Part D Claims for Opioid Drugs in the Roanoke Valley by Year



In total, these results indicate a reduction in direct-to-physician marketing in the Roanoke Valley to only one brand (Belbuca), or a cessation of marketing in the area for many companies. Marketing payments seem to be slowly climbing from near zero, but the composition of these payments is vastly different from those seen in 2016. The number of Part D reimbursements has decreased each year, and the makeup of these reimbursements has shifted to favor abuse deterrent formulations like buprenorphine. Certain brands like Ionsys were discontinued or fell out of popularity.

## LIMITATIONS

Some limitations of this research stem from the data sources. The accuracy of Open Payments data has been disputed due to its reliance on self-reporting, so it is possible that these results under- or over-represent reality [16]. In addition, Medicare Part D data only includes prescription claims from Medicare beneficiaries who have opted into Part D [10]. This creates a sample of mostly individuals who are elderly or have a disability, excluding opioid prescriptions that are written and filled outside of the Part D umbrella.

Open Payments is one of many initiatives to combat the drug crisis in the United States. It is perhaps the most expansive project, but opioid prescription rates and industry payments are influenced by other factors. These include things like patient age, patient health status, population demographics, physician and patient attitudes towards opioids, and industry training, most of which are difficult to measure in empirical research.

## **FUTURE OPPORUNITIES**

There are additional uses for the Roanoke Valley data that have yet to be explored. One opportunity is a regression analysis with the number of prescription claims regressed on the number of marketing payment interactions. Another opportunity is for expansion of the time periods studied to include more analysis on 2017-2020, as well as archived years 2014 and 2015.

## CONCLUSION

The opioid crisis is a main topic of discussion in policymaking, healthcare, and business ethics. In deeply affected areas like the Roanoke Valley, understanding the impacts of pharmaceutical marketing is vital. Existing research indicates that pharmaceutical marketing payments are associated with increases in both opioid prescribing rates and opioid-related deaths. The drastically different marketing environments of 2016 and 2021 provide a different angle of this issue. The reduction of direct-to-physician marketing in Roanoke may have reduced the number of patented opioid prescriptions under Medicare Part D, but further research is needed to separate these changes from other dynamic factors, such as general hesitations to prescribe opioids amid societal concerns. In particular, observational evidence shows a potential relationship between direct-tophysician marketing for Belbuca and resulting high rates of prescribing. For the Roanoke area, leaders should place emphasis on mitigating the influence of previous marketing efforts and educating the public about the Open Payments platform and Medicare Part D search tools. Physicians should take interest in new pharmaceutical developments, especially for safer opioid products, but do so in ways that are less likely to create financial conflicts-of-interest. Special attention should be paid to Belbuca as the manufacturers return to marketing, which could repeat the past. Additionally, patient education and easily-accessible opioid use disorder treatment programs will control the remaining instigating factors of the opioid crisis.

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#### **CELEBRITY ENDORSEMENTS – MARKETING'S GOLDEN GEESE**

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#### ABSTRACT

Celebrity endorsements are continuously growing and increasing in popularity among marketers, especially in the marketing strategies of sports brands. While a substantial body of literature exists observing the effects of stock market prices after the announcement of an endorsement deal, there is little research done observing the effect of these deals on the company's earnings. This study analyzes the impact of the amount spent on endorsement contracts, and the resulting net income for Nike Inc. between its fiscal years of 2005 and 2020 by analyzing the publicly available 10-Q and 10-K financial statements. A correlation and regression data analysis were performed in Excel using the amount spent on endorser compensation as the independent variable and net income as the dependent variable. The results from this study conclude a coefficient of correlation of 0.9293 indicating a very strong positive correlation between amount spent on endorser compensation and the resulting net income.

#### **INTRODUCTION**

Originally founded as Blue Ribbon Sports in 1964, Phil Knight, with the help of his former track coach Bill Bowerman, began creating and selling running shoes out of his car after striking up a deal with Japanese businesspeople [16]. In 1971, Blue Ribbon Sports, fully rebranded itself to Nike, after the Greek Goddess of Victory, coined by Nike's first employee Jeff Johnson [6]. The remainder of the 70s and 80s proved promising for the future of Nike, with the iconic Nike swoosh and "Just Do It" slogan allowing the company to gain a strong foothold in the market.

Arguably the company's second greatest asset is its endorsement deals with elite athletes of various sports. Nike secured their standing in the world of athletics by obtaining a fiveyear \$500,000 contract with future NBA star Michael Jordan in 1984, along with the promise of a shoe customizable to his request. This marked the beginning of Nike's Air Jordan line, which generated over \$100 million in revenue in its first year in the market [6]. Over the past few decades Nike has obtained several other major athletic endorsements, in 2003 alone they signed contracts with some of the biggest names in sports today, such as Lebron James, seven-year \$90 million, Cristiano Ronaldo, 7-year \$70 million, Kobe Bryant, five-year \$40 million, and Serena Williams, five-year \$40 million [2].

Athlete endorsements are a worthwhile marketing strategy primarily used to enhance a company's competitive standing by not only promoting the brand's image, awareness, and recognition but also generating a direct economic influence, for example, by increasing net

income. According to a study done at Harvard, the use of celebrity endorsements can increase a company's sales by at least 4% [7]. Figure 1 illustrates the concept; as companies utilize endorsements into their marketing strategy, it will enhance the brand's image, awareness, and recognition in the minds of consumers ultimately resulting in an increase in net income due to the favorability of the brand.

# Figure 1

Conceptual Model of Relationship between Endorser Compensation, Brand Image,

Awareness, and Recognition, and Net Income



The match-up hypothesis goes on to describe the idea that the effectiveness of any celebrity endorsement relies on the perceived match between the endorser and the brand or product being advertised as well as the match between the endorser and the target audience of the brand or product. This hypothesis combines concepts from marketing and psychology together to provide an understanding as to why consumers are more attracted and influenced by some endorsement campaigns rather than others.

## **Research Question & Hypotheses**

The aim of this study is to observe if there is a potential relationship between athletic endorsements and the overall net income for Nike. The research question that this paper intends to focus on is what effect, if any, does the amount spent on endorser compensation have on the total net income. In this study, the amount spent on endorser compensation is the independent variable (IV), and the resulting net income is the dependent variable (DV).

The following hypotheses have been formulated regarding the research question:

 $H_0$ : r = 0, No correlation exists between amount spent on endorser compensation and the amount of net income

 $H_1$ : r > 0, Positive correlation exists between the amount spent on endorser compensation and the amount of net income

H<sub>2</sub>: r < 0, Negative correlation exists between the amount spent on endorser compensation and the amount of net income

Having a strong and effective marketing strategy is important for all businesses to accurately reach their target audience and successfully attract new consumers to their brand and its products. Celebrity endorsements are one of several ways for brands to appeal to large audiences and break through the immense amount of clutter in the world of advertising. Therefore, it is important to determine if there is an observed correlation between the amount spent on endorsements and the result of net income.

## LITERATURE REVIEW.<sup>1</sup>

## Why Marketers Use Celebrity Endorsements

A celebrity endorser can be defined as an individual who enjoys public recognition and who uses this recognition on behalf of a consumer product by appearing with it in an advertisement [15]. In today's society, consumers see thousands of advertisements weekly, whether it be through the internet, social media, television, prints, or billboards. So, when celebrities are hired to endorse brands; they are able to draw more attention and break through the clutter of various competing companies which allows them to exert greater influence on their target audiences' behaviors [14].

Brands are willing to pay enormous salaries to celebrities to endorse their brand and its products with the goal of enhancing their brand image, credibility, attractiveness, likeability, and brand recall, which in turn, will affect their overall net income. According to Crutchfield [5], when a brand builds an endorsement deal with an athlete or celebrity, studies show that there can be up to a .25% increase in the company's stock once the deal is made public. This illustrates that when an athlete or celebrity signs an endorsement deal for a product, or with the entire company, an aspect of legitimacy suddenly becomes present in the company, simply due to the power of the name backing it. To elaborate on this further, on average, a company records a profit of .44% excess returns in their market value due to the announcements of a celebrity endorsement [1]. Celebrity endorsements are costly, but according to the study done by Agrawal & Kamakura [1], it was concluded that the atypical rise in average returns reflects the market's common belief that the projected incremental gain from celebrity endorsements surpasses the incremental costs of advertising due to these contracts.

There are various perceived benefits that come with the use of celebrity endorsements but the three main components to be achieved are increased brand image, brand awareness, and brand recognition. All these factors are intertwined with one another and can be positively impacted with the proper use of celebrity endorsements.

Brand image is the broadest category of understanding for a brand within the minds of the consumers. It can be defined as the perceptions that consumers and the public hold about a brand [20]. Celebrity endorsements give rise to a boost in the consumer perception of the brand's image through the cobranding between the image of the celebrity and the image of the brand coming together to influence the attitudes and behaviors of the consumers. An additional objective of celebrity endorsements is to build brand awareness, which is the ability of consumers to identify a brand by its attributes [20]; this, in turn, will increase

brand recognition, the public's ability to identify the brand [20]. If consumers are readily aware of a company, they feel more inclined to purchase, because customers tend to place more trust in what they recognize [20]. In a study done by Pillay [17], it was concluded that athletic endorsements are an effective marketing tool to ensure brand recognition and recall. Companies can capitalize on a celebrity's positive public image by inviting them to endorse their brand or products because their image will then be included with that of the brand they are endorsing.

## **Psychological and Marketing Theories**

Would you rather buy athletic wear that is promoted by Adam Sandler, actor, and comedian, or by Lebron James, one of the greatest players in NBA history? The choice is rather obvious but for what reason? The overall effectiveness of an endorser campaign relies on three components, the Product Match-Up hypothesis, the Source Credibility Model, and the Source Attractiveness Model. These three factors combine the use of psychology and marketing to help marketers better understand why some endorsements are deemed more effective than others.

The Product Match-Up hypothesis aims to explain that the effectiveness of an endorsement relies heavily on the strength of the perceived fit between an endorser and the brand being endorsed [14]. This hypothesis stemmed from the associative learning theory which describes that an association between two concepts is learned and stored in memory [13] allowing for improved recall. Nike selects the most elite athletes to endorse their brand, and this has been successful for them because the messages being conveyed by the athletes are consistent with the product image [4]. Additionally, the Product Match-Up hypothesis implies that there must also be an association between the target audiences of these brands and the celebrity chosen to endorse its products. According to Pillay [17], an endorser that is easily recognized by the target audience assures the greatest opportunity of attaining a permanent attitude or behavior change. The effective match between a high achieving endorser, consumers, and the brand or product being promoted results in a more enhanced brand recall,

Credibility refers to the tendency to believe or trust someone; this concept combines expertise, the perceived knowledge, experience, or skills possessed by a source, and trustworthiness, the perceived honesty, integrity, and believability of a source [3]. These factors together help formulate the Source Credibility Model which goes on to suggest that the message effectiveness from an endorser depends on their perceived credibility in the eyes of the consumer [4]. Through the process of internalization, the receiver accepts the source's position and allows it to influence their beliefs and behaviors because of the source's perceived credibility [3]. Professional athletes are a prime example of highly credible endorsers, primarily for athletic brands such as Nike, because they are deemed to be experts in this arena by the majority of consumers in these target audiences.

The Source Attractiveness Model suggests that message effectiveness depends on the similarity between the source and the receiver, source likeability, and source familiarity, usually through repeated media exposure [4]. The attractiveness of an endorser source

does not pertain to physical attractiveness, but primarily the qualities that appeal to consumers, such as their personality or what they stand for. Persuasion occurs through identification, which enhances the receiver's self-concept via association and or recognition of the source [3]. Athletes are an attractive source since they are recognized for their achievements in their sports and people have a high degree of respect for the athletes themselves; they embody the ideals of perfection and greatness in what they do and are therefore very attractive to the mere mortals who wish to be like them.

#### Nike's Use of Athlete Endorsements

In an interview with Nike's Phil Knight in 1992 he states, "For years, we thought of ourselves as a production-oriented company... But now we understand that the most important thing we do is market the product...Nike is a marketing-oriented company, and the product is our most important marketing tool. What I mean is that marketing knits the whole organization together..." [22]. Nike had the early realization that the key to a successful business is through the consumer, and the best way to swoon the consumers is by brand placement on the top athletes all over the world to help enhance the brand equity and image. Brand equity refers to the goodwill a brand has built up during its existence, while brand image refers to the associations that are evoked in memory when consumers think of a particular brand or product category [3]. These two factors come together to influence the attitudes and behaviors of consumers because when consumers see their favorite athletes in these brands, they become convinced that it would be great for them as well and are more inclined to purchase from the same brand.

Athletic endorsement contracts are a crucial point in Nike's marketing and communications strategy; After major success with Michael Jordan in 1984, Nike continually increased their spending on endorsements per year. According to Sandison [18], from 2006 to 2007 there was a 70% increase in spending on athletic endorsements for Nike. Their endorsement spending generally increases by approximately 10% each year, which is moderately faster than their sales growth [9]. Nike understands the value of its endorsement deals and continues to create additional contracts or renew its current ones. For example, as stated in the introduction, Lebron James signed a seven-year \$90 million endorsement contract with Nike in 2003, so when this contract ended in 2010, Nike renewed their deal with James for a lifetime \$1 billion contract deal [2]. Now that might seem jarring to pay an athlete \$1 billion for the rest of their life, but when Nike released the news of their first deal with Lebron James back in 2003, prior to his first NBA season, their stock rose .75% that same day [8]. This illustrates that market investors deemed that Nike had created a profitable strategy through this endorsement, and this was all before Lebron James was considered an NBA legend.

Pillay [17] makes the important note that Nike understands that endorsement deals alone will not build the brand but will work alongside the comprehensive brand building attributes that Nike has already built such as brand awareness, brand loyalty, and the perceived quality of their products. They then solidify and authenticate this image with the endorsers they choose to represent their brand. All these elements together create confidence in the consumers eyes as to the quality of the product and the credibility of the

company; if the kings and queens of sports rely on Nike to improve their performance then this would help us as well.

#### METHODOLOGY

## **Data Source & Collection**

To gather all the secondary data necessary to conduct the following research, the quarterly financial statements for Nike from the fiscal years of 2005-2020 were used, accessed through Nike (www. investors.nike.com). Both quarterly statements, Form 10-Q, and annual reports, Form 10-K, were utilized to collect the endorser compensation and net income from the Accrued Liabilities and Statements of Income for the first three fiscal quarters and annual period for the fiscal years of 2005-2020. The raw data composed provided sixty-three data points incorporating endorser compensation and net income for the first fiscal quarter of 2005 through the third quarter of 2020.

Nike's annual 10-K reports state that the end of their fiscal year being May 31 of the year So, their quarterly 10-Q reports contain information collected from two individual calendar years. For example, Nike's first quarterly period is June 1- August 31, their second quarterly period is September 1-November 30, their third quarterly period is December 1-February 28/29, and their fourth quarterly period is from March 1- May 31, marking the end of their fiscal year. For this reason, this research separates the raw data by Nike's fiscal year, rather than following the calendar year.

Since the Securities and Exchange Commission, SEC, does not require a fourth quarter 10-Q report, the annual 10-K reports were used for the purpose of providing constant quarterly data for the time frame given, 15 years. In order to compute the fourth quarter figures, the following calculations were used:

4th Quarter Endorser Compensation (EC) = Annual Endorser Compensation -

(Quarter 1 EC + Quarter 2 EC + Quarter 3 EC)

4th Quarter Net Income (NI) = Annual Net Income - (Quarter 1 NI + Quarter 2

NI + Quarter 3 NI)

## **Statistical Analysis**

The goal of this study is to answer whether there is a relationship between the amount spent on endorser compensation and the resulting net income, so a correlation and linear regression statistical analysis were performed in Excel. The raw data was recorded in Excel and was described by each quarter for the fifteen fiscal years and separated into the independent variable, Endorser Compensation, and the dependent variable, Net Income,

Independent: Endorser Compensation (in millions 2.585606748 0.130462 19.8189023

both in millions. The data was then computed with the use of Excel's Data Analysis application, which allowed for all the data to be analyzed simply and quickly while also removing the possibility for human error.

There are many variations of correlation to describe the relationship between two variables, but for this research we will be focusing on an index of linear relationship between the variables, more specifically, Pearson's product-moment correlation coefficient, Pearson's r (Landers, 2019).

#### RESULTS

#### **Correlation Analysis**

Results of the correlation analysis indicate that there is a positive correlation between amount spent on endorser compensation and net income. The p-value of 1.61E-28 indicates statistical significance, which rejects the null hypothesis that there is no correlation between amount spent on endorser compensation and net income. To establish which alternative hypothesis to accept, the correlation coefficient was analyzed.

## Table 1

Regn	ession Statistics									
Multiple R		0.9	29340094							
R Square Adjusted R Square Standard Error Observations		0	86367301							
		0.8	61474188							
		10	6.2931705							
			63							
ANOVA			df	22	MAG		-3	Ciar	ificance F	
Regression		-	<i>uj</i> 1	4437822	4437822.3	78 392.7	r 3 392.7888882		1.60987F-28	
Residual			62	700490.8	11298.238	09				
Total			63	5138313						
	Coefficients	andard Err	t Stat	P-value	Lower 95%	Upper 95%	Lower 9	5.0%	Upper 95.0%	
Intercept	-12.13635366	36.32259	-0.33412684	0.739411431	-84,74418515	60.47147784	-84.744	18515	60.47147784	

The correlation analysis resulted in a positive correlation coefficient (multiple r) of 0.929340094 and a coefficient of determination (r^2) of 0.86367301. A correlation coefficient greater than 0.9 signifies a very strong positive linear relationship between the two variables, therefore the alternative hypothesis, H1, that a positive correlation exists between amount spent on endorser compensation and net income is accepted. A coefficient of determination of 0.8636 implies that approximately 86% of the variance in net income can be explained by the variance in the amount spent on endorser compensation. Table 1 above demonstrates these findings.

1.61E-28 2.324817621 2.846395876 2.324817621 2.846395876

## **Regression Analysis**

Correlation, multiple r, expresses the strength of the relationship between two variables, meanwhile simple linear regression is used to predict precisely one interval, or ratio-level from one other interval or ratio-level variable (Landers, 2019). The linear regression equation resulting from the line of best fit of the scatterplot below is y = 2.5856x - 12.136, as displayed in Figure 2. Based on this regression, net income would be projected to increase by 2.59% for every approximate additional \$31 million spent on endorser compensation, yet the data does not signify that an increase in endorser compensation spending directly causes an increase in net income.



#### Figure 2



#### DISCUSSION

The purpose of this study is to demonstrate the relationship between the amount of money Nike spends on athlete endorsements and the effect on net income. The results of the statistical analysis support the alternative hypothesis that a positive correlation exists between the quantity spent on endorser compensation and the resulting net income. The correlation coefficient of .9293 indicates that there is a very strong positive correlation between the independent variable, the amount spent on endorser compensation, and the dependent variable, net income.

Although there is not much prior research done observing the correlation between the amount spent on endorser compensation and the resulting net income, there are similar studies that demonstrate the effects of stock market prices for sponsoring companies due to the announcements, (Fizel, McNeil, Smbay, 2008) and (Crutchfield, 2010), and the performance (Agrawal & Kamakura, 1995) of the endorsed athletes. These statistics are found throughout this study to provide evidence for the research.
Marketers could benefit from the information discussed in this study to help improve their own marketing strategies. Celebrity endorsements, more specifically athletic endorsements, are not cheap endeavors, but they are highly effective in improving the brand's image, awareness, and overall recognition among consumers. Marketers must keep the Match-Up hypothesis, Source Credibility, and Source Attractiveness Models in mind when selecting a source to endorse their brand or product so that the endorsement can be effective among consumers.

# Limitations

This study's research of the relationship between the amount spent on endorser compensation and net income was limited in that it only observes this relationship for one athletic brand, Nike, for a 15-year period. As stated, Nike has benefitted from athletic endorsements since the early 1980s, but they had not included an "endorser compensation" section in their financial statements until the third quarter of their 2004 fiscal year. In the fiscal year 2021 Nike began using a "demand creation expense" account in its total selling and administrative expenses section of their financial statements. This included the cost of endorsement contracts as well as advertising and promotion costs, complimentary products, television, digital and print advertising and media costs, brand events, and retail brand presentation; so, endorser compensation could no longer be tracked as its own account for the purpose of this research. The fourth quarter of Nike's 2020 fiscal year, period ending May 31, 2020, was excluded from the data set in this research due to the \$790 million loss that occurred in this period, which was primarily due to the COVID-19 pandemic shutdown. This outlier severely altered the results of the statistical analysis and the correlation and regression data used in this study.

Although this study provides evidence for a very strong positive correlation between endorser compensation and net income, it does not prove causation of the relationship between the two variables. There are various other factors that affect net income, such as operating expenses, operating income, interest income, interest expense, income taxes, and cost of goods sold; therefore, the correlation described in this research does not mean causation because it is impossible to simplify all the running factors of net income. This research includes an analysis of existing data; there is no proof that an increase in the independent variable causes an increase in the dependent variable because there are other factors playing a role in the changes in the dependent variable being studied. To date, there is no prior research explaining the relationship between the two variables in this study, and proof that the use of athletic endorsements increases net income would require additional experimentation.

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# APPLICATION OF KRIGING AND SUPER RESOLUTION TECHNIQUES ON FORCE SENSITIVE RESISTOR MATRIX

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## ABSTRACT

Navigating towards Industry 4.0, the integration of autonomous vehicles (AV) is becoming increasingly vital, driven by their potential to enhance safety, accessibility, and efficiency, while reducing traffic congestion. However, the reliable performance of AVs is contingent upon extensive sensor networks, which can lead to increased costs, power consumption, and maintenance challenges. This paper introduces an innovative approach aimed at achieving the capabilities of a sensor-rich environment with a more streamlined sensor array. We propose a methodology that combines 'Kriging', a statistical technique for spatial interpolation, with advanced super-resolution techniques-'Super Resolution - Generative Adversarial Networks' (SR-GAN) and 'Super Resolution - Variational Autoencoders' (SR-VAE)-applied to a Force Sensitive Resistor (FSR) matrix. A key focus of our study is the comparative analysis between SR-GAN and SR-VAE to evaluate their effectiveness in enhancing sensor data resolution. The research involves simulating forces on an AV driver seat, initially using a  $10 \times 10$ FSR matrix, from which a 5×5 FSR matrix is extracted. Kriging is utilized to generate two sets of pressure heatmaps: high-resolution (HR) and low-resolution (LR) weight distribution. Superresolution techniques are subsequently trained and applied to the LR data, resulting in precise pressure mapping of the car seat. Our results indicate a superior performance of SR-GAN over SR-VAE, demonstrating its efficacy in generating HR pressure maps with a reduced sensor count. This finding holds significant implications for the advancement of intelligent seat systems, the broader development of AV technology, and the application in other fields like agriculture and medicine, showcasing the potential of our methodology in optimizing sensor usage.

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# MENTAL HEALTH IN DIFFERENT ETHNIC GROUPS AND THE IMPACT OF COVID-19

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## ABSTRACT

A study carried out in the Metropolitan Denver area found that racial and ethnic groups in the United States have been disproportionately affected by the COVID-19 pandemic in terms of mental health. An anonymous survey was sent to the participants via email, covering topics such as demographics and socioeconomic status, the impact of mental health, anxiety, disorders, emotional problems, and mental health rate. Complete responses to the survey were obtained from 118 respondents. The results of the study showed that, in comparison to White, Black, Hispanic, and other ethnic participants, Asian participants' mental health declined, with notable emotional difficulties, anxiety, and behavioral issues.

**Keywords:** COVID-19, Different ethnic groups, Mental health impact, Emotional problems, Anxiety, Mental health rate, Disorder issues

## 1. Introduction

COVID-19 has an impact on our daily lives, organizations, worldwide trade and movements, and adverse economic repercussions, in addition to death, have been reported (Haleem and Javaid, 2020; Padhan and Prabheesh, 2021). Since the beginning of the COVID-19 pandemic, which began in March 2020. The effects of how it has impacted the mental health of so many different ethnic groups across the United States, leaving healthcare professionals scrambling to address the concerns head on.

When COVID-19 became an emergency for the community's health, the hospital systems felt the burden. According to Thomeer et al. (2022), Americans' overall mental health has deteriorated as a result of increasing rates of COVID-19 infections and deaths, particularly among communities of color who have been exposed to more pandemic-related stressors, such as unemployment and food insecurity, to name a few. Thus, the loss in mental health throughout the pandemic was more significant among Black, Hispanic, and Asian adults; nevertheless, these groups have had poorer access to mental health care (Tsamakis et al., 2021; Thomeer et al., 2022).

COVID-19 is the third major coronavirus outbreak in the last 20 years to have a significant socioeconomic impact; the difference between the coronaviruses is that COVID-19 was a pandemic, while the others were not. As a result, it is the first in the twenty-first century to strike countries around the world save Antarctica (Tsamakis et al., 2021). Because of the COVID-19 pandemic's lack of an endpoint, people have experienced great distress, uncertainty, and unpredictability.

There was no known vaccine or antidote at the start of the outbreak, which resulted in the emergence of mental health issues such as panic, anxiety, and depression, as well as the triggering of somatic symptoms and worsening of common conditions (Tsamakis et al., 2021). However, since then, a vaccination has been developed that has worked wonders for the entire world. When governments around the world undertook a widespread vaccination program to battle the COVID-

19 virus, the number of new cases decreased; however, mental health difficulties were released (Chen et al., 2022). More work need to be done as the illness claims fewer lives. With the wealth of knowledge gained about this virus and how it functions, researchers and scientists can build a serum to resist the next wave if one occurs.

The purpose of this study is to identify the effects of COVID-19 on the mental health of various ethnic groups, with particular focus on the impact of mental health, anxiety, disorders, emotional difficulties, and mental health rates. Using a series of statistical tests, this study analyzes the many sorts of mental impact and concerns across different race categories. As a result, the research question is: Are there disparities in the mental health impact between race groups?

To achieve this goal, we divide this paper as follows: In the second section, we do a theoretical literature review. The final segment will be dedicated to the data. The fourth section describes the empirical analysis methodology, while the fifth section empirically analyzes the key outcomes and graphs the average mental health impacts for race groups. Finally, after examining the findings, we conclude this research with some recommendations.

## 2. Literature Review

The mental health of racial and ethnic groups in the United States may be disproportionately affected by the COVID-19 pandemic due to a more intense experience with peri-pandemic stressors. However, Goldmann et al. (2021) observed that few research have systematically addressed racial and ethnic disparities in mental health outcomes in this context. This pandemic may have had a significant influence on the mental health of different racial groups in the United States because of increased exposure to pre-existing and COVID-related stressors. In addition to differences in COVID-19 results, race and class-based discrimination, harassment, and attacks, racial and ethnic minority groups are more vulnerable to COVID-related stresses such as economic difficulties (Goldmann et al., 2021).

According to Smith et al. (2020), the COVID-19 pandemic has rapidly developed into a global pandemic. Furthermore, since its emergence, the virus has made it clear that the risks of COVID-19, in terms of infection rates and serious complications, aren't spread equally throughout members of society. Meanwhile, while age, sex, and certain complications are all risk factors for hospitalization with COVID-19 infection, evidence indicates that Black, Asian, and Minority Ethnic (BAME) groups are disproportionately more likely to be negatively affected by COVID-19 in the UK and the USA.

In terms of the association between mental health and race in the United States, Zhou et al. (2021) found that during the COVID-19 pandemic, hate crimes against Asian Americans and Pacific Islanders (AAPIs) soared to previously unknown levels. As a result, individuals who confront racial/ethnic prejudice are more likely to develop depression, anxiety, suicidal self-injury, binge drinking, and suicidal ideation. According to Novacek et al. (2020), when it comes to mental health and race in black communities, Black Americans are especially vulnerable to negative mental health outcomes during large-scale national crises, requiring specific treatments. Despite increasing need, long-standing challenges such as expense, stigma, and cultural prejudice limits Black Americans from seeking and receiving mental health treatment. Furthermore, Saltzman et al. (2021) noted how comorbidities contributed to many of the COVID-19 virus's racial and ethnic inequities, raising concerns about behavioral health equity and its link to an intersectionality risk for minority communities.

When it comes to anxiety and race, prior to the pandemic, Owens et al. (2021) discovered that black people had lower rates of anxiety and depression than white people; however, during the pandemic, the outcomes began to shift and lean towards the notion that black people were disproportionately affected in terms of mortality, hospitalization, COVID-19 infection, and job loss. Furthermore, Khubchandani et al. (2021) discovered that Hispanics and blacks have had

higher rates of anxiety, depression, and COVID-19-related mortality since the pandemic began. Meanwhile, Tessler et al. (2020) highlighted that the hate crimes since the beginning of COVID-19 have heightened the amount of worry that Asian Americans have faced during those uncertain times, with many fearful for their physical safety when running everyday errands.

Another essential feature of this research is the identification of emotional issues among different racial groupings. According to Bui et al. (2020), COVID-19 had a severe influence on older minority communities, resulting in greater rates of stress and emotional discomfort than the White population of adults. Meanwhile, Clark et al. (2023) found that age, financial hardship, and increased alcohol consumption contributed to an increase in emotional distress among individuals of color during the pandemic. Nonetheless, the advent of the COVID-19 immunization has allowed individuals of color who have been afflicted to return to work, which has reduced their emotional distress levels because they can now support their families. Furthermore, those who were confined to their houses during the COVID-19 pandemic and unable to socialize with others suffered major mental health consequences. People of color in the hospital context, like nurses, are also feeling the effects of the epidemic, and they have surely paid a high price (Thomas-Hawkins et al., 2021).

Furthermore, mental health rates may differ by race. Loeb et al. (2021) suggested that black, indigenous, and people of color have long faced structural racism and oppression, which has disproportionately affected rates of trauma, poverty, and chronic diseases that span generations and are associated with increased COVID-19 morbidity and mortality rates. Ruprecht et al. (2020) also remarked that infectious diseases have not had an equal impact throughout cultures, which could explain why so many people have had to constantly deal with the consequences of the COVID-19 pandemic. This virus has continued to harm populations already marginalized due to systematic discrimination and racial profiling.

The last variables I'd like to examine in the paper are disorders across different race groups. The number of fatal drug overdoses and self-reported substance use problems has increased since the beginning of the COVID-19 pandemic (Cantor et al., 2022). This is concerning since an increase in cases may limit the number of available resources due to access concerns. COVID-19 has not only boosted substance misuse but has also resulted in an alarming number of posttraumatic stress disorder (PTSD) patients. According to Ashby et al. (2021), COVID-19 traumatic stress contributed a major percentage of the variance in PTSD beyond cumulative trauma, with a strong interaction effect suggesting that the role of the interaction was different for Asians and Whites. Several problems have been related to the COVID-19 pandemic, and they do not impact every ethnic group equally (Ashby et al., 2021).

To answer the research question, "Are there differences in mental health impact across race groups?" We will investigate five different types of mental health impact factors. To be more specific, we will look at how mental health, anxiety, emotional difficulties, mental health rates, and disorder conditions affect different race groups.

#### 3. Data

## 3.1 Data Collection

The framework of this study utilizes a quantitative survey. The survey was created and distributed through email and conducted anonymously. The email includes the link to the survey and instructions on submitting the answers. The questions included in this study's survey address mental health and COVID-19 from different ethnic group perspectives. Therefore, several variables measure the various mental health factors, such as mental health rate, anxiety, disorder...etc. The different ethnic groups will be crucial in the survey to capture the diversity and disparities with the COVID-19 impact.

# 3.2. Descriptive Statistics

This research paper aims to provide additional data and support the existing research on the topic. All the information that has been collected was given anonymously and therefore will serve as authentic information. After data cleaning, we kept 118 observations collected from the survey, which could provide sufficient information to observe the impact of COVID-19 on different ethnic groups. However, since the setting of my research takes place primarily in Colorado, this could have led to some limitations on my findings. **See Table 1.1**: Descriptive Statistics.

Variable	race	imp_mtl	anxious	emotions	mtl_r	disorder
(label)		_				
Description	1=White	Impact of	Do you feel	Have you	Overall,	Have
	2=Black	COVID-19 on	anxious about	ever	how would	you ever
	3=Hispa	Mental Health.	COVID-19?	experienced	you rate	been
	nic	7=Very Low;	5=Not	emotional	your mental	diagnose
	4=Asian	6=Low;	anxious at all	stress?	health?	d with a
	5=Other	5=Somewhat	4=Not Very	1=Yes	5=Excellent	mental
		Low;	Anxious	2=No	4=Somewh	disorder
		4=Neither	3=Somewhat		at good	before?
		Low nor High;	anxious		3=Average	1=Yes
		3=Somewhat	2=anxious1=		2=Somewh	2=No
		High; 2=High;	highly		at poor	
		1=Very High	anxious		1=Poor	
Mean	1.98	4.78	3.00	1.51	2.72	1.71
Median	1.00	5.00	3.00	2.00	3.00	2.00
Mode	1	7	3	2	2	2
Std. Dev.	1.105	1.766	1.407	.501	1.187	.457
Skewness	0.69	-0.304	-0.086	-0.033	0.139	-0.903
Std. Error of	0.115	0.115	0.115	0.118	0.115	0.115
Skewness						
Kurtosis	-0.482	-0.983	-1.205	-2.008	-0.991	-1.191
Std. Error of	0.229	0.229	0.229	0.235	0.229	0.229
Kurtosis						
Range	4	6	4	1	4	1
Min.	1	1	1	1	1	1
Max.	5	7	5	2	5	2

**Table 1.1:** Descriptive Statistics

# of	118	118	118	112	118	118
Observatio						
ns						
Note: a. Mult						

Since this dataset is from the Metropolitan Denver area, it serves as a good prospect to be compared with other data sets in various states, regions, and countries. As shown above, in **Table 1.1**, the variables in this study include the following: "race", "the impact of COVID-19 on your mental health ( $imp_mtl$ )", "do you feel anxious about the future of COVID-19 (anxious)", "have you experienced emotional stress (emotions)", "overall, how would you rate your mental health ( $mtl_r$ )" and "have you ever been diagnosed with a mental disorder before (disorder)".

## Table 1.2 Frequency Table for race

			Race		
					Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	White	61	51.7	51.7	51.7
	Black	12	10.2	10.2	61.9
	Hispanic	36	30.5	30.5	92.4
	Asian	5	4.2	4.2	96.6
	Others	4	3.4	3.4	100.0
	Total	118	100.0	100.0	

## 3.3 Skewness and Kurtosis

Table 2 shows the results of the z-score for Skewness and Kurtosis. According to the results, compared with the range of [-2.58, 2.58]:

- For *race*, the skewness z-score (6 > 2.58) shows the data series is not normally distributed while the Kurtosis z-score (-2.1) shows that the data series is normally distributed with only one peak.
- For *imp\_mtl*, the impact of mental health, the skewness z-score (-2.64) shows the data series is not normally distributed and the Kurtosis z-score (-4.29) suggests there are multiple peaks, not normally distributed.
- For *anxious*, the skewness z-score is -0.74, showing the data series is normally distributed while the Kurtosis z-score (-5.26) shows that the data series is not normally distributed with multiple peaks.
- For emotions, the skewness z-score is -0.27, showing the data series is normally distributed while the Kurtosis z-score (-8.54) shows that the data series is NOT normally distributed with multiple peaks.
- For the *mtl\_r*, mental health rate, the skewness z-score is 1.209, showing the data series is normally distributed while the Kurtosis z-score (-4.328) shows that the data series is not normally distributed with multiple peaks.
- For disorder, the skewness z-score is -7.85, which shows the data series is not normally distributed while the Kurtosis z-score (-5.20) shows that the data series is not normally distributed with multiple peaks.

According to the z-scores of Skewness and Kurtosis, all variables are not normally distributed, so I will have to use the non-parametric test (Chi-Square Test) to analyze the data.

Variable	race	imp_mtl	anxious	emotion	mtl_r	disorder
(label)						

 Table 2: z-score for Skewness and Kurtosis

Skewness	6.000	-2.643	-0.748	-0.280	1.209	-7.852
z-score						
Kurtosis z-	-2.105	-4 293	-5 262	-8 545	-4 328	-5 201
score	2.105	1.275	5.202	0.010	1.520	5.201

## 4. Methodology

The methodological approach to this study's data collection and analysis is primarily based on a survey given to participants in the Metropolitan Denver area. Then, various forms of statistical analysis were utilized to interpret the collected data. Recruitment for participants was completed through social media, emails, and "word-of-mouth" among colleagues, friends, and families. Volunteers were asked to take an anonymous survey that relates to mental health in different ethnic groups and the impact of COVID-19. Questions in the survey include questions about demographics, mental health, anxiety, disorders...etc. The survey was created using Qualtrics.

The independent variable in this study is race, White, Black, Hispanic, Asian, and others (As shown in Table 1.2). The 5 dependent variables that were used consisted of: the *imp\_mtl* (the impact of mental health), *anxious*, *emotion*, *mtl\_r* (mental health rate) and *disorder*. For the impact of mental health, from 1 to 7, "high impact" to "no impact". For the anxious level, from 1 to 5, "high anxious" to "not anxious at all". For the emotion level, "1=yes" and "2=no". For the mental health rate, from 1 to 5, "poor" to "excellent". And for the disorder level, "1=yes" and "2=no".

All variables in this study are either nominal or ordinal, which are all categorical. Since there are only 2 to 5 values for all the variables in this study, the data may not be normally distributed. Therefore, after checking the Skewness and Kurtosis z-scores, the normality test is also performed for each dependent variable against race, the independent variable. After the normality test is conducted, if normality does not hold for the data, the non-parametric test, the Chi-square test will be performed with the data.

The Chi-Square Test of Independence is commonly used to test the statistical independence or association between two categorical variables. Here in this study, the dependent variables (*imp\_mtl*), (*anxious*), (*emotion*), (*mtl\_r*) and (*disorder*), and the independent variable (*race*) are all category variables. Therefore, the Chi-square test is a good approach to test the question of this research: whether there is a difference in the mental health impact across the race groups. This approach would give more insight into the question that is being asked.

To better understand the data and identify the mental health impact on different race groups, we will graph the variables after the Chi-square tests. I chose to use graphing because it is a useful tool for highlighting variable characteristics. By examining the displays of the variables, we can easily observe the impact of mental health for different race groups.

## **5. Empirical Results**

## 5.1. Normality test results

First, the Normality tests are performed to check to see if the data series are normally distributed or not. The Normality test results are reported in Tables 3.1 to 3.5 for *imp-mtl, anxious, emotion, mtl\_r*, and *disorder*. As shown in the Normality Test results in Tables 3.1 to 3.5, N=118>50, Kolmogorov-Smirnova Test results were utilized, with all p-values < 0.05, we reject the null hypothesis that the data series is normally distributed. Therefore, since all the data series are not normally distributed, we must use non-parametric tests (Chi-Square Test) to do the data analysis.

 Table 3.1 Impact of Mental Health and Race: Normality Test

		Kolm	ogorov-Smir	nov <sup>a</sup>	Shapiro-Wilk			
	race	Statistic	df	Sig.	Statistic	df	Sig.	
imp_mtl	1	.169	226	.000	.928	226	.000	
	2	.200	47	.000	.910	47	.002	
	3	.248	151	.000	.836	151	.000	
	4	.440	14	.000	.615	14	.000	
	5	.381	13	.000	.642	13	.000	

### Tests of Normality

a. Lilliefors Significance Correction

		Test	ts of Norma	ality				
	race	Kolmogor	(olmogorov-Smirnova S			Shapiro-Wilk		
		Statisti c	df	Sig.	Statistic	df	Sig.	
anxious	1	0.185	226	0	0.899	226	0	
	2	0.389	47	0	0.652	47	0	
	3	0.213	151	0	0.859	151	0	
	4	0.366	14	0	0.673	14	0	
	5	0.352	13	0	0.646	13	0	
a Lilliefors Significar	nce Correct	ion						

# Table 3.2 Anxious and Race: Map and Normality Test

## Table 3.3 Emotions and Race: Normality Test

#### Tests of Normality

		Kolm	ogorov-Smir	nov <sup>a</sup>	Shapiro-Wilk			
	race	Statistic	df	Sig.	Statistic	df	Sig.	
emotion	1	.396	219	.000	.619	219	.000	
	2	.409	44	.000	.609	44	.000	
	3	.383	141	.000	.627	141	.000	
	4	.443	14	.000	.576	14	.000	
	5	.352	13	.000	.646	13	.000	

a. Lilliefors Significance Correction

Table 3.4 Emotions and Race: Normality Test

		Kolm	ogorov-Smir	nov <sup>a</sup>	Shapiro-Wilk			
	race	Statistic	df	Sig.	Statistic	df	Sig.	
mtl_r	1	.188	226	.000	.897	226	.000	
	2	.265	47	.000	.799	47	.000	
	3	.202	151	.000	.901	151	.000	
	4	.332	14	.000	.773	14	.002	
	5	.294	13	.003	.786	13	.005	

#### Tests of Normality

a. Lilliefors Significance Correction

#### Table 3.5 Disorder and Race: Normality Test

		Kolm	ogorov-Smir	nov <sup>a</sup>	Shapiro-Wilk			
	race Stat		df	Sig.	Statistic	df	Sig.	
disorder	1	.465	226	.000	.544	226	.000	
	2	.484	47	.000	.504	47	.000	
	3	.431	151	.000	.590	151	.000	
	4	.443	14	.000	.576	14	.000	
	5	.352	13	.000	.646	13	.000	

#### Tests of Normality

a. Lilliefors Significance Correction

#### 5.2 Chi-square test results

After testing the normality for each dependent variable, the results suggest that those variables are not normally distributed. Therefore, I used the non-parametric test, the Chi-square test of Independence (Franke, Ho, and Christie, 2012; George and Mallery, 2019; Hinton, McMurray, and Brownlow, 2014) to check if the mental health variables statistically are different for different race groups or not. To get the unbiased estimation, I activated the weighted cases and set the frequency variable as the weight before running the Chi-square test (Singer and Kouda, 1999). The Chi-square test results are reported in **Tables 4.1** to **4.5**, along with the crosstabulation tables for those mental health impact variables and race.

Table 4.1 Chi-Square Tests for imp_mtl across race								
ValuedfAsymptotic Significance (2-sided)								
Pearson Chi-Square	137.144ª	24	0.000					
Likelihood Ratio	129.756	24	0.000					
Linear-by-Linear Association	5.398	1	0.02					
N of Valid Cases	451							
<sup>a</sup> 16 cells (45.7%) have expected c	<sup>a</sup> 16 cells (45.7%) have expected count less than 5. The minimum expected count is .43.							

#### Impact on mental health (imp\_mtl) across race Crosstabulation

Count

				race			
		White	Black	Hispanic	Asian	Others	Total
imp_mtl	Very high	7	0	12	8	10	37
	High	11	6	15	4	0	36
	Somewhat high	11	6	18	0	0	35
	Neither low nor high	14	2	21	0	0	37
	Somewhat low	5	6	6	8	5	30
	Low	8	2	9	0	5	24
	Very low	5	2	27	0	0	34
Total		61	24	108	20	20	233

According to Table 4.1.2, with the Chi-square statistics =137.144, p-value=0.000 < 0.05, we reject the null hypothesis that the impact of mental health is the same across various levels of race, statistically significant. Therefore, the impact of mental health is significantly different for different race groups.

## **Anxious across Race Crosstabulation**

Count

race

Total

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		White	Black	Hispanic	Asian	Others	
anxious	1	3	14	27	0	10	54
	2	7	4	6	4	0	21
	3	19	2	27	4	0	52
	4	14	2	27	0	0	43
	5	18	2	21	12	10	63
Total		61	24	108	20	20	233

Table 4.2 Chi-Square Tests for anxious across race						
	Value	df	Asymptotic Significance (2-sided)			
Pearson Chi-Square	77.325 <sup>a</sup>	16	0.000			
Likelihood Ratio	74.537	16	0.000			
Linear-by-Linear Association	.002	1	.968			
N of Valid Cases 386						
<sup>a</sup> 11 cells (44.0%) have expected count less than 5. The minimum expected count is .65.						

According to Table 4.2, with the Chi-square statistics=77.325, p-value=0.000 <0.05, we reject the null hypothesis that the level for anxiety is the same across various levels of race, statistically significant. Therefore, the anxiety level is significantly different for different race groups.

# **Emotion across Race Crosstabulation**

Count

		race					
		White	Black	Hispanic	Asian	Others	Total
emotion	1	18	10	42	8	5	83
	2	41	12	57	12	15	137
Total		59	22	99	20	20	220

Table 4.3 Chi-Square Tests for emotion across race							
Value         df         Asymptotic Significance (2-sided)							
Pearson Chi-Square	2.510 <sup>a</sup>	4	.643				
Likelihood Ratio	2.486	4	.647				
Linear-by-Linear Association	.690	1	.406				
N of Valid Cases 184							
<sup>a</sup> 3 cells (30.0%) have expected count less than 5. The minimum expected count is 1.52.							

According to Table 4.3, with the Chi-square statistics=2.486, p-value=0.647 > 0.05, we accept the null hypothesis that the variable for emotions is the same across various levels of race, statistically significant. Therefore, the emotion problems are not significantly different for different race groups.

# Mental Health Rate (*mtl\_r*) across race Crosstabulation

Count

			race					
		White	Black	Hispanic	Asian	Others	Total	
mtl_r	1	19	10	21	8	5	63	
	2	19	4	33	8	5	69	
	3	13	6	18	0	5	42	
	4	9	4	24	4	5	46	
	5	1	0	12	0	0	13	
Total		61	24	108	20	20	233	

Table 4.4 Chi-Square Tests for mtl_r across race						
Value         df         Asymptotic Significance (2-sided)						
Pearson Chi-Square	37.059 <sup>a</sup>	16	.002			
Likelihood Ratio	40.956	16	.001			
Linear-by-Linear Association	6.672	1	.010			
N of Valid Cases	282					

<sup>a</sup> 12 cells (48.0%) have expected count less than 5. The minimum expected count is .89.

According to Table 4.4, with the Chi-square statistics=37.059, p-value=0.002 <0.05, we reject the null hypothesis that the mental health rates are the same across various levels of race, statistically significant. Therefore, the mental health rates are significantly different for different race groups.

## **Disorder across Race Crosstabulation**

Count

		White	Black	Hispanic	Asian	Others	Total
disorder	1	13	4	24	8	5	54
	2	48	20	84	12	15	179
Total		61	24	108	20	20	233

Table 4.5 Chi-Square Tests for disorder across race							
ValuedfAsymptotic Significance (2-sided)							
Pearson Chi-Square	1.439 <sup>a</sup>	4	.837				
Likelihood Ratio	1.228	4	.873				
Linear-by-Linear Association	.306	1	.580				
N of Valid Cases 210							
<sup>a</sup> 3 cells (30.0%) have expected count less than 5. The minimum expected count is .87.							

According to Table 4.5, with the Chi-square statistics =1.439, p-value=.837 >0.05, we accept the null hypothesis that the disorders are the same across various levels of race, statistically significant. Therefore, the disorder conditions are not significantly different for different race groups.

Among the 5 mental health impact variables, *imp\_mtl, anxious*, and *mtl\_r* are significantly different across race groups. However, the emotion and disorder do not significantly differ across race groups according to the results. This might be because these two variables are binomial variables with only 2 values (Yes, No), and most of the participants have no emotional or disorder problems. Thus, there are very few cases of "Yes".

## 5.3 Graphs

To get a direct and clear image of the mental health impact on different race groups, we graphed each dependent variable against race after the Chi-square tests. The relationships are depicted in Figures 1 to 5 for *imp\_mtl, anxious, emotion, mtl-r*, and *disorder*.

As shown in Figure 1, the impact of mental health  $(imp_mtl)$  is different for different race groups. The Hispanic group feels the impact of their mental health is low (with the average value between 6=Low and 5=Somewhat Low) while the Asian feels the impact of COVID-19 on their mental health is high and severe, with an average value lower than 4=Neither Low nor High, approaching 3=Somewhat high.



*Imp\_mtl*: (7) Very Low; (6) Low; (5) Somewhat Low; (4) Neither Low nor High;

(3) Somewhat High; (2) High; (1) Very High

Race: 1-White; 2-Black; 3-Hispanic; 4-Asian; 5-Other





(2) anxious; (1) highly anxious.

Race: 1-White; 2-Black; 3-Hispanic; 4-Asian; 5-Other

As shown in Figure 2, the anxiety levels are different for different race groups. According to the graph, the Black group's level of anxiety is fairly high (with the average value between 2=anxious and 1=highly anxious) when it comes to anxiety about the future of COVID-19, while on the other hand, Asians and White groups are not very anxious (approaching 4= not very anxious) about it.

As shown in Figure 3, Asian groups are more likely to experience emotional problems, with the average value approaching 1=Yes, having emotional problems. The White group, on the other hand, is more likely to have no emotional problems, with the average value approaching 2=No, no emotional problems, according to the survey and graph.



*Emotion:* (1) Yes, having emotional problems; (2) No, no emotional problem *Race:* 1-White; 2-Black; 3-Hispanic; 4-Asian; 5-Other



*Mtl\_r:* (5) Excellent; (4) Somewhat good; (3) Average; (2) Somewhat poor; (1) Poor *Race:* 1-White; 2-Black; 3-Hispanic; 4-Asian; 5-Other

As shown in Figure 4, the Hispanic groups have shown that their mental health rate is higher than 3 (average), while the Black group is showing poor ratings when it comes to their overall mental health rate, with the rate lower than 2.5, and the only group with a rate lower than average.



*Disorder:* (1) Yes, having a disorder problem; (2) No, disorder problem *Race:* 1-White; 2-Black; 3-Hispanic; 4-Asian; 5-Other

As shown in Figure 5. Disorder across race groups, among the five groups, the Asian group (with a lower value approaching 1=Yes, having the disorder problem) is more likely to have a mental disorder problem while the Black and White groups are not likely to have a disorder problem, with a relatively higher value approaching 2=No, without the disorder problem.

#### 6. Discussion and Conclusion

I used 118 observations to evaluate individuals' mental impact, anxiety level, emotional difficulties, mental health rate, and disorder problems across race groups. According to empirical findings, not all ethnic groups received the same mental health impact as COVID-19. This study is consistent with Pandey et al.'s (2021) observation that mass catastrophes, particularly those involving contagious diseases, cause heightened anxiety and terror in many groups.

According to the findings, Asian and Black individuals' mental health deteriorated compared to White, Hispanic, and other ethnic participants in the post-pandemic period, with significantly higher mental health effect, emotional problems, anxiety, and disorder issues. According to Francois (2023), the pandemic has had a profound influence on mental health, and the Black community is no exception. The stress and anxiety of living through a global health crisis, combined with the loss of loved ones, has had a negative impact on many Black people's mental health (Francois, 2023).

Furthermore, this may reveal evidence of the anti-Asian occurrences. Since COVID-19 was first recorded in China, people of Asian and Pacific Islander heritage have been blamed exclusively based on their ethnicity, which has had a significant impact on their mental health. Furthermore, according to the American Psychiatric Association (2023), Asian Americans are less likely than other Americans to seek mental health care, which could be due to language barriers, stigma, and a lack of awareness of resources and mental health services.

In conclusion, the goal of my research was to uncover the relationships between different ethnic groups and focus on how COVID-19 has affected their mental health in the United States. The data that I acquired from the 118 participants via an anonymous survey clearly show that the impact on those participants' mental health has changed between race groups.

This research has significant drawbacks. First, the sample size is sufficient and appropriate for the research; however, a bigger sample size would be preferred because it could improve the accuracy of the estimates. Second, for emotional problem and disorder variables, using ordinal variables with many values rather than binomial variables may result in more significant and relevant findings. As a result, for future studies, it is recommended to increase the sample size and transition from binomial variables to ordinal variables--this will aid in understanding the differences in mental impact across different race groups in greater depth. It could help researchers gain a better grasp of population health disparities in the same COVID-19-affected environment. There is still considerable work to be done on this topic

There are several limitations in this research. First, the sample size is good and valid for the research; however, a larger sample size would be preferable as it could increase the accuracy of the estimations. Secondly, for emotional problem and disorder variables, switching to ordinal variables with multiple values instead of binomial might produce significant and more meaningful results. Therefore, for future studies, it is recommended to increase the sample size and switch the binomial variables to ordinal variables— that can help to understand the difference of the mental impact across different race groups in-depth. It might give researchers a better understanding of the population health disparities under the same COVID-19-impacted environment. There is still a lot of work to be done on this topic, including more post-pandemic resources for various ethnic groups.

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# MITIGATING THE PANDEMIC CONSEQUENCES IN THE SECTOR OF FASHION & LEATHER GOODS: AN LVMH CASE STUDY

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# ABSTRACT

The global personal luxury goods market has had a steady growth since the late 1990s. However, a considerable increase was recorded post-pandemic. Leather goods and apparel grew by more than 22% in 2022 surpassing previous and pre-pandemic years. The luxury conglomerate LVMH, Louis Vuitton Moët Hennessy, demonstrated strong resilience during the pandemic. LVMH reported in 2020 a revenue decline for the fashion and leather goods category of 3% in terms of organic growth.

The conglomerate was forced to close stores and production facilities in most countries, this was one of the main reasons behind the revenue and profit reduction. This research investigated the reason behind the strong resilience and found that a variety of operational and logistical approaches aided in reducing the financial impact of the pandemic.

Online sales accelerated considerably, somewhat compensating for the previous. To mitigate financial effects as much as possible in all categories; marketing was reduced and the luxury houses were able to reduce their lease through negotiation which are observed in their marketing and selling expenses, aiding the conglomerate to save 20% compared to 2019. Christian Dior Couture and Louis Vuitton performed well during the pandemic as they remastered iconic leather goods and released limited edition collections with various individuals. The fashion and leather goods category tightened management, especially in flagship stores. LVMH was able to enhance customer relations and boost customer service. The combination of the previous logistics and the strong brand reputation that each maison holds were crucial for the minimal decline in profits in the fashion and leather goods sector of LVMH.

Data from LVMH's consolidated financial statements served as evidence of the conglomerate's tactics to alleviate the pandemic's impact, allocated mainly on expenses from recurring operations, lease expenses, and sales strategy.

The paper relies on behavioral economics as a foundation for the analysis of consumer behavior and luxury brands, especially during economic crises. The role of marketing becomes fundamental for influencing consumer perception on brands and manipulating customer expectations of purchase and willingness to pay.

## HIGHER-ED STUDENT MENTAL STRESS MITIGATION MODEL: WHY IT'S IMPORTANT IN A POST-PANDEMIC LANDSCAPE Ms. Victoria Alexandra Horton-Roark

#### ABSTRACT

During and after the Covid-19 pandemic, the four following mental stressor categories became of prominent importance regarding student mental health: student support systems, academic support services, mental health services, and technostress. 12 Ga Higher-Ed institutions were analyzed regarding their 2018-2025 actual and projected enrollment numbers, student auxiliary and activity budgets for 2023, and their mitigation strategies for the four mental stressor categories. By studying the strategies utilized by the institutions who are predicted to experience an enrollment increase in 2025 compared to 2018, a Higher-Ed Student Mental Stress Mitigation Model has been created and is proposed to reduce student distress levels and boost overall enrollment and tuition revenue.

Keywords: Higher-Education (Higher-Ed), Student Mental Health, Student Mental Stress, Technostress, Mitigation Strategies, Tuition Revenue, Higher-Ed Total Enrollment

#### **1.0 INTRODUCTION**

The existence of higher-education (higher-ed) student mental stress and the negative impact it can have on student morale and enrollment rates is neither a novel concept nor is it an isolated event related specifically to the Covid-19 pandemic. Son, Hedge, Smith, Wang, and Sasangohar (2020) highlight the history of mental stress for higher-ed students in "Effects of Covid-19 on College Students' Mental Health in the United States: Interview Survey Study". According to Son et al (2020), higher-ed students have historically felt stress whilst pursuing degrees, in that:

For college-bound students, the start of the school year can be a time of excitement and optimism. Still, a new study brings to light that the college years are also a time of increased risk of stressful events and a wide range of accompanying mental health challenges, including risk of suicide. [73]

Even though attending college is often viewed as a way of furthering one's education and pursuing a profitable career path, the stress brought about by higher-ed can lead to detrimental stress levels if left unmitigated.

As Zawn Villines (2022) highlights in "Eustress vs. Distress: What is the Difference?", the stress brought about by any transition, including the transition to a higher-ed learning level or facility, can present in an individual as beneficial eustress of negative distress [103]. Eustress applies necessary pressure to encourage personal and educational growth. For individuals with sufficient coping mechanisms, it can lead to altering their behavior to maintain positive performance despite continued academia-related challenges. In contrast, distress can often lead to an individual feeling overwhelmed by the pressures of their academic pursuits. This can lead to lowered educational performance levels, burnout symptoms, withdrawals from campus life, and lowered enrollment rates in response to higher educational pressures.

Whether the stress experienced by students is eustress which promotes growth and skills or is distress which affects physical health and leads to anxiety and depression depends upon the coping mechanism capabilities of higher-ed students. As Andreas Busjhan (1999) states in "Genetic and Environmental Influences on Coping Styles", these coping mechanisms are often

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derived from a combination of personal and environmental factors [11]. Therefore, aspects of a higher-ed student and their perceived environment will impact how capable they are of positively coping with higher-ed stressors, the ultimate impact of the eustress or distress experienced, and how long the pressure related to either form of stress will last for them. These three factors combined can impact higher-ed students' performance as well as the institutions where they are enrolled.

As Michael Burke (2022) highlights in "Cost, emotional stress leading to enrollment challenges at colleges, study finds", the impact that mental stress has on higher-ed student bodies is not just an issue that the students must contend with. Rather, student mental health is becoming more of a problem at the higher-ed institutional level. Whilst Burke (2022) acknowledges the impact that tuition costs can have on higher-ed students' decisions to enroll or maintain enrollment with institutions, mental stress related to higher-ed experiences also plays a role in deterring interest in pursuing degrees [10]. As a result, declining student mental health has led to even large state run institutions experiencing a significant decrease in enrollment rates in recent years, which ultimately impacts their tuition revenues [10]. As tuition revenues play a vital role in maintaining the financial resources required for higher-ed institutions to continue to function effectively, Burke (2022) calls for changes to be made to improve higher-ed student mental health to maintain enrollment rates of students already attending higher-ed institutions.

According to Burke (2022), it is imperative for higher-ed institutions to focus on mental health as a determinant factor for continued enrollment, since:

For students who have considered dropping out, by far the most cited reason was emotional stress, with 71% saying that was among the most important factors leading to them considering withdrawing. [10]

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It is not enough to attempt to reduce tuition costs and simply get students in the door. Once they are in the door, it is the task of higher-ed institutions to attempt to reduce the distress felt by their pupils to encourage them to continue to invest in degree pursuance.

In response to the evidence provided by Burke and others regarding the impact of highered student mental health on student performance and enrollment rates, the current study seeks to provide an informed Higher-Ed Student Mental Stress Mitigation Model as a multi-faceted strategy for higher-ed institutions to reduce the distress felt by higher-ed students and increase student performance and improve enrollment rates. To accomplish this, four primary mental stressor categories suggested by the literature are studied and mitigation strategies for these categories are analyzed across 12 Georgia Higher-Ed Institutions of varying enrollment ranges to determine which strategies are most effective in mitigating student mental distress. *Through the implementation of the resulting Mitigation Model, higher-ed institutions should see a marked improvement in student mental health, performance, and enrollment.* 

## 2.0 LITERATURE REVIEW

Multiple studies of the impact of stress on higher-education (higher-ed) student bodies have highlighted the negative effects that distress can have on those pursuing higher-educational courses. These effects include but are not limited to depression, anxiety, binge drinking, weight gain, casual sex, sleep deprivation, debt, and suicidal tendencies [70]. During and after the Covid-19 pandemic higher-ed distress and its resulting depreciating effects have increased.

As the study by Son et al (2020) indicates, the global impact of Covid-19 affected many aspects of higher-ed students' lives, resulting in heightened mental stress levels for the students.

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According to their study, the Covid-19 pandemic presented many higher-ed students with residual:

Stressful life events, defined as exposures that the student felt were traumatic or difficult to handle, including academics, career-related issues, death of a family member or friend, family problems, intimate relationships, other social relationships, finances, health problems of . . . family member[s] or partner[s], personal appearance[s], personal health issues, and sleep difficulties. [73]

As Son et al (2020) observe, not all of the stress experienced by higher-ed students are academically based. However, the heightened distress experienced by students in their study correlates with increased anxiety and depression as well as lowered academic performance and increased withdrawal symptoms.

A study conducted regarding 1,062 students attending mid-sized public colleges in the Mid-Atlantic Region by Sarah W. Bisconer and Makenna B. McGill (2022) further shows how Covid-19 related heightened stress levels in higher-ed students correlated with a rise in multiple mental stress symptoms amongst the observed student population. According to Bisconer and McGill (2022), 74% of the students in their study of the heavily populated Mid-Atlantic Region reported some degree of anxiety-whether it was mild, moderate, or severe- since the beginning of the pandemic and its resulting NPI protocols [8]. Bisconer and McGill's (2022) reports also allege that of the students in the study 54% experienced some degree of depression, 10% engaged in an increase of illicit substance use, 9% experienced an increase in alcohol use, and 33% reported a decline in academic performance during the first years of the Covid-19 pandemic [8]. Due to this significant increase in distress symptoms amongst higher-ed student bodies
during the Covid-19 pandemic, multiple studies have tried to identify primary stressors that directly impact the mental health of higher-ed students.

Whilst the primary stressors researchers have focused upon have historically been present in students' lives, their impact on students was magnified due to the NPI and Vaccination protocols pursued during the Covid-19 pandemic to stem the spread of the virus. *These stressors involve a perceived lack of personal support systems, a lack of perceived academic support, limited mental health services, and increased technostress regarding technologically enhanced learning (TEL).* The impact of these four stressors on higher-ed students is shown in the Higher-Ed Student Mental Stress Model, in Figure 1.

As the model indicates, the four primary stressors can have either a positive or a negative impact on higher-ed student bodies, dependent on the coping mechanisms that students implement regarding said stressors. These coping mechanisms, as Busjahn (1999) indicates, differ based on everyone's internal and environmental factors [11]. For Covid-19 an example of an internal factor could include an individual's perception regarding their personal health and safety and the effectiveness of Covid-19 NPI protocols and vaccination mandates for offering protection from the virus.

Regarding environmental factors, an individual's available financial resources and economic stability can impact their coping capabilities. These environmental factors have always been present in higher-ed due to tuition rates. However, as stated in "The Effects of Covid-19 on College Students", by Murphy and associates (2022), "The pandemic has put a lot of financial burden on students and the economy", increasing the financial stress and burden on higher-ed students [55]. During the Covid-19 pandemic, the impact of these factors led to an increase in poor higher-ed student coping mechanisms, distress symptoms in higher-ed students, and decreased enrollment rates.



Figure 1: Higher-Ed Student Mental Stress Model

#### Source: Horton-Roark

As Elissa Nadworny (2021) indicates in "College enrollment plummeted during the pandemic. This fall, it's even worse", various higher-ed institutions experienced a decrease in enrollment rates during Covid-19 [56]. This decrease has continued to last throughout the years following the global spread of the virus [56]. This rapid drop in enrollment rates has led to an unforeseen impact on higher-ed tuition-based revenues. Whilst some universities and colleges have managed to regain some of their lost enrollment numbers, others still struggle to return to the enrollment rates experienced prior to the pandemic.

It is imperative, therefore, for higher-ed institutions to maintain a level of control over the four primary stressors for higher-ed students investigated in this study, by implementing various strategies to mitigate their impact on individuals. Whilst this does not limit the role that internal and external factors (outside of the mitigation strategies' scope) may play in contributing to higher-ed student mental health, it can increase the likelihood of eustress amongst students and lead to improved academic performance and enrollment rate retention.

### 2.1 Lack of Support Systems

According to Zawn Villines (2022), an important stressor involved with higher-ed is a lack of perceived social support. For many students, having a support system consisting of family members, friends, classmates, or faculty can act as an anchor of stability as they traverse the necessary steps to acquire a degree [103]. Regardless of whether the support system offers the student helpful knowledge, physical resources, an emotional outlet, or advisement, the existence and availability of such a system has been proven to alleviate the negative effects of student academic stress.

Unfortunately for higher-ed students during the Covid-19 pandemic, this support system was taken away, primarily through the government and university implementation of nonpharmaceutical interventions (NPIs) to reduce the spread of the virus. According to a study by Raaper, Brown, and Llewellyn (2021), these NPIs (primarily those regarding social distancing and isolation protocols) led to many students being unable to physically connect with their potential support systems [67]. According to Bisconer and McGill (2022), younger students residing on university campuses especially felt the effects of isolation from their social support systems, as they found themselves isolated on campus and within their dorm rooms [8]. Even

after higher-ed institutions relaxed their NPI protocols, the re-emergence of support systems has been a slow and gradual process.

Although the primary purpose of higher education is for the spreading of academic knowledge and excellence, the impact that a social support system has on the learning process makes it an important facet of campus life. Marler, Bruce, Abaoud, Henrichsen, Suksatan, Homvisetvongsa, and Matsuo (2021) highlight the importance of social support and networking for higher education in "The Impact of Covid-19 on University Students' Academic Motivation, Social Connection, and Psychological Well-Being". According to Marler and associates (2021), "People have an innate need for social connection [and] belonging. . . A sense of social belonging provides meaning in life and promotes a greater sense of psychological well-being." [50]. In higher-ed environments, a lower perception of support is associated with lower levels of educational success and engagement with others [50]. As a result of the impact of social support systems and lack thereof on higher-ed student wellbeing and educational performance, there is therefore a need for higher-ed institutions to assist students in forming their support systems. This sentiment is further emphasized in the work of Raaper et al (2021).

Whilst higher-educational institutions' impact on students' familial support systems is limited, one way that institutions can attempt to boost students' support systems is through the presence of a diverse group of student organizations. As stated by the Ohio State University Center for the Study of Student Life (2023) in "Involvement in college matters", involvement of students in student organizations and healthy aspects of campus life apart from academia often correlates with improved academic performance and morale [62]. By offering enough organizations to cater to the interests of most students, a higher-ed institution affords students the ability to form their social support networks within student organizations. Not only does this

provide them with a sense of belonging outside of the classroom, but it also affords students of similar interests a method by which they can express themselves outside of academia to a group of individuals who they can then seek advice from regarding any higher-ed challenges they might encounter. Therefore, having a diverse number of organizations established and presented in an easy-to-understand manner to students is a tool that institutions can utilize to reduce student distress.

#### **2.2 Importance of Academic Assistance in Higher Education**

Due to the heavier workload that comes with higher-ed institutions, tutoring has historically had a significant impact on student achievement and success in the higher-ed realm of academia. As Rheinheimer, Grace-Odeleye, Francois, and Kusorgbor (2010) indicate, the impact of tutoring in higher-ed isn't limited to simply informing students regarding specific course instruction and reinforcing learning objectives. Rather, "some indirect effects achieved by tutoring include persistence, academic achievement, retention, and degree attainment" [69]. Often, the listed additional impacts are achieved by way of tutors teaching students specific skills regarding learning, note-taking, student-teacher communication, and test taking strategies, focusing on specific areas that the students appear to be less proficient in. Mamy of these skills are transferable to more than one course, and many students who receive them by way of tutoring for one subject can transition their usage into studying other subjects, furthering the impact of their tutoring sessions.

In addition to innovative and interactive tutoring sessions, higher-ed students can also benefit from the provision of academic coaching and workshops. These types of academic support may not be related to specific classes. Instead, they can focus on all aspects of student life, including financial budgeting, time management, public speaking practice, wellness

maintenance, academic paper writing, and other topics important to the successful completion of higher-educational courses. As the Raleigh ICF Higher Education Special Interest Group Publication Team (2021) states, these types of coaching and workshop opportunities are effective ways to increase:

awareness of values and alignment with decision making, confidence in goal setting and attainment, confidence in the choice of major, satisfaction with major, compatibility of choices with faith, values, and strengths, confidence in life purpose, and confidence in self. [68]

For some students, workshops are highly effective, in that they often find themselves in a group of peers who are experiencing similar challenges whilst pursuing their own degrees. Institutions have also explored the utilization of peer coaching and tutoring to lower apprehension regarding asking for help, for similar reasons.

Whilst tutoring, academic coaching, and workshops are effective academic support measures to have at a university, during Covid-19 many universities had to restructure or eliminate their traditional methods for offering them to higher-ed student bodies. As Al-Maskari, Al-Rivami, Kunjumuhammed (2021) indicate in "Students' Academic and Social Concerns during Covid-19 pandemic", due to the distance education implemented during the Covid-19 pandemic face-to-face coaching and tutoring sessions were no longer available to students who were struggling in higher-education [2]. As a result, many students experienced lower academic performance and retention levels, despite the offerings that institutions made regarding distance tutoring and coaching.

As higher-ed institutions move forward, a combination of online services, easy-to-use apps, and face-to-face individual and group tutoring/coaching sessions and workshops would ideally offer students the academic support that has appeared to be lacking during the Covid-19 pandemic. In their 2021 study, J. Singh, K. Steele, and L. Singh recommend this "blended" or "hybrid" learning approach to assist as many traditional and nontraditional students as possible to boost overall academic retention [72]. Therefore, higher-ed institutions, by offering virtual as well as traditional types of academic support, can further assist in boosting student morale, achievement, and enrollment.

## 2.3 The Higher-Ed Impact of Mental Health Services

As advancements have been made in technological systems in recent years, the need for physical higher-ed mental health centers has been brought into question. As Newman (2022) indicates, some individuals may not attend physical mental health centers due to stigmas that have continued to exist around mental health disorders in society [57]. Additionally, some individuals prefer the ease of use offered by telehealth services. Because of this, many institutions have debated whether they should continue to offer physical locations to facilitate mental health counseling.

Whilst their usage remains a dubious debate amongst educators and university personnel, the closure of physical mental health and counseling centers at higher-ed institutions during the Covid-19 pandemic correlated with an increase in mental distress levels of students. As indicated by Levin (2022) in "University MH Centers Strain to Keep Up With Increased Demand", when Covid-19 lockdowns began and NPI protocols were implemented, face-to-face physical counseling facilities were no longer available to higher-ed students to receive psychological help and counseling from [49]. For students, regardless of whether they would have utilized campus

mental health or counseling centers prior to the Covid-19 lockdown, the perceived inability to access these services has appeared to have increased stress levels during the Covid-19 lockdown and pandemic.

Specifically, universities in heavily populated areas appeared to experience not just heightened mental stress among their students but also an increased number of suicides or suicidal thoughts as well. A study by Erica J. Seidel and associates (2020) analyzed the different mental stress results that correlated with varying levels of mental health support offered during the Covid-19 lockdown among higher-education students in New York and surrounding areas [71]. The study found that some institutions only offered minimal information regarding Covid-19 safety protocols, remote counseling resources, and information crisis centers by way of difficult-to-navigate webpages [71]. Meanwhile, other institutions included in the study offered a larger amount of information to their students via easily accessible web pages structured as substitutes for physical mental health centers [71]. When compared, the latter institutions had a higher enrollment rate during the Covid-19 pandemic even though 93% of their students claimed to experience anxiety and stress during that period [71]. These students did not all utilize the counseling and mental health services offered by the institutions. Those who did not utilize the counseling and mental health services argued that it was the perception of mental health service availability that encouraged them to continue to pursue their studies. Therefore, merely offering a safety net in the form of readily available mental health services can reduce the impact of stressors on students and improve their academic performance and retention.

The lack of physical mental health centers had an impact on higher-education students during Covid-19, and the ways universities utilized remote or virtual channels to continue to provide mental health services were a deciding factor in the stress experienced by higher-

education students during the initial lockdown and Covid-19 pandemic. As universities have opened their physical mental health centers back to the public, it could prove effective to continue to maximize online services and apps to continue to assist those who may wish to avoid traditional interactions with counselors or therapists.

Some strategies by which institutions can offer this hybrid approach to mental health for their students include peer help and assistance, 1-on-1 counseling, virtual sessions with therapists and counselors, the continued provision of a physical mental health facility, an informative web page with links to information on various mental health issues up to and including suicide awareness, an informative web page with contact information not just for the institution's mental health services but also for crisis hotlines, group sessions hosted to assist students in airing out their issues in a safe space amongst peers facing similar challenges, information about college life and other assistance programs, the utilization of apps to assist in mental health and wellbeing (ie-meditation and calming apps), preliminary psychological evaluation screenings, and an emphasis on improving one's physical health.

As Viano (2022) indicates, this approach can improve student well-being and retention overall, and should be considered as a multi-faceted option by institutions wishing to aid as many students as possible [102].

### 2.4 Technostress

As advancements have been made in technology in recent years, higher-educational institutions have shifted resources to offer more online and hybrid courses. Specifically, institutions have been offering these courses to appeal to nontraditional students whose schedules are incompatible with traditional course schedules or who may be more comfortable within an

online or hybrid setting. According to Beyond Campus Innovations (2019), prior to Covid-19 the availability of online learning courses provided a substantial revenue stream for higher-ed institutions. Online learning accomplished this through proven online success and efficiency regarding online or hybrid courses, the increased influx of modern learners (who prefer online learning platforms) to institutions, the increased inclusion of online career specific course offerings, and the ability for nontraditional students to utilize career driven courses to create a virtual network of potential workplace partnerships [7]. Regardless of which aspect of online learning applied to each student, the offering of traditional and online courses offered a hybrid curriculum that led to marked revenue and enrollment growth for many institutions, as well as the creation of solely online institutions.

During the initial Covid-19 outbreak and resulting lockdown, both traditional face-to-face and hybrid higher-education courses had to switch to being fully online in accordance with NPI procedures and protocols. As Chisadza and associates (2020) indicated in "Online and Face-to-Face Learning: Evidence from students' performance during the Covid-19 pandemic", the transition was relatively smooth and simple for online and hybrid courses compared to more traditional courses, with minimal changes to course syllabi and requirements needing to be made to the courses which already involved online or technological elements [12]. In this manner, nontraditional students who preferred online and hybrid courses were largely unaffected by the increase in technologically enhanced learning (TEL) during the initial Covid-19 lockdown.

Unfortunately, the transition was more complex and rushed for face-to-face courses, as more aspects of the courses had to be changed or altered to fit an online or TEL setting [12]. These rapid transitions towards fully online courses led to many traditional students

unaccustomed to the courses encountering Technostress as they engaged in social-distance learning.

Technostress is defined by John Galvin and his associates (2022) in "Technostress, Coping, and Anxious and Depressive Symptomatology in University Students During the Covid-19 Pandemic" as the "inability to adapt or cope with information and communication technologies (ICT) in a healthy manner" [21]. For higher-ed student bodies, this translates into the inability to properly adapt to and utilize TEL platforms to accomplish learning objectives and acquire appropriate course comprehension.

Technostress can involve different kinds of stress related to various aspects of TEL usage. These different kinds of stress form the five subcategories of Techno-Overload, Techno-Complexity, Techno-Invasion, Techno-Uncertainty, and Techno-Insecurity [9]. As stated by Wang and associates, Techno-Overload refers to scenarios where higher-ed students feel overwhelmed by the perceived increase in individual tasks included in TEL, such as discussion posts to facilitate topic discussion and understanding [104]. The next subcategory, or Techno-Complexity, occurs when the usage of multiple platforms and applications for online learning can lead to heightened stress levels and confusion [104]. The third subcategory, or Techno-Invasion, occurs when individuals have difficulty maintaining boundaries between the time they devote to their course work and to other interests and aspects of their lives, leading to a feeling that their personal time is being invaded by TEL requirements [95]. All three of the described Technostress subcategories are directly involved with feeling overwhelmed in higher-educational students pursuing TEL.

The remaining two categories, or Techno-Uncertainty and Techno-Insecurity, involve students questioning both their ability to properly complete online courses as well as the ability of

institutions to offer proper support related to online courses. Regarding Techno-Uncertainty, due to the multiple updates and changes that may be made to TEL platforms and apps during online semesters, students begin to question the ability of the platforms to consistently present course syllabi in an understandable manner and to meet all learning objectives related to online courses [4]. For these students, whether online courses are sufficient substitutes for their traditional counterparts plays a heavy role in their Technostress. For many students experiencing Techno-Uncertainty, not only are they uncertain about what tasks need to be completed for their online courses but they are also uncertain as to whether they are receiving an adequate amount of instruction while engaging in TEL.

The fifth and final subcategory of Technostress, or Techno-Insecurity, involves students questioning the support they receive from their higher-ed institution's IT department, instructors, and peers whilst engaging in TEL. For these students, not only does the limited interaction between themselves and their instructor and peers lead to a perceived lack of support, but an additional perceived inadequacy in their institution's IT department to resolve any issues they may have with TEL platforms also contributes to their Technostress [95]. These students may continuously question whether they can complete an online course successfully and with the desired outcome, since they feel in large part as if they have been left on their own to complete their online course to the best of their abilities. For students with low technological self-efficacy, Techno-Insecurity can be heavily detrimental to their mental health.

Even though many institutions have begun to re-integrate traditional face-to-face courses into their curriculum, TEL maintains a significant presence across higher education Ortagus (2020) indicates, that online courses offer financial benefits for institutions seeking to increase enrollment rates while minimizing facility costs [63]. TEL can benefit universities in this way because it does not require the utilization of a physical classroom to maintain a class schedule. Because of this, not only can institutions save on the costs associated with offering facilities for face-to-face classes, but they can also offer more "seats" to those interested in engaging in the courses. For example, for a course that in a face-to-face setting could only enroll 25 students per semester, in a TEL setting, the course could offer enrollment to over 50 students. Therefore, for many institutions, the ability to offer a TEL platform and reach more students is appealing. Because of this, it can be assumed that TEL is going to remain a prominent aspect of higher-ed institutions moving forward.

Because of the continued presence of TEL, institutions should implement strategies to reduce the impact of Technostress and prevent the drop in student morale and performance that Technostress can spawn. Some strategies for accomplishing this, as suggested by the literature, include the provision of training for individuals needing to utilize technological platforms for daily operations, a minimization and optimization of the different technologies required for technologically enhanced processes as well as a monitoring of user performance regarding said processes, continual re-assessment of the use of technological processes and their impact on user technostress, an interactive support system for individuals engaging in TEL, the hiring of more IT professionals and other diverse personnel, clear communication regarding issues and updates, streamlining of online work flow, and the monitoring of technologies needed and utilized in TEL [5] [64] [75]. By implementing these strategies effectively, higher-ed institutions can help negate the detrimental impact of Technostress and continue to boost student enrollment rates and academic retention.

#### **3.0 METHODOLOGY**

The present study seeks to create an educational model geared towards minimizing the mental distress experienced by higher-education (higher-ed) student bodies, thereby leading to improved academic performance, increased student retention rates, and increased enrollment rates. Based off the review of the literature, the model will focus on mitigating the impact of the following four mental stressors common amongst higher-ed institutions: perceived lack of support systems, need for academic assistance, limited mental health services and support, and increased student technostress due to the rise in technologically enhanced learning (TEL).

In the present study, the service offerings, and institutional strategies of 12 Georgia Higher-Education Institutional systems were studied, to determine which mitigation strategies each employed regarding the four mental stressor categories and the enrollment trends which correlated with their implementation. The institutions studied ranged in student population size, including four "large" institutions with student enrollment numbers of 20,000 and up, four "medium" institutions with student enrollment numbers ranging from 10,000 to 19,999, and four "small" institutions with student total enrollment below 10,000. The three different institutional sizes were utilized to adequately represent the 27 institutions presently included in the University System of Georgia as recognized by the Board of Regents, and to increase the generalizability of the strategies explored and model formed by the current study to multiple higher-ed institutions within and outside of Georgia.

In the present study, the four "large" institutions include the University of Georgia (UGA), Georgia Tech (GT), Georgia Southern University (GSU), and Kennesaw State University (KSU). The four "medium" institutions included the University of North Georgia (UNG), Valdosta State University (VSU), University of West Georgia (UWG), and Georgia Gwinnett College (GGC). The four "small" institutions included Middle Georgia State University (MGA), Fort Valley State

University (FVSU), Georgia College and State University (GCSU), and Gordon State College (Gordon). For the sake of forecasting enrollment trends for each higher-ed institution, the total enrollment numbers for 2018-2022 were acquired for each to forecast enrollment trends through 2025. Additionally, the current auxiliary and student activity fiscal budgets for 2023 were acquired for each institution, to gain an understanding of the ratio of budgeted funds related to student mental stress mitigation strategies per student for each institution. The auxiliary and student activity budgets were the only budgets studied for each institution, as each of these budgets would primarily impact the presence of student organizations, academic support services, mental health services, and technostress strategies, all of which are directly related to the four primary stressors.

Based off the literature review, four hypotheses are posited regarding strategies institutions can implement to mitigate the impact of the four stressors and their success across various higher-ed institutions. In the current study, institutional success regarding strategies for mitigating student mental stressors will be determined by way of forecasted enrollment trends based on current enrollment rates.

The first hypothesis is regarding the impact of student support systems and states "Does a lower student population to institutional organization ratio correlate with increased enrollment rates?" The primary way universities can attempt to improve student support systems is through the offering of multiple student organizations. By offering students access to multiple diverse organizations, a higher-ed institution has a better chance of providing an "organic" support system of peers per student. By this notion, as the student-organization ratio lowers, the coverage each organization can have regarding an institution's student populace increases, as more organizations are available in relation to student population size. As a result, organizations with a lower student:

organization ratio should experience reduced distress rates and increased academic performance and enrollment rates.

The second hypothesis is regarding the impact of academic support services on student mental stress and states "Does a greater variety of academic support services correlate with increased enrollment rates?" A hybrid academic support system wherein face-to-face, individual, group, workshop, and virtually driven academic coaching and tutoring are offered to higher-ed students is rising in popularity regarding efficiency and the span by which higher-ed institutions can mitigate the distress experienced by students in a higher-ed academic setting [72]. Therefore, an increased number and variation of strategies involved in higher-ed institution academic support services should correlate with increased enrollment rates. The strategies, based on the literature, that the current study focuses on are academic coaching, peer tutoring, peer learning assistance, academic workshops, presentation practice wherein students can practice their class presentations before an unbiased audience prior to presenting them to their professor, and the availability of various interactive academic support apps by way of laptops and smart devices. A rubric was created to monitor the presence of all these academic support services in the analysis of the 12 higher-ed institution data samples. Information regarding academic support service offerings was gathered by accessing the academic support webpages of each institution.

The third hypothesis is regarding the impact of student mental health services on student mental stress and states "Does offering a greater variety of mental health services correlate with increased enrollment rates?" As the literature indicates, the presence of a hybrid and flexible mental health services program can lead to lower distress levels amongst higher-ed student bodies, even if the students do not actively partake in the offered services. Therefore, an increased number and variation of strategies involved in higher-ed mental health and support services should correlate with increased enrollment rates. The strategies suggested by the literature include the offering of peer help and counseling, counseling services provided by trained professionals, virtual counseling sessions either by telehealth or other means of distance communication, the physical presence of a mental health facility on campus, the presence of informational online content regarding various mental health topics including suicide awareness, the offering of various contact information on higher-ed mental health webpages regarding the institution's mental health facility and various crisis hotlines, the offering of group sessions in a "safe space", providing students with helpful college information, the offering of various apps geared towards boosting one's mental health by way of meditation and others strategies which can be easily accessed online and by way of smart devices, free psychological ( $\Psi$ ) evaluations and screenings, and an emphasis on student physical health and wellbeing. A rubric was created to monitor the presence of all these mental health services in the analysis of the 12 higher-ed institution data samples. Information regarding mental health service offerings was gathered by accessing the mental health service webpages of each institution.

The fourth hypothesis, related to Technostress, poses the following question: "Does increased utilization of various technostress mitigation strategies correlate with increased student enrollment rates?" As indicated by the literature, the presence of technologically enhanced learning (TEL) in higher education has been increasing for decades and has recently risen in popularity due to its provision of distance learning for nontraditional students as well as the financial benefits online course offerings can afford higher-ed institutions. As a result, various strategies need to be implemented to mitigate technostress levels. The strategies that the current

study focuses on include the following: systems training for instructors and/or students, the provision of support systems for online courses, the streamlining of online workflow, informative web pages regarding the relevance of TEL platforms, the monitoring of technologies deemed necessary for TEL, the monitoring of the utilization success of technologies in TEL, increases in IT staff to maintain successful TEL strategies, continual assessment of the success of TEL strategies, and clear communication regarding any issues or updates related to TEL strategies. A rubric was created to monitor the presence of all these technostress mitigation strategies in the analysis of the technological strategic plans of the12 higher-ed institution data sample.

#### 4.0 RESULTS

All the data was gathered regarding the 12 higher-educational (higher-ed) institutions in the study to determine which strategies are utilized most consistently by the institutions which are forecasted to experience an increase in enrollment rates in 2025 over their enrollment rates in 2018. This, along with an analysis of the budgets allocated by each institution regarding auxiliary costs and student activities/organizations will contribute to a Higher-Ed Student Mental Stress Mitigation Model geared towards minimizing the distress experienced by higher-ed students and increasing overall enrollment rates. The institutions included in the study included University of Georgia (UGA), Georgia Tech (GT), Georgia Southern University (GSU), Kennesaw State University (KSU), University of North Georgia (UNG), Valdosta State University (VSU), University of West Georgia (UWG), Georgia Gwinnett College (GGC), Middle Georgia State University (MGA), Fort Valley State University (FVSU), Georgia College and State University (GCSU), and Gordon State College (Gordon).

The sample of institutions vary in geographical location, commuter vs residential status, and population size, offering a well-rounded analysis of the effectiveness of higher-ed strategies for mitigating mental stress and increasing enrollment rates.

## **4.1 Institutional Enrollment Rates**

To determine their enrollment success, information regarding the 2018-2022 total enrollment rates of the 12 institutions was gathered and the enrollment rates for 2023-2025 were forecasted based on current trends.

Of the 12 institutions, the institution which noted the second greatest consistent increase in enrollment rates from 2018 to 2022 was the University of Georgia (UGA) in Athens, Ga. As seen in Figure 2, UGA experienced total enrollment numbers of 38,652 in 2018, 38,920 in 2019, 39,147 in 2020, 40,118 in 2021, and 40,607 in 2022 [77]. Should the university follow the enrollment trend predicted by its 2018-2022 numbers, it should experience enrollment rates of 41,095 in 2023, 41,583 in 2024, and 42,071 in 2025. This continued gradual increase in enrollment should lead to a 68% enrollment INCREASE for the university in 2025 compared to its 2018 rate.



Figure 2: UGA 2018-2025 Estimated Enrollment Trends

Source: [73]

Of the 12 higher-ed institutions, Georgia Tech (GT) saw the greatest consistent increase in enrollment rates from 2018 to 2022. As displayed in Figure 3, the Atlanta-based school experienced a total enrollment of 32,722 in 2018, 36,489 in 2019, 39,772 in 2020, 43,859 in 2021, and 45,296 in 2022 [105] [106] [93].





Sources: [105] [106] & [93]

Should GT's trends continue along the predicted trajectory, the higher-ed institute should experience a total enrollment of 48,714 in 2023, 51,839 in 2024, and 54,964 in 2025. This would lead to a 68% enrollment INCREASE for the technical college in 2025 in relation to its 2018 rate.

Georgia Southern University (GSU) experienced fluctuations in their enrollment rates between 2018 and 2022. As Figure 4 illustrates, their total enrollment was 26,408 in 2018, 25,054 in 2019, 26,949 in 2020, 27,091 in 2021, and 25,506 in 2022 [58] [59] [60] [61].





Sources: [58], [59], [60], & [61]

It is forecasted that GSU will experience an enrollment rate of 26,765 in 2023, 28,020 in 2024, and 27,395 in 2025. While the 2025 projected enrollment rate is higher than the 2018 total, it is less than some of the total enrollments experienced throughout the studied period. Furthermore, it is approximately only a 4% INCREASE over 2018's enrollment rate, which is minimal compared to the higher increases that UGA and GT should experience. Kennesaw State University (KSU) is the fourth institution in the study. As shown in

Figure 5, KSU largely experienced enrollment rate increases between 2018-2022, creating an enrollment trend like those of UGA and GT.

Figure 5: KSU 2018-2025 Estimated Enrollment Trends



Source: [44]

KSU experienced enrollment rates of 35,846 in 2018, 35,420 in 2019, 37,807 in 2020, 41,181 in 2021, and 42,983 in 2022 [44]. Based on the 2018-2022 enrollment trends, KSU should experience estimated enrollment rates of 45,091 in 2023, 47,132 in 2024, and 49,174 in 2025. Based on the projected rates, KSU will experience a 33% INCREASE in enrollment rates between 2018 and 2025.

University of North Georgia (UNG) is the fifth institution included in the study. As Figure 6 indicates, UNG experienced a drop from their 19,722 2018 enrollment rate to their 18,046 2022 enrollment rate [94] [15] [42].



# Figure 6: UNG 2018-2025 Estimated Enrollment Trends

Source: [94], [15], & [42]

UNG as an institution appeared capable of maintaining enrollment rates in the first years of the Covid-19 lockdown and resulting NPI protocols, with the enrollment years 2018-2020 seeing rates of 19,722, 19,748, and 19,793 respectively [94] [15] [42]. However, in 2021and 2022 the university experienced gradual drops in enrollment that have now set it on a downward trend. Following this projection, in 2025, UNG is predicted to have an enrollment rate of 16,955. This is a 14% DECREASE from the institution's 2018 total.

The next institution included in the study is Valdosta State University (VSU). In 2018 the institution experienced 11,211 total enrollments. Like GSU, VSU's enrollment rates fluctuated in the period between 2018 and 2023, with 11,270 in 2019, 12,304 in 2020, 11,557 in 2021, and 10,209 in 2022, as shown in Figure 7 [17].







Should the institution continue its path of fluctuation it should experience a total

enrollment of 10,010 in 2025, an 11% DECREASE from its 2018 enrollment rate.

University of West Georgia (UWG), as with UNG, experienced an overall decline in enrollment rates between 2018 and 2022. As shown in Figure 8, UWG experienced enrollment *Figure 8: UWG 2018-2025 Estimated Enrollment Rate Trends* 



Source: [16]

rates of 13,733, 13,238, 13,419, 12,687, and 11,893 across the years of 2018-2022, respectively [16]. Should UWG's enrollment trend continue its current downward path, the institution should experience enrollment rates of 10,682 in 2025, a 22% DECREASE compared to the 2018 rates.

Georgia Gwinnett College (GGC) experienced a rise in enrollment rates between 2018 and 2019 but as the Covid-19 pandemic and resulting protocols set in, its enrollment rates followed a generally downward trend through 2022, as shown in Figure 9. *Figure 9: GGC 2018-2025 Estimated Enrollment Trends* 



Source: [6]

As indicated, although GGC experienced a 323-student rise in enrollment between 2018 and 2019, the enrollment rates that followed were less impressive [6]. For the years 2020-2022, GGC enrollment rates were 11,644, 10,949, and 11,030 [6]. Although this indicates that in 2022 GGC did experience a slight rise in enrollment, the 2022 rates were still less than those in 2018. Additionally, if GGC enrollment continues along the projected trend, enrollment rates in 2025 should reach an even lower level of 8,880. This would be a 26% DECREASE from the 2018 totals.

Since 2018, Middle Georgia State University (MGA) has experienced fluctuation in enrollment rates, gradually resulting in an overall decline between 2018 and 2022, as seen in Figure 10 [14].



Figure 10: MGA 2018-2025 Estimated Enrollment Trends

## Source: [14]

In 2018, MGA experienced a total fall enrollment rate of 7,802, followed by a rise to 8,066 in 2019 and to 8,404 in 2020 [14]. The university then experienced the beginning of a steady decline in rates in 2021 with 7,800 students and in 2022 with 7,259 [14]. Currently, the institution is predicted to have an enrollment rate of 7,301 in 2023, followed by 7,135 in 2024 and 6,969 in 2025. This indicates that there should be an 11% DECREASE between MGA's 2018 and 2025 enrollment totals.

Fort Valley State University (FVSU) experienced similar fluctuations during Covid-19, ultimately resulting in an enrollment total of 2,354 in 2022 in contrast to 2,776 in 2018, as shown in Figure 11 [96] [92] [74].



# Figure 11: FVSU 2018-2025 Estimated Enrollment Trends



Should FVSU continue along its established path of fluctuation, the institution is forecasted to have an enrollment total of 2,305 in 2025, 471 students shy of its 2018 enrollment rate. If enrollment rates continue along the projected path, the institution will experience a 17% DECREASE in 2025 compared to its 2018 total.

The next institution analyzed is Georgia College and State University (GCSU) of Milledgeville, Ga. As shown in Figure 12, GCSU's total enrollment of 6,989 in 2018 exceeded both its total enrollment in 2022 of 6,315 and its predicted enrollment for 2025, even after a short-lived increase in enrollment in 2019 to 7,031 [23] [97].

Figure 12: GCSU 2018-2025 Estimated Enrollment Trends



Sources: [23] & [97]

As Figure 12 illustrates, GCSU is predicted to continue to decrease in enrollment until it reaches 5,915 in 2025. This would result in a 15% DECREASE from its 2018 total.

As seen in Figure 13, Gordon State College (GSC) had 3,663 students enrolled in 2018, which, after a steady decline until 2021 and a minor rise in rates between 2021 and 2022, resulted in only 3,144 in 2022 [65] [13].

Figure 13: GSC 2018-2025 Estimated Enrollment Trends



Sources: [65] & [13].

The College is expected to have an enrollment rate of 2,661 in 2025, a 27% DECREASE from its 2018 numbers.

## 4.2 Student-Organization Ratio Analysis

A ratio formula was implemented to determine the coverage offered by institutionally recognized Student Organizations for each higher-ed student attending the 12 institutions included in the study. The ratio was utilized to therein determine the availability of "organic" support systems in the form of peer groups with common interests for each student attending the higher-ed institutions.

Consisting of the total enrollment population of each institution in 2022 divided by the number of Student Organizations offered in 2023, the ratio highlights not just the number of Organizations currently available to student but also the amount of coverage each institution

offers its student populace considering the previous year's total enrollment. Therefore, the Student-Organization ratio assesses the efforts made by the institution to provide adequate student support systems found in Student Organizations for each student.

By going to the various Student Organization Web Pages for each of the 12 institutions involved in the study, each institution's formal Student Organization count was determined by the number of Organizations offered to undergraduates. The topics of these Organizations ranged from Major-Specific Interests to LGBTQ+ Rights to Artistry to Pop Culture and much more. The numbers of organizations per institution are displayed in Table 1.

Table 1: Student Organizations Per Higher-Ed I	Institution
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Higher-Ed	Student Organizations
UGA	839
GT	669
GSU	346
KSU	453
UNG	304
VSU	237
UWG	239
GGC	114
MGA	130
FVSU	54
GCSU	203
Gordon	35

Sources: [78], [34], [30], [45], [83], [98], [87], [26], [51], [22], [18], & [38]

It should be noted that most institutions utilized easy-to-use web portals to present their available student organizations to their student population in a manner that enabled interested students to apply to join each organization through a series of links. The only institution that did not utilize the described portals was Fort Valley State University (FVSU), which only listed its organizations on a web page with no links for virtually contacting the organizations.

Once the number of organizations for each institution was acquired, each institution's Student-Organization ratio was determined. The ratios are displayed in Figure 14. As shown, Kennesaw State University (KSU), Georgia Gwinnett College (GGC), and Gordon State College each had the highest Student-Organization ratio of the Large, Medium, and Small Institutional groups included in the study at 94.89, 96.75, and 89.83 students per organization respectively. *Figure 14: Georgia Higher-Ed Student-Organization Ratios* 



Sources: [78], [73], [93], [34], [30], [61], [45], [44], [83], [42], [98], [17], [87], [16], [26], [6], [51], [14], [22], [74], [18], [97], [38], & [13]

Conversely, University of Georgia (UGA), Valdosta State University (VSU), and Georgia College and State University (GCSU) had the lowest student-organization ratios of their institutional size groups, at 47.82, 43.08, and 31.11 students per organization. Through this analysis, it can be deduced that the latter three institutions offered more organizations and as a consequence more student support group opportunities relative to their student population size than the first three. For the other institutions in the study, those closer to the lower ratios offered more opportunities per student than the higher ratios, with the number of opportunities relative to enrollment descending as the ratio value increased.

## 4.3 Student Academic Support Services Variation Analysis

In terms of Academic Support Services, each institution's tutoring and academic support web pages were analyzed to determine the quantity and variety of Academic Support Services offered. The Academic Support Services available at each institution were analyzed utilizing a rubric, focusing on the availability of Academic Counseling (A. C.), Peer Tutoring (P. T.), Peer Learning Assistants (P. L. A.), Workshops (WSHPS), Presentation Practice (P. P.), and Learning Support Apps (APPS) for students to utilize for Academic success.

The results of the Academic Support Analysis are displayed in Table 2.

lable	2:	High	ier-E	d I	nsti	tut	ion	Acaa	lemic	Sup	port I	Anal	ysis	

Higher-						
Ed	A.C.	P. T.	P.L.A.	WSHPS	P. P.	APP
UGA	Х	Х	Х	Х	Х	Х
GT	Х	Х	Х			Х
GSU	Х	Х	Х	Х		Х
KSU	Х	Х	Х	Х		Х
UNG	Х	Х				Х
VSU	Х	Х	Х	Х		Х
UWG	Х	Х	Х	Х		
GGC		Х	Х	Х		Х
MGA	Х	Х	Х	Х		Х
FVSU		Х				
GCSU	Х	Х		Х		
Gordon	X	Х	Х			Х

Sources: [79], [35], [31], [46], [84], [99], [88], [27], [52], [76], [24], & [40]

As shown, the variety and quantity of Academic Support Services per institution varies. Of all the institutions, only the University of Georgia (UGA) offers all the Academic Support Services suggested by the literature and included in the analysis. Furthermore, UGA is the only institution to offer Presentation Practice out of the 12 institutions studied. In contrast, Fort Valley State University (FVSU) only offers Peer Tutoring. The Academic Support Service that is consistent across all 12 institutions is Peer Tutoring, followed by Online Applications, Academic Counseling, Peer Learning Assistants, Workshops, and Presentation Practice.

## 4.4 Student Mental Health Services Analysis

In terms of Student Mental Health Services, each institution's mental health services web pages were analyzed to determine the quantity and variety of services offered. The Mental Health Services available at each institution were analyzed utilizing a rubric, focusing on the provision of Contact Information (#'s), Peer Help (P. H.), Counseling Services (C. S.), Virtual Sessions (V.S.), Physical Locations (P. L.), Online Information on Various Mental Health Topics (O. I.), Group Sessions (G. S.), College Information Assistance (Coll. Info), availability of Online Applications to Boost Mental Health (Apps), availability of Psychological Evaluations or Screenings (Ψ Eval), and promotion of Physical Health (Ph. Hlth.).

The results of the Higher-Ed Student Mental Health Service Analysis are displayed in Table 3.

Higher-Ed	#'s	P. H.	C.S.	V. S.	P. L.	<b>O</b> . <b>I</b> .	G. S.	Coll. Info	Apps	Ψ Eval.	Ph. Hlth.
UGA	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
GT	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
GSU	Х		Х	Х	Х	Х	Х	Х		Х	Х
KSU	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
UNG	Х		Х	Х	Х	Х	Х	Х		Х	Х
VSU	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х
UWG	Х		Х	Х	Х	Х	Х	Х	Х	Х	
GGC	Х		Х	Х	Х		Х	Х			
MGA	Х		Х	Х	Х	Х	Х	Х	Х	Х	
FVSU	Х		Х		Х		Х				
GCSU	Х		Х	Х	Х	Х	Х	Х		Х	
Gordon	Х		Х		Х	Х	X				

Table 3: Higher-Ed Student Mental Health Service Analysis

Sources: [80], [36], [32], [47], [85], [100], [89], [28], [53], [19], [25], & [40]

University of Georgia (UGA), Georgia Tech (GT), Kennesaw State University (KSU), and Valdosta State University (VSU) offer all the Mental Health Services included in the analysis to their students. Whilst the offerings of the other institutions vary in both type of service and quantity, Contact Information, Counseling Services, Physical Locations, and Group Sessions are consistently offered by all 12 institutions. Furthermore, Virtual Sessions, Online Information on Mental Health Topics, and College Information Assistance are each offered in 10 of the institutions. Following them consistently are the following services: Psychological Evaluations in 9 institutions, Online Applications in 6 institutions, Physical Health promotion in 6 institutions, and Peer Help in 4 institutions.

## **4.5 Higher-Ed Technostress Mitigation Strategy Analysis**

In terms of Technostress Mitigation Strategy, each of the 12 institutions' current strategic plans were analyzed to determine the Mitigation Strategies implemented in each. The Strategies analyzed included: Systems Training (ST), Support Services (SS), Streamlining of Online Workflow (SOW), Informative Web Pages (IWP), Monitoring of Technologies Needed for TEL (MTN), Monitoring of Technologies Utilized in TEL (MTU), Increasing IT Staff (ITS), Continual Assessment of TEL Effectiveness (CA), and Clear Communication Regarding TEL Updates and Issues (CC). The Institutional Analysis can be viewed in Table 4.

Of the institutions studied, Georgia Southern University (GSU) was the only one to include all 9 Technostress Mitigation Strategies. Of all the Strategies, Support Services were utilized in all 12 institutions. Additionally, regarding individual Strategic Plans, Monitoring of Technologies Needed and Monitoring of Technologies Utilized were present in 9, Systems Training and IT Staff Increases were present in 8, Streamlining of Online Workflow and Continual Assessment were present in 6, Informative Web Pages were present in 5, and Clear Communication was present in 4.

Higher-Ed	ST	SS	SOW	IWP	MTN	MTU	ITS	CA	CC
UGA	Х	Х	Х		Х	Х	Х		
GT	Х	Х	Х	Х	Х	Х		Х	Х
GSU	Х	Х	Х	Х	Х	Х	Х	Х	Х
KSU	Х	Х	Х		Х	Х	Х	Х	Х
UNG		Х			Х	Х	Х	Х	
VSU		Х		Х	Х	Х	Х	Х	
UWG		Х			Х		Х		
GGC	Х	Х	Х		Х	Х	Х	Х	Х
MGA	Х	Х		Х					
FVSU	Х	Х	Х						
GCSU		Х		Х	Х	Х			
Gordon	Х	Х				Х	Х		

 Table 4: Higher-Ed Technostress Mitigation Strategy Analysis

Sources: [81], [37], [33], [48], [86], [101], [90], [29], [54], [20], [43], & [40]

# 4.6 Auxiliary and Student Activity Budgetary Allowances per Student Allocation Analysis

To study the 2023 Auxiliary and Student Activity Budgetary Allocations per Student for each institution, the total Fiscal Year 2023 Auxiliary and Student Activity Budgets for each of the 12 institutions were gathered and divided by the 2022 Student Total Enrollment numbers. The Total Auxiliary and Student Activity Budgets for 2023 of each institution are listed in Table 5.

Table 5: Total 2023 Fiscal Year Budgets for Auxiliary and Student Activity Budgets

Higher-Ed	2023 FY Aux. and S.A. Budget
UGA	\$289,000,000
GT	\$189,000,000
GSU	\$112,000,000
KSU	\$128,000,000
UNG	\$39,000,000
VSU	\$43,000,000
UWG	\$41,000,000
GGC	\$22,000,000
MGA	\$20,000,000
FVSU	\$17,000,000
GCSU	\$33,000,000
Gordon	\$9,000,000

Sources: [82] & [91]

As larger institutions, the University of Georgia (UGA), Georgia Tech (GT), Georgia Southern University (GSU), and Kennesaw State University (KSU) have more financial resources both through the USG system, tuition payments, and other various funding sources. As a result, these institutions are capable of having large allotments in their budget for Auxiliary and Student Activity expenses, which would be related to their priorities around Student Organizations and Support Systems, Student Academic Support Services, Student Mental Health Services, and Technostress Mitigation Strategies. However, each of these institutions also have more students that had enrolled in the 2022 year, which played a part in determining their 2023 Fiscal Year budgets, than the other institutions involved in the study.

To account for student population size, the present study sought to determine the Auxiliary and Student Activity Budgetary Allocations per Student for each of the 12 institutions. To accomplish this, the total Auxiliary and Student Activity Budgeted amounts were divided by the total enrollment numbers for each institution in 2022, to determine the amount that each institution devoted to each pupil and by consequence the financial priorities devoted to the four mental health stressor mitigators analyzed in the current study. The total allocation amounts per student can be viewed in Figure 15.



Figure 15: Auxiliary and Student Activity Budgetary Allowances per Student Allocation Analysis

Sources: [82], [73], [91], [93], [61], [44], [42], [17], [16], [6], [14], [74], [97], & [13]

As seen in Figure 15, despite having total auxiliary (aux.) and student activity (s.a.) budgetary differences exceeding \$200 million, both UGA and Fort Valley State University (FVSU) allocated similar financial resources per student, according to the budgetary analysis conducted. Similarly, GT, GSU, and Valdosta State University (VSU), despite there being a roughly \$80 million difference between the total aux. and s.a. budget allocations of the larger institutions and VSU, budgeted similar amounts per student. Additionally, despite there being similar budgetary differences between KSU, University of North Georgia (UNG), Middle Georgia State University (MGA), and Gordon State College (Gordon), all four of the mentioned institutions had budgeted allocations per student within the \$2,000-\$3,000 range. These similarities implied similar allocation strategies amongst the mentioned institutions, regardless of their effectiveness in executing their budgetary allowances that were created as a result to utilize strategies to properly mitigate student mental stress.

#### **5.0 DISCUSSION**

In the current study, an analysis of the data collected regarding the 12 higher-educational (higher-ed) institutions, their auxiliary and student activities budget allocations, and their highered student mental stress mitigation strategies contributed to the formation of a Higher-Ed Student Mental Stress Mitigation Model, displayed in Figure 16. It is suggested that through the implementation of and adherence to the model that institutions can reduce the mental distress experienced by their students, increase student achievement, and improve student enrollment rates.


## Figure 16: Higher-Ed Student Mental Stress Mitigation Model

Source: Horton-Roark

To create the model, the strategies of the higher-ed institutions with predicted enrollment increases regarding their forecasted 2025 enrollment rates compared to their 2018 rates were analyzed for similarities. These strategies were combined and compared to create the Higher-Ed Student Mental Stress Mitigation Model to be utilized in a general manner by all higher-ed institutions to boost enrollment rates. Of the institutions studied, only the University of Georgia (UGA), Georgia Tech (GT), Georgia Southern University (GSU), and Kennesaw State University (KSU) are predicted to experience increases in their 2025 enrollment rates compared to their 2018 enrollment rates. As a result, they are the institutions whose similarities in their mental stress mitigation strategies are the focus of the Higher-Ed Student Mental Stress Mitigation Model creation.

In terms of their Student- Organization ratios, UGA had the lowest ratio of roughly 48 students per student organization whilst KSU had the highest ratio of roughly 95 students per student organization. GT experienced a ratio of roughly 68 students per student organization and GSU experienced a ratio of roughly 74 students per student organization. Whilst there was significant fluctuation amongst the ratios of the four schools, the mean amongst the ratios was 71 students per organization and the median amongst them was 71 students per organization as well. As a result, it is recommended that 71 students per organization is the ratio to aim for in higher ed institutions regarding student-organizational coverage, to maintain overall financial resources whilst offering each student an adequate support system.

In terms of their Academic Support Service offerings, amongst UGA, GT, GSU, and KSU, the most consistently utilized services were Academic Counseling, Peer Tutoring, Peer Learning Assistants, Online Learning Applications, and Academic Skill Workshops, with the first four services offered in all of the listed institutions and the final service offered in 3. As a result, all five services are recommended for institutions to offer their student populace, to assist them in relieving mental stress related directly to their academia.

Regarding their Mental Health Services offerings, UGA, GT, GSU, and KSU all utilized most if not all the listed Mental Health Services included in the study. Based off this, it can be

assumed that ALL of the Mental Health Services included in the study have merit and therefore should be implemented to promote the Mental Health and Wellbeing of all students to aid in preventing student distress levels. This involves institutions the following to all students in an easily accessible manner: Contact Information, Peer Help, Counseling Services, Virtual Sessions, Physical Locations, Online Information on Various Mental Health Topics, Group Sessions, College Information Assistance, availability of Online Applications to Boost Mental Health, availability of Psychological Evaluations or Screenings, and promotion of Physical Health.

Regarding Technostress Mitigation Strategies, whilst there were more variations regarding their inclusion in the studied Strategic Plans compared to the Academic and Mental Stress Services, there were 8 strategies that appeared in 3 if not 4 of the institutions' strategic plans. These included Systems Training (S.T.), Support Systems (S.S.), Streamlining of Online Workflow (S.O.W.), Monitoring of Technologies Needed for TEL (M.T.N.), Monitoring of Technologies Utilized for TEL (M.T.U.), Increases in IT Staff (I.T.S.), Continual Assessment of TEL strategies (C.A.), and Clear Communication (C. C.) regarding Updates and Issues with TEL platforms. All of these strategies target the subcategories of Technostress either by preparing faculty and students for the demands of TEL through S.T., minimizing the amount of Technostress associated with completing TEL tasks by way of S.OW., M. T. N., and M.T. U., and improving student and faculty confidence in their usage of TEL by way of S. S., C. A., and C. C.. Because of this, all eight strategies could mitigate Technostress in higher-ed.

Finally, the mean and median budgeted allocations per student were analyzed amongst UGA, GT, GSU, and KSU. Of the four, UGA allocated the most auxiliary and student activities financial resources per student at \$7,117, followed by GSU with \$4,391, GT with \$4,173, and KSU with \$2,978. Of the listed amounts, the mean amongst the four institutions was

approximately \$4,665, whereas the median was \$4,282. Based on this information, it can be deduced that having a budgetary allocation of \$4,282-\$4,655 would be ideal both financially and in regard to student coverage regarding budgets for covering each of the four Mental Stress Mitigation Strategies included in the model.

Whilst the model would need to be adjusted based on financial resource fluctuations as well as assessments based on student opinions and campus events that take place, based on the literature and data gathered, the suggested model should apply to multiple institutions and should lead to a general increase in overall enrollment numbers moving forward.

It should be noted that allocating a lot of budgetary resources per student isn't enough to drive enrollment rates since Fort Valley State University (FVSU) allocated \$7,223 per student (more than UGA's \$7,117) but is predicted to experience a 17% DECREASE in its 2025 enrollment numbers compared to 2018. Part of the incongruence between the amount allocated and its impact on the student body can be accounted for by how the funds are utilized in terms of the four mental stressor mitigation categories involved in this study.

Whilst FVSU's Student-Organization ratio is 43.59, the ease-of-access regarding the organizations is minimal, as FVSU's web site only offers a list of its offered organizations with minimal contact information for each as opposed to the interactive portals provided by the other institutions in the study. In terms of Academic Support Services, FVSU only offers Peer Tutoring. Regarding Mental Health Services, FVSU only offers Contact Information, Counseling Services, a Physical Location, and Group Sessions out of the 11 included in the study. Finally, FVSU only offers in terms of Technostress Mitigation Strategies Systems Training, Support Services, and Streamlining of Online Workflow. Whilst each of these services have merit, given the fact that FVSU has a total Auxiliary and Student Activities Budget of over \$7,000 per

student, it would behoove the organization to reassess how it is utilizing those funds to boost enrollment.

### **6.0 CONCLUSION**

In "Student mental health is in crisis. Campuses are rethinking their approach", Zara Abrams (2022) highlights the rise in higher-educational (higher-ed) student mental stress in recent decades, citing that during the 2021-2022 school year, over 60% of college students fit the criteria of at least one diagnosable mental health issue that impacted their college performance and motivation [1]. As Abrams (2022) goes on to point out, whilst Covid-19 certainly led to a rise in student mental health issues, the impact of higher-ed experiences on students had led to a strain on both student mental health and campus services before the start of the pandemic. According to Abrams, "Even before the pandemic, schools were facing a surge in demand for care that far outpaced capacity, and it has become increasingly clear that the traditional counseling center model is ill-equipped to solve the problem" [1]. Since mental health demands related to higher-ed institutions didn't begin with Covid-19, they won't disappear as the pandemic becomes less prominent.

The impact of the continued strain on higher-ed students' mental health will therefore continue and needs to be mitigated, both for the sake of the students and for the continued revenue required to fund higher-ed institutions. As Johanna Alonso (2023) indicates in "Stress Prevents Students from Pursuing Higher Ed", 58% of students who feel deterred from pursuing their higher-ed degrees cite mental stress as one of the primary reasons for their withdrawal or lack of enrollment [3]. This makes mental stress the fourth most commonly cited reason behind the cost of higher education (81%), inflation (77%), and work conflicts (69%) [3]. All the three most common reasons are aspects of higher-ed student lives that higher-ed institutions have

relatively little control over. Granted, they can attempt to lower their tuition rates, but only marginally, given the cost of the utilities and services they must provide to their student populace. Additionally, higher-ed institutes should tread carefully when removing services, as various services may impact the higher-ed student experience and performance. Furthermore, there is little that higher-ed institutions can do to have any short-term impact on national inflation rates and the amount of work that students must perform outside academia.

Therefore, it would behoove higher-ed institutions to utilize the Higher-Ed Student Mental Stress Mitigation Model recommended in the current study to attempt to impact the fourth most common deterrent, student mental health. Whilst the Model is not an allencompassing cure for Student Mental Stress, the data involved in the study supports the positive impact it can have on student wellbeing. As a result, implementing the Model offers institutions an opportunity to experience higher enrollment rates, which would drive tuition revenue.

### 7.0 LIMITATIONS OF STUDY AND FUTURE WORK

Whilst the present study sought to provide a comprehensive model for mitigating highered student mental stress, there are some notable limitations regarding its scope which are listed below:

Individual Factors. As indicated by the literature, individual factors of students may impact their coping processes regarding mental stress related to higher-ed demands. The number of individual factors impacting students ranges from diagnosable conditions to coping mechanisms that the students have learned over time and internalized. Therefore, the impact that the Mitigation Model can have on those individual factors is limited, as it can be difficult to tailor the model to each student's situation. **Environmental Factors.** Whilst the Higher-Ed Student Mental Stress Mitigation Model attempts to impact the higher-ed environment of students, other environmental factors can impact student mental health which the Model does not account for. These environmental factors include student financial resources, family life, day-to-day work, and other life events and experiences outside academia.

The Size of the Data Sample. Whilst 12 institutions of varying enrollment ranges were utilized in the study to create a generalizable Higher-Ed Student Mental Stress Mitigation Model, there are limitations to the information they can provide. Many of these institutions were specifically selected based on the ease with which the data involved in the study could be gathered from each. Unfortunately, this led to limitations regarding higher-ed data implemented in the Mitigation Model creation process.

Presently, there are 27 Higher-Ed Institutions in the University System of Georgia. To garner a more comprehensive model regarding the USG's strategies for mitigating student mental stress, expanding the study to include all 27 Higher-Ed Institutions would create a more comprehensive model. Additionally, the study could be expanded to include institutions from surrounding states or nationwide to increase its generalizability.

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## IDENTIFYING FACTORS AFFECTING CAMPAIGN SUCCESS IN PLATFORM-BASED SPORTS CROWDFUNDING

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# ABSTRACT

Crowdfunding, formally defined as "a method of collecting small contribu-tions through an online funding platform or site from a large number of funders" [8, pg. 50] has emerged as major source of financing for individual creators and businesses alike, with ~ \$13.5 billion market size in 2021, which is expected to grow to ~\$28.2 billion by 2028 [4]. Not only has the crowdfunding topic been of academic research interest with over 140 manuscripts published in the last decade, but it has led to development of novel business models primarily aimed at supporting the campaign creators. For instance, the largest rewards-based crowdfunding platform Kickstarter offers the Experts service with the aim that they can leverage their data and experience in working with successful crowdfunding campaigns to the benefit of new creators [6].

Interestingly, factors affecting rewards-based crowdfunding outcomes are not consistent across sectors or industries, hence disparate research exists on the analysis of crowdfunding success – such as in music (e.g., [9]), restaurants (e.g., [5]), theatre (e.g., [3]), among many others. Some of the key factors that have been shown to affect crowdfunding outcomes are structural factors such as funding goals, campaign durations and campaign length (e.g., [2]), textual factors such as positive and negative sentiments, trustworthiness, joy (e.g., [10]), and entrepreneurial factors such as agentic narcissism (e.g., [1]).

We particularly aim to look at sports rewards-based online crowdfunding (hereafter referred to as sports crowdfunding), as it is a growing niche, with increasing interest from both academicians and practitioners [7][11]. In this study, we collected data on 1,143 sports-crowdfunding campaigns from the SportFunder website, a leading website for online sports crowdfunding. Of the 1,143 campaigns, only 5.8% were successful, indicating that it is very hard to compete for funds in the sports crowdfunding market. Using sentiment analysis we identified various sentiments – positive, negative, joy, sadness, trust, fear and utilized agentic narcissism dictionary [1] followed by factor analysis to identify the extent of agentic narcissism present in campaign descriptions.

We evaluated the importance of various factors through multiple machine learning approaches – decision tree and logistic regression. The logistic regression model provided the best AUC of 0.685 and we identified that campaigns with lower funding goal, higher trustworthiness and higher joy invoking words have a higher likelihood of success. We extended our analysis by exploring the potential of neural networks, and our best performing model was able to predict crowdfunding outcomes with 97% accuracy and AUC of 0.842 Our study has potential research and practical implications for academicians and entrepreneurs within the sports-crowdfunding market.

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# A CAUSAL INFERENCE STUDY OF CRASHES AT HIGHWAY-RAIL

# **GRADE CROSSINGS**

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# ABSTRACT

Frequent collisions between vehicles and trains at highway-rail grade crossings (HRGCs) often result in severe injuries, primarily due to the significant mass and high speeds of trains. Several factors have been identified as contributing to the elevated risk of accidents at these critical intersections, including roadway conditions, railway crossing elements, driver behavior, weather conditions, and various environmental factors.

This study explores the causal relationships between these commonly identified factors and the risk of crashes at HRGCs. Using HRGC data from Texas, one of the leading states in the USA in HRGC crashes spanning seven years from 2015 to 2021, the methodology involves integrating data from various sources, including information about road and railway inventory, crash details, vehicle and driver characteristics, and meteorological data. The study will employ a causal inference model framework to analyze the dataset, with results compared to widely accepted and researched findings.

The study is expected to provide valuable insights for transportation agencies, researchers, decision-makers, and other stakeholders in the road safety sector, enhancing their understanding of the causal factors contributing to crashes at HRGCs. Moreover, our research seeks to advance the use of causal inference techniques in examining the causes of accidents to contribute to developing more effective safety measures and strategies at these critical junctures.

In conclusion, we aim to offer valuable insights to guide safety improvements and save lives at these critical intersections by employing rigorous data analysis and causal inference techniques. The practical applications of this research can potentially enhance road safety for both transportation agencies and the general public.

# A NOVEL APPROACH TO GEODESY CLUSTERING: AN ALGORITHM FOR CLUSTERING NODES IN LARGE, ORGANIZED, SPARSE GRAPHS BASED ON NODE WEIGHT, AND AUTO-ASSIGNING GROUP COLORS

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## ABSTRACT

This paper introduces a new algorithm that solves the NP-hard Geodesy clustering problem. Geodesy is a JavaScript Minecraft mod that enables players to design efficient farms for the collection of Amethyst Geodes. The location and layout of this resource dictate an intricate farm design, one that is unique for every cluster of amethyst [1]. This algorithm solves the design of these farms by implementing code to cluster nodes in a large, organized, sparse graph based on node weight, and then auto-assigning group colors. Several logical steps are introduced to prune the number of clusters tested, increasing efficiency. The algorithm first identifies initial groups of nodes greater than the maximum allowed cluster size and marks them for partitioning. After this, a novel use of the ConSubG algorithm [2] was implemented to return possible clusters for selection. Finally, once every node has been assigned to a cluster, the algorithm color codes the clusters based on a staggered color requirement. The algorithm has been tested against a sample of 1000 sample graphs, and against custom graphs generated for use in edge case handling. It is set to receive a matrix input of any size representing the 2D geode projection currently being clustered. The output is that same matrix with entries designating the color assignment. As the Geodesy mod runs JavaScript, converting the algorithm to run as part of Geodesy will follow soon. The algorithm can cluster and color large sparse graphs with around 120 nodes at an average rate of 0.29 seconds. While the use case for this algorithm is slightly narrow, its underlying study of logical graph clustering by node weight can be applied to many other use cases.

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## CREATING ART WITH PYTHON AND GENERATIVE AI IN COLAB

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### ABSTRACT

Python is one of the world's most widely used and popular, general-purpose, high-level programming languages, known for its ease of learning and readability. Generative AI refers to artificial intelligence models that generate new content, such as text, images, audio, or video, based on learned patterns from data. Google Cloud Platform: Colab, simply "Colab," is an interactive cloud-based service that allows users to write and execute Python code through their browser. We will present how to create art with Python and generative AI in Colab.

## Keywords

Art, recursive relation, algorithms, generative AI, ChatGPT, Python Programming Language, Google Cloud Platform: Colab

## SCIENTIFIC COMPUTING WITH PYTHON AND GENERATIVE AI IN COLAB

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## ABSTRACT

Python is one of the world's most widely used and popular, general-purpose, high-level programming languages, known for its ease of learning and readability. Generative AI refers to artificial intelligence models that generate new content, such as text, images, audio, or video, based on learned patterns from data. Google Cloud Platform: Colab, simply "Colab," is an interactive cloud-based service that allows users to write and execute Python code through their browser. We will present how to solve scientific computing problems with Python and generative AI in Colab.

## Keywords

Scientific computing, complexity, efficiency, algorithms, generative AI, ChatGPT, Python Programming Language, Google Cloud Platform: Colab

# OPTIMIZING ENGAGEMENT: CRAFTING A COMPREHENSIVE VOLUNTEER MODEL FOR KINGDOM BOXING FITNESS FOUNDATION

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## ABSTRACT

Following the COVID-19 pandemic's impact on societal structures, this paper posits that youth-based non-profit organizations (NPOs) can revitalize their volunteer engagement by implementing conventional methodologies with innovative digital strategies. A Post COVID-19 Pandemic Revised Volunteer Acquisition, Management, and Retention Model is proposed for bridging the volunteer engagement gap, with special focus regarding the 18–24 year volunteer demographic, based off data from a distributed Kingdom Boxing Volunteer Experience Survey. The model suggests a hybrid strategy harmonizing digital communication with direct personal interactions, complemented with specialized training, integration-geared infrastructures, and increased alumni influence. It emphasizes volunteer recognition through social media for strengthening engagement and retention. The suggested model is designed to rejuvenate volunteer involvement, empowering NPOs like the Kingdom Boxing Foundation to sustain and amplify their mission of nurturing youth and enhancing community welfare in a post-pandemic world.

Keywords: volunteer engagement, youth-based non-profit organizations (NPOs), communitybased organizations (CBOs), Kingdom Boxing Fitness Foundation (KBFF)

## **1.0 INTRODUCTION**

In 2023, Warner Robins, Georgia witnessed the establishment of the youth-based nonprofit organization (NPO) entitled the Kingdom Boxing Fitness Foundation (KBFF), an initiative of the Kingdom Boxing Gym that was established in 2018. Embarking on its journey with a modest group of less than 20 clients, Kingdom Boxing's momentum quickly propelled it into a phase of rapid expansion. Kingdom Boxing's growth necessitated several location and staff related shifts until they found a fitting home beside the Jet Training Basketball Academy in 2019. By 2023, their membership swelled to over 140, assisting with the establishment of the KBFF, with their youth segment serving students across all academic levels, claiming a significant 59% of their membership. Throughout its growth, Kingdom Boxing has collaborated with numerous local NPOs, organizing events and community drives. It has also welcomed influential figures, such as Warner Robins native and Seattle Seahawks Tight End Tyler Mabry, to speak at events and inspire its youth members.

As the youth memberships burgeoned, coupled with the gym's longstanding engagements with local charities, the vision for the KBFF crystallized. With a mission to empower students, the KBFF focuses on pivotal areas in its members' lives like financial literacy and pathways to college and careers. Furthermore, the foundation has anchored itself as a sanctuary where students can access essential resources that bolster their academic journey and their steps into the world beyond school. Initiatives such as Youth Game Nights and workshops regarding indispensable life skills punctuate the foundation's commitment to comprehensive youth development.

Given the foundation's trajectory and its expansive community engagement, it has become evident that a robust volunteer presence is instrumental in amplifying its impact. This paper postulates the necessity of a structured volunteer model tailored to reinforce and sustain the Kingdom Boxing Fitness Foundation's mission of holistic youth empowerment. The volunteer model for an organization like the Kingdom Boxing Fitness Foundation, particularly

when focusing on youth development, will be integral for its effectiveness and sustainability. The composition of this model will be developed around key elements such as recruitment, training, retention, feedback and adaptation, and transition/Alumni, with the purpose of increasing its applicability to all youth-based NPOs, not just the KBFF.

### 2.0 LITERATURE REVIEW

The Kingdom Boxing Fitness Foundation (KBFF), paralleling the achievements of renowned nonprofits such as the Boys and Girls Club and the Big Brother/Big Sister programs, serves as a pillar in the Warner Robins, Georgia community. It offers pathways for youth to attain athletic prowess, career guidance, and personal development. Kingdom Boxing's success prior to the Foundation's establishment manifests in its alumni, who have excelled in professional athletic arenas, reflecting its regional significance. A key feature of its operation is the virtuous cycle of mentorship, where past beneficiaries like Alejandro Trimier return to KBFF to guide new generations, reinforcing Kingdom Boxing's and KBFF's community impact. Trimier, affectionately known as Coach AT, attributes his transformation to the discipline he learned through boxing thanks to Kingdom Boxing, sharing with Caleesha Moore (2022) that the sport was instrumental in his life [18]. His journey from impulsivity to control exemplifies the profound influence Kingdom Boxing has on its youth, as reported by 13WMAZ.

This narrative aligns with Naomi Camper's assertion that it indeed "takes a village" to nurture a child. Non-profit organizations (NPOs) offer crucial support systems for otherwise underserved youth, a sentiment echoed by Camper in 2016 [6]. As the need for such supportive services escalates, so does the demand for dedicated volunteers. The KBFF, through its structured initiatives and skill development programs, supports individual growth and contributes

to community vitality and economic resilience, embodying Camper's vision of NPOs as cornerstones of community development [6].

Raj's 2023 analysis on the Donorbox blog further expands on this theme, outlining the five significant advantages volunteers offer NPOs: cost savings, increased visibility, advocacy, diversity, and a broad skill set [22]. These contributions are crucial for NPOs and drive them to seek innovative, in-person, and online volunteer recruitment strategies.

Kingdom Boxing has been a pillar in the Warner Robins community since 2018. However, Kingdom Boxing's initial strategies for volunteer coaching recruitment faced unprecedented challenges during the Covid-19 lockdown. The organization's pre-pandemic reliance on direct interaction was abruptly halted due to the lockdown, as depicted in the Covid-19 Kingdom Boxing Volunteer Acquisition Model illustrated in Figure 1 below. This led to a shutdown in volunteer management and a subsequent shift to online platforms to maintain engagement. Despite these adjustments, the organization experienced a stark increase in the student-to-coach ratio post-lockdown, suggesting that the digital outreach could only partially compensate for the face-to-face volunteer recruitment hiatus. This disparity highlights a critical gap and points to the need for an in-depth exploration of alternative volunteer acquisition and retention strategies that could sustain organizations like Kingdom Boxing during crises and beyond.



Figure 1: Covid-19 Kingdom Boxing Volunteer Acquisition Model

#### Source: Furtney

This literature review strategically focuses on key areas instrumental in creating an optimal volunteer model for Kingdom Boxing Fitness Foundation and other non-profit organizations (NPOs), particularly in the aftermath of the COVID-19 pandemic. We begin with Section 2.1, which assesses the amplified importance of youth-based NPOs in community outreach, a factor that has become increasingly critical in light of the pandemic's social challenges. Understanding this will inform the development of targeted volunteer programs. Section 2.2 addresses the escalating demand for volunteers, underscoring the need for a robust volunteer base to support NPOs' expanded roles.

In Section 2.3, we scrutinize the obstacles that hinder the acquisition and retention of volunteers, recognizing that overcoming these barriers is essential for shaping an effective volunteer framework. Finally, Section 2.4 presents a range of strategies to enhance volunteer

acquisition and engagement, each offering potential pathways to refine and perfect the volunteer model. The synthesis of these topics will contribute to a comprehensive blueprint for an optimal volunteer model that can adapt to the evolving needs of NPOs and the communities they serve.

#### 2.1 Importance of Youth-Based NPOs and Community Outreach Increased by Covid-19

Research conducted by Molly A. Miller (2019) highlights that the impact that Youth-Based NPOs can have on at-risk or impulsive youths is significant and, therefore, cements the necessity for Youth-Based NPOs to continue to be a vibrant part of communities nationwide. Following her analysis of the Son of a Saint (SOAS) mentorship program for young fatherless boys in New Orleans, Miller claims that the male youth-focused NPO:

seeks to improve the lives of fatherless young boys through emotional support, development of life skills, increased community involvement, and the formation of positive peer relationships. . . [and] seeks to alleviate some of this risk by pairing boys with mentors, who serve as adult male role models to help fill the need created by the loss of the father figure. . . [and who] coordinate boys' activities and involvement at various community events. [16]

The efforts of SOAS are akin to those of the KBFF, in that while coaches are utilized to teach both boys and girls physical fitness, the coaches and other volunteers also strive to provide the youth under their charge with important skills and lessons and to motivate them in further career and personal development.

In many ways, NPOs like SOAS and KBFF are "filling the gaps" left by an apparent lack of government involvement. As Miller (2019) indicates, as a result the "number of community-

based, nonprofit organizations (NPOs) providing social services has grown so much that NPOs now outnumber state- or publicly- funded organizations responsible for administering youth prevention and intervention programs" [16]. This makes NPOs such as Kingdom Boxing Fitness Foundation which seek to increase the potential for positive adjustment and prosocial behavior whilst reducing negative outcomes and antisocial behavior significant contributors to the youth of their communities [16]. These Community Based Organizations (CBOs) target "multiple domains of youth functioning, including family relationships, school attendance/performance, peer relationships, and community involvement" [16]. As the nation has sought to recover from Covid-19, the need for these NPOs and CBOS to continue their hard and diligent work has increased as they have sought to assist families left in a tumultuous state regarding both childcare and economic forces.

The increase of CBOs and youth-based NPOs following the initial Covid-19 lockdown has increased the need to maintain their reach across their regions. As indicated by the Administration for Strategic Preparedness and Response (2023), the impact of the COVID-19 Pandemic will remain high for many at-risk individuals following the pandemic regarding their health, economic stability, and childcare needs [2]. As government resources to meet these needs are gradually exhausted, CBOs play an essential role in helping these individuals and their youth obtain critical services and support, allowing them to adjust to the COVID-19 era [2]. Specifically, CBOs and NPOs focused on providing a support network for the youth of their communities and their families stand out for their critical role in broadening sports access and provision of life skills, with community culture playing a central role in decision-making processes related to athletics programming. The KBFF's collaborative endeavors with organizations like the Jet Training Basketball Academy and Central Georgia Technical College underscore the power of inter-organizational relationships (IORs), which increases the impact Kingdom Boxing and its efforts can have.

### 2.2 Need for Volunteers Following Covid-19

During Covid-19, the need for volunteers to support NPOs and their efforts increased. As Ginger Abbot (2021) of LAProgressive indicates, Covid-19 significantly impacted NPOs and their financial and human resources [1]. This impact was largely due to the economic standstill and lag brought about by the pandemic, as well as the social distancing protocols put in place to stem the spread of the virus.

As the initial Lockdown was lifted, many NPOs felt the need to reach out to volunteers during the Pandemic, pursuing strategies that relied heavily on technological platforms even more than before. As a result, the evolving efforts employed by NPOs to both manage themselves and engage in community and volunteer outreach minimized face-to-face interaction requirements and maximized social media and other technologically based efforts due to social distancing protocols, including holding virtual meetings amongst administrative members and their teams [27]. Unfortunately, despite the additional efforts made at virtual communication, many NPOs like Kingdom Boxing have failed to experience the influx their strategies were geared towards providing, primarily due to the strain placed on the personal connections with donors and potential or current volunteers [27]. In many cases, this has resulted in the human resources of NPOs such as Kingdom Boxing Fitness Foundation being stretched thin by drops in acquisition and retention rates and increases in their communities' needs for their continued efforts.

Beaty and Gamboa (2023) emphasize the disproportionate number of volunteers available for NPOs concerning the increased need for their community presence in "Volunteering has been declining for decades, but the pandemic and economic struggles made it a lot worse: 'This is a wake-up call'". According to Beaty and Gamboa (2023), many NPOs have "been able to retain keeping the number of children [served] . . . fairly consistent. . . but [NPOS]. . . should have been increasing [volunteers]. . . [due to taking on] new counties [and responsibilities]" [4]. As a result, "It's reached the point where the lack of volunteers strains the safety net that nonprofits provide to many of society's most vulnerable" [4]. As the volunteer-to-youth ratio becomes strained for NPOs in the youth-based sector, the potential impact of the NPOs on the individuals they seek to assist becomes limited. As deduced from wider Georgia patterns, the essence of mentorship is in the depth and consistency of interactions between mentors and mentees. With the loss of the personal impact of these mentorships, various youths may be left in the lurch.

### 2.3 Factors Impeding Volunteer Acquisition and Retention in a Post-Pandemic Landscape

A study by Samad and Ahmad (2021) indicates that NPOs have historically faced challenges regarding lack of funds, trust, cooperation, and support. During COVID-19, these issues, as well as a reduction in volunteer engagement, have been increased, resulting in a need to study factors that may impact or impede volunteer acquisition and retention, two factors that are vital for NPOs' continued sustainability [23]. These latter factors are vital assets to NPOs whose greatest strengths are found in the willingness of others to invest their time, energy, and monetary resources for their common cause and the communities that the NPOs serve [23]. Studies regarding the factors that impede volunteer acquisition and retention focus on organizational factors, generational factors, and Person-Organization (P-O) fit.
In terms of organizational factors, Samad and Ahmad (2021) indicate that the following factors can influence volunteer acquisition, engagement, and retention: input, organizational capacity, output, and outcome. Of these factors, organizational capacity plays a pivotal role in determining volunteer engagement and satisfaction, leading to increased volunteer retention and volunteer recommendations to other community members regarding donating their time and financial resources to an NPO [23]. As Samad and Ahmad (2021) state, organizational capacity "reflects [an] NPO's ability to generate outputs or outcomes effectively" based on inputs requested and acquired from community outreach programs [23]. Therefore, organizational capacity is "perceived as important to achieving sustainability" [23]. The effectiveness of organizational capacity at promoting a sustainable NPO by providing outputs or tangible products and outcomes or public perceptions and nontangible effects of an NPO to societal and community standards aligned with the NPO's mission is an important aspect of volunteers' and communities' perceptions of an NPO as a viable organization worthy of investment.

An NPO's effectiveness regarding organizational capacity is determined by its value or supply chain's effectiveness in providing its services or products to the community within which it is based. If volunteers or potential volunteers observe that the NPO is effectively utilizing all of its resources to accomplish its stated mission, they will, as a consequence, be more inclined to not only volunteer and continue to contribute to the NPO but to encourage others to do so as well as active advocates [23]. It is important to understand that the effectiveness of a value chain for an NPO falls both on the tangible effects of the value chain and others' perceptions of its effectiveness. Because of this, the literature suggests that not only is the creation of an effective value chain vital for continued NPO success, but a level of transparency regarding the value chain and its success is also important.

NPOs such as Kingdom Boxing Fitness Foundation must contend with individual-based factors as well, namely generational factors, impacting individuals' likelihood to volunteer or continue to volunteer with an NPO. As a study by Choi, Lee, and Park (2023) indicates, there are marked differences in the tendencies of recent generational groups regarding their likelihood of volunteering their time and financial resources to NPOs. As defined by Choi and associates (2023), a generation is "a demographic cohort that lives in the same period and has experienced the same historical events" [7]. As the Baby Boomer (1946-1964) and Gen X (1965-1980) volunteers have gradually begun to cycle out of those available to afford their time and other resources to NPOs, those of the Millennial (1981-1995) and Gen Z (1996-2015) generations are becoming the target audience for NPO volunteer outreach. Therefore, it is important to understand the actions of these generations regarding volunteer engagement.

Unfortunately, Millennials (1981-1995) appear to be less interested than previous generations in volunteering. As Choi and associates (2023) highlight in their study, research has shown that due to various factors such as economic stability and lifestyle choices and events, the volunteer behavior of Millennials is divided between two contradictory sides of the cohort [7]. These two sides are referred to as the "self-centered" or "apathetic" "Generation Me" sector and the more "optimistic" and "community-focused" "Generation We" sector [7]. While the "Generation We" sector of Millennials is more likely to assist NPOs, Millennials in general appear to be primarily interested in "civil and health organizations and are less likely to engage in religious organizations than older generations" [7]. This stands in contrast to the Baby Boomer and Gen X cohorts. Because of the "Me/We" separation and studied aversion to religious-based organizations, it has become more difficult for NPOs to appeal to Millennials, and it is for that

reason that NPOs should make greater efforts to appeal to the Millennial and Gen Z cohorts moving forward.

A final factor that plays a part in determining volunteer interest in NPOs is Person-Organizational (P-O) Fit. According to Choi and associates (2023), P-O Fit posits that a fit needs to exist between individual and organizational characteristics and that this fit can influence volunteer attitudes and behaviors [7]. If an individual feels that an NPO's values and mission align best with their own, they are more likely to donate to the NPO in terms of time, energy, and resources. Conversely, if an individual feels that the values and mission of an NPO are not aligned with their own, they will be less likely to contribute.

### 2.4 Strategies for Increasing Volunteer Acquisition and Engagement

The literature has suggested various strategies for volunteer acquisition, management, and retention. These include marketing strategies for NPO branding, task management or optimization, and value fulfillment.

As with other businesses, the brand image of an NPO is its "face" to the public and to potential investors or consumers. An NPO's brand is meant to state its image, accomplishments, mission, and values. As Mitchell and Clark (2021) indicate, the presentation of an NPO's brand "is a powerful influence on the decision to volunteer" [17]. For NPOs, marketing their brand is especially important since:

Non-profit organizations (NPOs) need to attract resources to survive. These are not simply financial but, for many organizations, also include attracting and retaining volunteer time to enable them to deliver their mission. [17]

Therefore, marketing accomplishments and values to a target volunteer market comprised of individuals of both the Millennial and Gen X generations is an important part of NPO volunteer outreach strategy. This involves utilizing technological platforms for the conveyance of information and perpetual adaptation to what brand images appeal the most to the chosen volunteer base while remaining aligned with NPO values and missions.

In a study by Kaur, Smith, Pazour, and Schumacher (2022), the importance of task optimization and management in NPOs was analyzed. As a strategy for promoting organizational capacity and thus fortifying an NPO as an effective organization to its potential and current volunteers, Kaur and associates (2022) offer that through optimization, volunteers can be more motivated to invest their resources in NPOs such as Kingdom Boxing Fitness Foundation [13]. By utilizing a deterministic model to balance volunteer needs and values with organizational tasks, Kaur and associates (2022) posit that volunteer engagement and retention can be increased [13]. This strategy employs careful management and placement of volunteers and their resources to benefit not just the NPO but the volunteers as well. This not only gives the volunteers a sense of belonging and importance within an NPO's operations but also assists with P-O Fit as it caters to individual volunteers' skills and values in the pursuance of the NPO's mission.

The third strategy suggested by the literature for NPO volunteer acquisition and retention involves value fulfillment for volunteers. Despite fewer Millennials expressing interest in volunteering for NPOs, the work of Choi and associates (2023) indicates that a P-O fit between Millennial and NPO values can persuade more volunteers to devote time and resources to an NPO's cause [7]. Fait, Cillo, Papa, Meissner, and Scorrano (2021) work supports the strategies Choi et al. suggested (2023). According to the Fait et al. (2021) study, a focus on providing

volunteer-valued intellectual capital and value fulfillment is important for NPOs seeking to maintain volunteer engagement and retention [8]. By prioritizing in Knowledge Sharing Intention (KSI) and Volunteer Employee Engagement (VEE), the model suggested by Fait and associates (2021) emphasizes that by offering something of value-intellectual capital and value fulfillment- to volunteer employees as well as the youth who youth-based NPOs are primarily geared towards assisting, NPOs can further drive volunteer engagement and improve their sustainability [8]. This involves offering multiple opportunities for intellectual interaction and monitoring overall volunteer satisfaction while operating within the NPO.

## **3.0 METHODOLOGY**

To gather insights into the experiences of volunteers at Kingdom Boxing Fitness Foundation, we developed the Kingdom Boxing Volunteer Experience survey. This tool was crafted to collect demographic details and explore volunteers' expectations, ambitions, perspectives, and plans about the youth-focused non-profit organization (NPO), including its mission and values. Created with Survey Monkey, the survey was disseminated for volunteers to fill out anonymously.

The survey aimed to fulfill two main goals. The first was to map out the demographic profile of volunteers engaged with the Kingdom Boxing Foundation. The second goal was to unravel their motivations and future intentions regarding their volunteer work. Understanding these elements enables the current study to design targeted interventions and strategies. These are intended to resonate with the volunteers' motives and preferences, thereby enhancing the development of a robust and enduring volunteer acquisition and retention model. This model is envisioned to be beneficial not only for Kingdom Boxing but also for other youth-oriented NPOs.

The survey questions were designed along six distinct sections, each tailored to draw insights on specific domains identified in the volunteer model. The sections are as follows:

- **Demographics**: This section collated information on each respondent's background, encapsulating age group, gender, educational qualifications, and current professional standing for each individual.
- **Training**: This section was centered around discerning the efficacy of existing training protocols, identifying gaps, and eliciting feedback for enhancement regarding Kingdom Boxing Fitness Foundation.
- **Retention**: The crux here was to unearth the elements that anchor volunteers to the foundation and to understand potential challenges or pain points they might encounter.
- Feedback and Adaptation: This portion was devised to gauge existing feedback mechanisms and observe the foundation's adaptability based on the input from volunteers.
- **Transition/Alumni:** The questions here were crafted to understand the alumni and transition experience, emphasizing the possibility of a sustained association even postactive volunteering.
- **Motivations and Intentions:** A pivotal section focused on understanding the deep-seated reasons propelling individuals to volunteer with the foundation.

We commenced our research for the Kingdom Boxing study with a preliminary pilot survey distributed among a select group of volunteers. This initial step was crucial to evaluate the clarity and relevance of the questions we intended to ask. Upon reviewing the feedback from this group, we refined the survey to better align with the study's goals before launching it on a larger scale. The data thus collected was integral to our analysis.

In the next phase, we compiled all survey responses for a comprehensive analysis. We employed advanced statistical tools to ensure a rigorous examination of the data. The initial assessment used descriptive statistics to outline basic trends and patterns. Subsequently, we applied inferential statistical techniques to uncover deeper relationships and to deduce potential causative factors.

Ethical integrity was paramount throughout this research process. We guaranteed anonymity to all volunteer respondents to maintain the confidentiality of their contributions. Before their participation, we provided a thorough briefing about the survey's purpose and obtained their informed consent. We emphasized the voluntary nature of their participation, affirming that they were under no obligation to partake in the survey.

#### 4.0 RESULTS

This study conducted the Kingdom Boxing Volunteer Experience survey among the current volunteers of the youth-oriented non-profit organization Kingdom Boxing Fitness Foundation (KBFF) in Warner Robins, Georgia. We collected anonymous responses on demographic variables and volunteers' experiences, expectations, and aspirations related to the NPO, including its mission, values, events, and management. Using Survey Monkey, we analyzed the data to identify the volunteers' demographic patterns and understand their motivations and experiences. This information was crucial for developing a comprehensive model of volunteer acquisition, engagement, and retention that can be adopted by various youth-based NPOs, extending beyond the scope of KBFF.

The first demographic analyzed for the sake of the present study was the predominant age ranges of the Kingdom Boxing Fitness Foundation's volunteers. As shown in Figure 2, the ages of the respondents ranged from under 18 years old to 44 years of age.



Figure 2: Ages of Respondents

Source: Kingdom Boxing Volunteer Experience Survey

As shown in the figure, the age demographic with the highest level of representation amongst Kingdom Boxing volunteers was under 18 years of age at 45%. The under-18 demographic was followed in quantity by the 25-34 demographic at 33%, then the 35-44 demographic at 16%, and finally, the 18-24 demographic at 6%. One of the foundational goals of the Kingdom Boxing Fitness Foundation was to design a mentorship structure wherein individuals positively impacted by the program's mentors would eventually transition into mentor roles themselves. This aspirational model seems substantiated by the age demographic data in that the data displays a robust younger demographic engagement, with 45% of respondents being under 18, 33% between the ages of 25-34, and the remaining 16% within the 35-44 bracket. However, the data also shows a sharp cut down in volunteer representation when it comes to the 18-24 age group, where the 45% representation experienced by those under 18 declines sharply to 6%, suggesting a significant dip in volunteer engagement until representation picks up again in the 25-34 age bracket.

According to the surveys, the monthly Youth Game Nights hosted by the organization serve as a primary catalyst for drawing new, younger participants of the under-18 demographic bracket. The survey's dominant younger demographic further reinforces this event's popularity among a younger audience.

Another noteworthy outreach initiative of the foundation is the annual back-to-school backpack and school supplies giveaway community event, often occurring at summer's end. This event ranks as the second most potent incentive for individuals associated with the organization. While the Youth Game Nights appeal to the younger demographic, the backpack and school supplies giveaway appeals more to the 35 and over age brackets. These events and age demographic data underscore the organization's strong alignment with its vision of fostering a mentor-mentee continuum in its community, actively involving youth and middle-aged and older adults in its mission. Additionally, the 2023 Thanksgiving Can Drive hosted by Kingdom Boxing drew an older demographic by incorporating the parents of the youth reached by the organization. The backpacking events, along with the can drive each, have been outreach opportunities to increase the involvement of the 25-44 age brackets, which made up 49% of survey respondents.

Figure 3 provides a detailed insight into the educational attainment levels of participants associated with the Kingdom Boxing Fitness Foundation's programs.



Figure 3: Education Level of Respondents

Source: Kingdom Boxing Volunteer Experience Survey

The demographic data regarding education levels among Kingdom Boxing volunteers revealed a significant spread across the educational spectrum, with 45% indicating some high school education and 33% possessing a Bachelor's degree or higher. Meanwhile, 22% of respondents had completed high school or obtained a GED. This variance in educational attainment indicates a wide array of knowledge and experiences within the volunteer base. However, it also suggests a smaller representation of individuals with only a high school diploma.

In terms of sports engagement, the data was revealing. Although Kingdom Boxing originated as a sports-centric organization, the survey responses regarding participation in competitive sports during high school were split. This finding is particularly insightful given the foundation's efforts to incorporate sports, such as basketball, into its mentorship programs, hinting that many volunteers are drawn to the organization for career and personal development opportunities, not just sports. The survey also shed light on the volunteers' personal goals. Half of the participants volunteered to socialize and forge new friendships, while one-third were motivated by the chance to work with youth. A dedicated 16% were inspired by the opportunity to contribute to their community.

Previous involvement with NPOs, especially those serving young people, was prevalent among respondents, with 66% having prior nonprofit experience, enriching the volunteer pool with their diverse backgrounds. Additionally, there was unanimous willingness among respondents to serve in supervisory capacities, with all indicating a readiness to chaperone events such as Youth Nights and field trips.

Furthermore, the survey collected data on the roles held by respondents at Kingdom Boxing Fitness Foundation or other NPOs at the time of the survey, details of which are presented in Figure 4. This information contributes to a more nuanced understanding of the roles and responsibilities that volunteers are willing to assume, which is essential for shaping an effective volunteer model.



Figure 4: Past Experiences with NPOs

Source: Kingdom Boxing Volunteer Experience Survey

Delving into other roles respondents have held in NPOs provides a clearer picture of their expertise and their expectations for how they may contribute to NPOs. Aspects of that picture are displayed in Figure 4 and listed below:

- 33% have undertaken an administrative role, such as chair, secretary, committee member, Club Captain, or even President.
- 33% have provided practical assistance, such as transporting children and youths for events, stewardship roles, or aiding with sports kits and equipment.
- 16% have taken on the responsibilities of a team coach or leader.
- Another 16% have experience acting as chaperones for youth-oriented events or activities.

All the data gathered provides an understanding of the caliber of Kingdom Boxing's volunteers and contributes to the formation of a Volunteer Acquisition and Retention Model for youth-based NPOs to boost engagement in well-represented and under-represented demographics through various strategies.

### **5.0 DISCUSSION**

The insights gleaned from the Kingdom Boxing Volunteer Experience Survey shed light on the profile of volunteers that the organization attracts and highlight potential enhancements to the volunteer acquisition, management, and retention frameworks applicable to Kingdom Boxing Fitness Foundation and other youth-centric non-profit organizations (NPOs).

A primary observation from the survey is the concentration of volunteers in the under-18 and 25-plus age groups, accounting for 94% of the survey participants. These volunteers typically encompass high school students, early college attendees, or middle-aged adults, possibly at the outset of their careers or actively parenting. This distribution underscores Kingdom Boxing's connection with younger individuals and more established adults.

However, there is a noticeable engagement gap with the 18-24 age demographic—those transitioning into higher education or the early stages of their careers. The data suggest that while current strategies resonate with the well-represented age groups, there is an opportunity to refine outreach efforts to better connect with this crucial young adult segment.

The educational demographics of the volunteers further underscore this opportunity. With a considerable portion of the survey's respondents either possessing some form of high school education or advanced degrees, the young adults who may be currently in college or have yet to pursue higher education are the least represented. This indicates the potential for Kingdom Boxing Fitness Foundation to develop more inclusive and attractive initiatives for individuals within this educational bracket.

Moreover, the survey intimates that volunteers look beyond basic participatory roles, showing a strong interest in leadership, management, and administrative positions within the organization. This is a significant indicator that volunteers aspire to contribute at a higher level and are seeking avenues for greater involvement and responsibility.

These insights have been instrumental in formulating a Post Covid-19 Pandemic Revised Volunteer Acquisition, Management, and Retention Model. This model is designed to enhance the rates of volunteer acquisition, retention, and engagement for youth-based NPOs and community-based organizations (CBOs), including the Kingdom Boxing Fitness Foundation. The details of this model are presented in Figure 5 and aim to serve as a comprehensive guide for bolstering volunteer participation in a post-pandemic era.



Figure 5: Post Covid-19 Pandemic Revised Volunteer Acquisition, Management, and Retention Model

#### Source: Furtney

As indicated, one of the first strategies that can be employed to boost Volunteer Acquisition, Retention, and Volunteer-Based Enlistment in Youth NPOs is the utilization of social media to encourage communication regarding events, both group and individual volunteer efforts, volunteer opportunities, volunteer benefits, and community support events (such as can drives and backpack drives). In the current technologically driven age, social media offers an efficient and transparent communication platform to reach potential and current individuals with important information regarding NPOs, and often proves to be a much faster communication line than news broadcasts, newspapers, or word-of-mouth. This makes social media platforms such as Facebook, YouTube, Instagram, Twitter, Pinterest, LinkedIn, and TikTok important aspects of NPO marketing regarding brands, missions, efforts, and values [3]. By informing others through posts, videos, photos, "story" updates, and reels about upcoming events, NPOs can boost community awareness regarding their efforts and overall impact [5]. The reduction in costs in advertising that comes with social media further cements it as a viable option for boosting community awareness of NPO efforts.

In addition to boosting community awareness, social media allows NPOs to recognize volunteers' impacts and efforts within their organization. This is important for boosting volunteer acquisition, engagement, and retention. As Forbes (2023) indicates in "How To Keep Nonprofit Volunteers Engaged In Your Nonprofit's Mission," apart from recognizing volunteers' values and applying their unique skills efficiently, positive feedback and recognition are important aspects of NPO practices that boost volunteer engagement and retention [10]. By recognizing volunteer efforts and assistance by actively listening to their suggestions, providing regular communication and feedback, affording them a sense of ownership, showing them the NPO and community impact of their hard work, expressing gratitude for their efforts, helping them feel pride for what they do, and encouraging them to post stories about their NPO experiences online, NPOs assist volunteers in feeling connected and vital to the organization and its efforts through social media communication [10]. Merely encouraging volunteers to re-post NPO-originated news regarding upcoming and current events and opportunities or to tag the NPO's social media page to their posts can further boost the feeling of inclusion volunteers experience as a part of the organization [25]. By encouraging reposting NPO content or tagging NPOs in original posts, the organization implies that volunteers are not only important to the NPO, but the networking connections they have to offer the NPO are also important. This

increases the volunteer's self-efficacy as a member of the NPO and encourages them to reach out to others who may be interested in assisting the NPO.

The second strategy of the model involves maximizing face-to-face interactions at NPO facilities, events, and career fairs, as well as on news broadcasting stations to perform many of the tasks that social media allows smooth communication for. While technological advances pave the way for social media marketing and communication, the person-to-person advantage that traditional face-to-face interactions offer youth-based NPOs is still of valid importance. As First Nonprofit (2014) emphasizes in "The continuing importance of face-to-face interactions for Nonprofits," despite the ease of communication offered by social media processes, face-to-face interactions still provide value for NPOs [9]. This is primarily because face-to-face interactions offer various key benefits to NPOs and their volunteers.

As "Face-To-Face Meetings: 9 Benefits and Why They're Important" highlights, there are nine key benefits that Face-to-Face meetings offer any type of organization, including NPOs. The first is the benefit of interpreting nonverbal cues [12]. While video and photo posts can assist viewers with understanding the nonverbal cues from the individuals posting NPO content, the interpretation is severely one-way and limited. Despite seeing how many times a post is viewed on some social media sites, NPOs rarely can see volunteers' or other viewers' true reactions to the posts outside of pressing a "like" or "love" icon on a computer or phone screen. Face-to-face interactions give NPOs more information on how they are being interpreted and allow them to adjust their strategies quickly.

The second benefit of face-to-face interactions is spawned from the back-and-forth that these interactions permit. This benefit involves the formation of new ideas, a process that can be relatively stagnant through the usage of technological methodologies dependent on individuals'

internet access and temporal availability [12]. The mentioned limitation of technological communication's need for internet access leads to the third benefit of face-to-face interactions, in that technological access or fluctuations in access have minimal effect on face-to-face interactions outside of any necessary usage of technology to set up meetings or other face-to-face events [12]. The fourth benefit is building new relationships, which is easier to do when one can put a face to a name or organization [12]. Often, building relationships is assisted with the next listed benefit of small talk allowance [12]. Utilizing technological communication methods can streamline conversation to focus on pertinent matters. Unfortunately, this can also limit small talk as individuals feel obligated to stay on topic. While social media does assist with adding small talk to virtual conversations, thus breaking any tension with moments of levity needed to ease the ebb and flow of conversation, face-to-face interactions historically have bolstered small talk and permitted for deeper connections and conversations.

The sixth, seventh, and eighth benefits go hand in hand, much like the fourth and fifth do. These involve the addressing of sensitive issues, which may be best-handled face-to-face, effective communication regarding any concerns or issues the potential or current volunteer may have with the NPO's values and mission, and limiting other distractions such as additional social media conversations, posts, or tabs that could be open on a phone or computer [12]. All these lead to conversations that may include necessary relationship-building small talk which will ultimately address the primary purpose of the conversation of providing information regarding an NPO's goals and efforts in its community.

The final benefit that face-to-face interactions offer an NPO is the ability to increase participation and engagement [12]. By devoting time to interacting with their prospective volunteer(s) face-to-face, an NPO informs them nonverbally that they prioritize their volunteers

and are willing to devote resources to engage with them and inform them about their organization's goals. Often, this encourages volunteer(s) to reciprocate with engagement to some degree. All of the listed benefits carry with them the ability to cement an NPO in the minds of current and potential volunteers and foster current and future engagement regarding their mission and goals. When combined with social media strategies, the emerging hybrid approach can assist an NPO in reaching more members of its target volunteer market.

The third listed strategy in the Volunteer Acquisition, Management, and Retention Model is a strategy already utilized by multiple organizations. This strategy involves including carefully considered training courses in both volunteer onboarding strategies and transitioning volunteers from one role to another within an NPO. This training, akin to training frequently utilized by forprofit organizations, is meant to inform individuals about their roles in an NPO and the goals of the NPO as it prepares them to work for an NPO. As indicated by Nick Wood (2023) in "Post-Pandemic: Rebuilding Your Volunteer and Financial Base", this training can take on multiple forms, ranging from a pamphlet or online tutorial to face-to-face interactions and classes [26]. While covering safety topics and certifications as needed, the most important role of the training is to inform individuals about an NPO and how important their role will be in it.

Formal training emphasizes a volunteer's contribution to the NPO and its importance. It can show them paths within the NPO where they can move to different roles and grow professionally and personally if they wish. These are two important factors that impact volunteer engagement that training programs can offer [19]. Raj (2023) further emphasizes the benefits of providing training and resources to volunteers and preparing them for larger roles [22]. This strategy implies to the volunteer that the NPO views their relationship with the volunteer as part

of a long-term strategy and pursuit, thus adding value to the relationship and prioritizing it in the volunteer's mindset.

The fourth strategy involves having successful alumni volunteers and individuals that the NPO has assisted return to the NPO to inspire and advise current volunteers and individuals that the NPO seeks to impact. As Tanvi Patel (2022) states in "Alumni Engagement Strategy & Best Practices: 9 Top Ways to Nurture Your Network", a maintained alumni engagement strategy offers three primary benefits to an NPO. These include the following: bringing tangible benefits to your organization (funds, career guidance to current volunteers and individuals assisted by the NPO, and high attendance at events), creating a network of individuals linked by one common cause, and helping individuals with life advice, career advice, and job prospects [20] . Additionally, having successful alumni or third-party individuals linked to the NPO speak at events emphasizes the NPO's impact on individuals and its importance in its community.

The fifth strategy of Town Hall Meetings is geared towards actively engaging with volunteers and providing P-O fit to Millennial and Generation Z individuals who make up a generous amount of the 19-34-year-old age demographics that youth-based NPOs like Kingdom Boxing Fitness Foundation seek to reach for volunteer recruitment, acquisition, and engagement. By offering volunteers the opportunity to congregate, collaborate, and mediate over potential upcoming events, current NPO processes and goals, and NPO internal structures and functions, Town Hall Meetings offer Millennials and Gen Zers the opportunity to feel integrated and involved with an NPO, its methodologies, and its actions. The processes of collaboration and integration are highlighted by Lan Ha (2021) in "New Strategies to Engage Millennials and Generation Z in Times of Uncertainty" as being of importance when it comes to promoting engagement with Millennials and Generation Z [11]. By feeling as though they have influence

and can invest their ideas in an NPO whose values already appeal to them, these two generational demographics feel more inclined to invest time and financial resources in NPOs and their causes. This process of co-creating with internal stakeholders and actively listening to their ideas is also promoted as a volunteer engagement strategy in "What are the best practices for designing user experiences for non-profit organizations?" [14]. Town Hall Meetings also permit NPOs to gauge what their volunteers value the most regarding NPO efforts and to attempt to align their mission and upcoming events with those values.

The sixth and final strategy mentioned in the model involves extending outreach opportunities to appeal to all target age groups. Like Kingdom Boxing Fitness Foundation, most youth-based NPOs have many events that would appeal to their Youth, such as Youth Shut-Ins, Nights, Fundraisers, and Trips. Additionally, most youth-based NPOs have several events that appeal to parents who wish to be involved with NPOs and Community-Based Organizations, such as Backpack Drives and Canned Food Drives. Because of this, many youth-based NPOs experience many volunteers in the 17 and under and 25 and over age demographics whilst experiencing a severe decline in their volunteers within the 18-24 age group, which traditionally involves college students and individuals seeking to begin their career journeys. Because of this, the sixth strategy is geared towards maintaining outreach efforts already in place while implementing new outreach efforts to appeal to the college student age demographic.

There are three main ways that NPOs can appeal to college students. These include working with educational institutions and their students to provide resume-building internships, sending spokespeople and representatives to college career fairs and events, and working closely with higher-education student organizations whose missions and values align with the NPOs. The first method of offering internships to students appeals to undergraduates and graduates

attempting to build their resumes before graduation. For these students, especially those seeking careers in management, social work, or political activism, an internship with an NPO can provide them with valuable work experience to list on their resumes. It can provide the NPO with a valuable, skilled volunteer [21]. Therefore, NPOs should contact local institutions to create this win-win scenario.

The second way NPOs can appeal to college students involves sending spokespeople and representatives to college career fairs and events. For students, a career fair is an open field of guidance, consultancy, and exploring multiple career options [24]. They offer students an opportunity to practice their public speaking skills, garner knowledge about available jobs and internships in their chosen career path, and explore opportunities for growth in their chosen industry, all while gaining career and resume-related advice [24]. Because of these benefits, many students attend career fairs open to the knowledge they may garner. This makes career fairs an excellent opportunity for NPOs to send representatives to campuses to interact with students, represent their NPO's mission and values, and persuade students to volunteer for NPOs to boost their resume and job portfolio. As more jobs require experience and a graduate degree for applicants to be seriously considered, the likelihood of students recognizing the benefit of adding an NPO volunteer position to their resume has risen in recent years.

The final method NPOs can utilize to reach college students involves contacting student organizations and clubs at local institutions and coordinating with them regarding events and community support initiatives. Many student organizations and clubs that are formed in support of political or social causes, like NPOs, are made up of individuals willing to volunteer their time and effort to support events that align with their values [15]. By this notion, NPOs have an opportunity to create collaborative, large, and impactful events through coordinated efforts with

student organizations. Furthermore, they have a great chance of recruiting student organization members to volunteer for their NPOs even after the collaborative events have been completed.

#### **6.0 CONCLUSION**

In conclusion, the Post Covid-19 Pandemic Revised Volunteer Acquisition, Management, and Retention Model depicted in Figure 5 encapsulates a forward-thinking approach for youthbased non-profit organizations (NPOs) navigating the new normal. This model synthesizes strategic insights and pragmatic actions derived from the recent experiences of organizations like Kingdom Boxing Fitness Foundation, tailored to address the evolving landscape of volunteer engagement.

The model underscores the imperative of leveraging social media as a dynamic communication, connection, and recognition tool, tapping into the potential of digital platforms to reach a diverse volunteer base. It also acknowledges the power of face-to-face interactions in fostering meaningful relationships, nurturing trust, and facilitating candid dialogue—elements that remain irreplaceable even in an age dominated by technology.

Crucially, the model advocates for comprehensive volunteer training, which equips individuals with the necessary knowledge and skills and a deeper understanding of their vital role within the organization. It showcases the invaluable impact of involving alumni and successful volunteers in inspiring and mentoring the current and prospective volunteer workforce, creating a continuum of engagement and a living testimony to the organization's impact.

Town Hall Meetings are presented as a platform to empower volunteers, particularly from the Millennial and Gen Z cohorts, ensuring their voices are heard, and their contributions are integral to the organization's mission and direction. This aligns with a more inclusive and participatory organizational culture that resonates with younger generations.

Finally, the model calls for a strategic outreach extension, particularly towards the 18-24 age demographic, underscoring the necessity to align volunteer opportunities with the aspirations and developmental stages of college students and early-career adults. By doing so, NPOs can bridge the gap in volunteer demographics, creating a robust, versatile, and sustainable volunteer base.

Reflecting on this model, it is clear that the post-pandemic world requires youth-based NPOs to be adaptive, innovative, and holistic in their approach to volunteer management. By embracing this comprehensive model, organizations can not only recover from the challenges posed by the pandemic. Still, they can also thrive, enhancing their capacity to serve their communities and fulfill their mission in an ever-changing world.

### 7.0 LIMITATIONS OF STUDY AND OPPORTUNITIES FOR FUTURE RESEARCH

This study endeavors to craft a detailed framework for boosting volunteer acquisition and retention for youth-based non-profit organizations (NPOs). However, it encounters specific limitations that circumscribe its findings:

• Firstly, the scope of the survey. The survey administered to Kingdom Boxing volunteers incorporated various demographic details and queries related to volunteer experiences. Yet, constraints on the number of questions set by the Survey Monkey platform meant that while the survey yielded relevant data, it did not cover as extensively as desired the motivations behind volunteerism and the quality of the volunteers' experiences. Future studies could employ alternative platforms allowing a broader range of questions to deepen our understanding of volunteer experiences at Kingdom Boxing Fitness Foundation.

• Secondly, the survey's distribution frequency. The survey, tailored for this study, had a single deployment outside its initial test phase, capturing only a snapshot of the volunteers'

perspectives at that time. For a richer, temporal insight into volunteer experiences and to assess the impact of volunteer outreach initiatives, the survey could be distributed periodically, such as quarterly. This would allow for tracking changes in volunteer engagement and sentiment over time, providing actionable feedback to refine the proposed volunteer model.

• Lastly, the sample size and data breadth. The current study was limited to survey data from Kingdom Boxing Fitness Foundation and existing literature, which narrows the data pool in forming the revised Volunteer Acquisition and Retention model. Future research should consider exploring volunteer strategies across a diverse array of youth-based NPOs at both state and national levels. Such an expansion could offer a more robust view of volunteer engagement strategies, potentially enhancing the model's relevance and applicability across various youth-centric organizations.

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## **URGENCY & ADAPTABILITY: A PRACTICAL MODEL**

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## ABSTRACT

Adaptability is a vital characteristic in an unpredictable environment, and the current business environment is quite unpredictable. Through foundational research in the Complexity Leadership model, a new model is developed to visualize the relationship between adaptability and urgency in various business environments. Along with this model are three broadly defined leadership styles to allow businesses to gauge their location on the Urgency Adaptability curve: absent leadership, enabling leadership, and bureaucratic leadership. The final goal of this model is to allow businesses to visualize their current level of adaptability and adjust to move along the curve toward optimal adaptability. Methods for shifting along the curve revolve around manipulating company culture and creating employee incentives for rewarding certain behaviors. An application is also drawn from the historic and present time U.S. textile industry.

## **OPENING REMARKS**

Throughout history, leadership has been the center of attention for business academia. Many of the well-known names in management theory history have studied leadership and its relationship to other outlets of varying business environments. The amount of unique defined leadership styles itself makes it clear that leadership has been a primary topic of study for decades, and it continues to be a foundational concept in these papers and developed models. Through the connection to "urgency," broad leadership styles will be defined, a model will be provided, and tools will emerge for businesses and their leaders to utilize to achieve a more adaptable future. Application will also be drawn through the past and present of the textile industry in the United States. It is imperative that research surrounding business leadership contain beneficial and practical tools for business leaders to inspect, critique, research, and use. This is the only way that academia in business leadership can prove itself helpful to a practical and realistic business audience. This motive of practicality has driven this model to produce meaningful diagnostics for businesses, thus proving itself helpful. This model constructed of urgency, adaptability, and defined general leadership styles provides helpful information to businesses and generates a visual representation of these concepts.

## **TRADITIONAL VIEWS**

The development of management strategies is never a clean and cut process, but a process more accurately described by trial and error, and even at times a disconnect between academia and

industry. Given the goal of this research initiative is to begin the process of providing applicable and usable management strategies instead of focusing on theory apart from reality, there is a gap which must not be neglected between academia and industry. Along with a foothold on this overall purpose, the depths of academic material must be explored which create valuable foundations for applicable management theory. Without academic foundations and explorations, management theory in industry would only arise through trial and error, and may be more susceptible to the flowing changes of societal opinion. With scientific and academic foundations, however, these theories can be upheld through research and analysis regardless of societal ideologies or selfish business motives. This research can only exist, therefore, through the theorists who have dedicated their studies to management theory and practice.

Of the many business management theorists that arise in discussion, there are a few which have published necessary materials in understanding the various theories surrounding a business's ability to adapt and react to change in any given environment. Chester I. Barnard created management theory surrounding the individual and concern for their welfare [1, p. 1003]. In relation to this study, this can apply to the ways in which employers use, or choose to not use, employees for the purposes of positioning the organization in a way to react properly to change. This may mean using more employees to increase the company's ability to react to internal and external changes, or using less employees to achieve lean operations. When using more employees, the organization would be allowing more employees the opportunity to work in return for standard hourly wages or overtime. In the latter example, this could be granting employees more vacation time. In both of these scenarios, the organization can be seen as one that is pouring into the welfare of its employees, and empowering them on an individual basis. In the same instance, both of these scenarios are ways that any given organization can adjust its ability to adapt and react to change, thus making this theorist's ideas vital in understanding the theory derived through this study. As they are part of the Triple Bottom Line, people are vital for an organization, thus using them to achieve your goals is no simple change or application, but one with consequences and rewards alike.

Barnard also made it a point to utilize the promotional system of any given organization, thus pouring further into individual employees and, ideally in turn, increasing the individuals productivity and contributions to the organization. Put simply, if organizations reward, or invest, in employees, then they will invest themselves back into the company. This model worked well in the past, especially in labor markets where almost all individuals were job-[seeking and showed higher levels of self-motivation [1, p. 1003-1004]. Barnard's theories have also focused on a concept known as the Zone of Indifference. This concept, along with other theories from Barnard, focuses on the individual and their perception of authority in their respective organization and workplace [1, p. 1004]. This perception of authority is thought to greatly influence an individual's desire to comply with company standard, organizational best practices, and the requests of their given superior. It is not likely that an individual with a lesser view of the value of authority will fully and properly comply with the authority under which they find themselves. An organization's ability to adapt may be affected by an individual's choices to obey, or disobey, authority in various business environments. While Barnard took to the individual, other business management theorists such as Fredrick W. Taylor focused more heavily on the whole, or society at large [1, p. 1003].

The management theories of Taylor were heavily focused on the entire organism rather than individual needs. The closest his theories ever came to individualism was the high value that he placed on education. Taylor presented a main point in promoting the value of higher education among individuals in the workplace, however his motivations were primarily centered on the benefit of the organization rather than the benefit of the individual [1, p. 1005]. His overall goal in business management theory was to understand the overarching societal benefits of a wellworking system, thus leading to lower levels of individualism within his models. This push away from the celebration of the individual led to a heavier focus on cooperation within his theories, encouraging employees and other resources to work together to achieve an organizational goal, rather than to explore the ideas of the individuals involved. Relying this heavily on company goals rather than gaining an understanding of individual employee's ideas can have a great effect on the organization's ability to adapt and react within a quickly changing business environment. If any given company is focused too heavily on organizational goals rather than listening to experienced employees, the company may lower their adaptive position, and in turn lower the rate at which they react to change. In past business environments and labor markets, these two theorists, Barnard and Taylor, have produced some of the foundational thought behind business management theory, and these concepts can be used as a starting point for further exploration in this study's dissection of adaptability, and an organization's rate of reaction to change. It is vital, however, to maintain the understanding that these theories are still very fallible, and that they cannot be relied on to their fullest extent.

# A MODERN APPROACH

The foundational research on which this paper will adjust and expound was developed by Mary Uhl-Bien and Michael Arena, who have developed a more clear understanding of adaptability and its related variables. Understanding parts of this foundational research is necessary to understanding the relationships within the model constructed in these papers. The model developed by Uhl-Bien and Arena, coined the model of "Complexity Leadership," focuses on different defined leadership styles and how they relate to levels of "emergence" [3, p. 9]. The Complexity Leadership model shows that as levels of emergence increase, the leadership styles evolve from entrepreneurial leadership, to Enabling Leadership, to operational leadership [3, p. 15]. These three leadership styles create a spectrum on which every business can place themselves. This model is very helpful for businesses who desire to learn more about their current adaptability, and want to find ways to be more adaptable. The model developed in these papers, the "Urgency Leadership" model, adjusts these leadership styles, and explains changes in leadership as levels of urgency increase both within an individual organization, and even within an entire industry. As previously explained, the goal of any management theory or model should be to provide a useful tool to practical businesses and their leaders. This developed model will give businesses the opportunity to understand the relationship between leadership and urgency in the workplace and more broad business spaces.

The Complexity Leadership model relates three defined leadership styles to the concepts of "emergence" and "adaptability" [3, p. 10]. Entrepreneurial leadership is defined by its use and leveraging of novelty to "capitalize on opportunities" [3, p. 16] This style of leadership has little

to no "rich interconnectedness" and boasts little complexity [3, p. 9]. Entrepreneurial ideas correlate with low levels of emergence as well, which is caused by its lower levels of interconnectedness [3, p. 15]. Emergence is a concept described as various interactions causing unexpected outcomes, so when more interconnectedness is present, levels of emergence may rise [3, p. 10]. On the opposite side of the emergence spectrum lies Operational Leadership, identified by its rigid structure and bureaucratic processes. This style of leadership focuses on control and structure, so while it boasts high levels of rich interconnectedness, it does not provide optimal room for adaptability [3, p. 11-12]. In between these two styles, however, is "Enabling Leadership" [3, p. 14]. This leadership style holds the position containing optimal adaptability, with medium levels of emergence and rich interconnectedness. The relationships between these leadership styles and levels of adaptability are the foundation for the Urgency Leadership model, though adjustments have been made to better present ideas for the purposes of bettering leadership and business adaptability through urgency. The Complexity Leadership model, however, does not contain the variable of urgency within an organization or industry, even with urgency being a primary driving force in many business environments.

# THE URGENCY LEADERSHIP MODEL

The concept of urgency in business leadership carries much weight in determining the culture and processes of any given firm, so it is vital for an organization to understand their respective level of urgency and how it affects their standing within their business environment and industry. It can be defined as the need for quick and accurate decision making for the purposes of this model, and in many businesses this can greatly affect operations. As urgency changes, many aspects of an organization change in accordance with these shifts. The two variables that shift with urgency are adaptability and leadership styles. Lower levels of urgency can cause a work environment with little to no rich interconnectedness, however this is not in relation to the entrepreneurial leadership style. This was a primary reason for an adjustment to the Complexity Leadership model for the purposes of measuring and understanding urgency. Entrepreneurial leadership must remain urgent, possibly even more so than other leadership styles given the volatility of entrepreneurial endeavors. Instead of an Entrepreneurial Leadership style, this portion of the Urgency Leadership curve describes Absent Leadership, one that carries so little urgency that goals are not met, and expectations are poorly defined. As urgency reaches the top of the spectrum opposite of Absent Leadership, the Bureaucratic Leadership style is more prevalent, with quick decisions and bureaucratic processes. Towards the middle of this urgency spectrum is an optimal level of urgency at which Enabling Leadership exists similarly to Uhl-Bien's model, and an optimal level of adaptability also exists. This spectrum, and understanding a business's place on it, are necessary to understanding said business's adaptability within its environment and industry. This adaptability is a primary tie between this Urgency Leadership model and the Complexity Leadership model. Both models develop management and leadership theories to support the effects to, effects of, and strategies for adaptability. Understanding adaptability through levels of urgency provides a new lens through which to understand a business's positioning in any given business environment.



The relationship between adaptability and urgency is a visually simple concept, however application becomes complex due to the infinite nuances of business leadership and variations of business environments. As levels of urgency within an organization increases, adaptability changes in a type of curve with its vertex representing a peak, or optimal, level of adaptability. This concept of adaptability can be defined as a business's position to optimize its ability to adjust to new environmental changes either within the business itself, within its respective industry, or within a global business environment [3, p. 15]. The Complexity Leadership model shows an adaptive space that can be created through the Enabling Leadership style, hence its name as it "enables" said adaptive space [3, p. 15]. The Urgency Leadership curve gives businesses a visual way of understanding their respective levels of urgency, their leadership styles, and thus their level of adaptability. The Urgency Leadership curve appears as a curve denoting the point along the urgency spectrum which produces both an Enabling Leadership style and the optimal level of adaptability. Moving away from the vertex of this curve in either direction produces lower levels of adaptability, however it can produce either higher or lower levels of urgency depending on the direction of movement along the curve. These lower levels of adaptability simply mean that a firm within these leadership zones are showing characteristics of one of two opposing leadership styles and urgency levels.

ABSENT	ENABLING	BUREAUCRATIC
LEADERSHIP	LEADERSHIP	LEADERSHIP
		<b>`</b>

# URGENCY

If the firm is showing lower levels of urgency, then they are on the left side of the vertex along the curve, and they are showing characteristics of Absent Leadership. This is defined by low levels of desire, or "drive," within management. With such low levels of urgency, the firm has no agility to reach a point of adaptability while maintaining an Absent Leadership style. On the opposite side of the urgency spectrum, the firm may be showing characteristics of Bureaucratic Leadership. This style of leadership is kin to extremely high levels of urgency to a point where processes and systems are developed to their most rigid state. These high levels of urgency mixed with a Bureaucratic Leadership style creates a space that restricts any ability to be adaptable as a firm. This rigidness flows from top to bottom, creating strict protocols and processes throughout the organization, thus hindering any possibility for adaptability in the

business environment or within the industry. In between these two extremes is the vertex of the curve, and the point of optimal adaptability. This point lies at a relatively ambiguous point on the urgency spectrum, and has proven itself difficult to determine. The ambiguity of this point is not due to the level of adaptability since the optimal level is the highest amount of adaptability possible. The issue lies within the urgency. As further explained, different industries may have different barriers to movement along the curve such as legal or other external factors. Understanding where this optimal point is on the curve, and in relation to a business's industry, is vital in the process of helping businesses move in the right direction toward a more adaptable existence.

# **RIDING THE CURVE**

Strategies for moving along this curve vary and can be heavily dependent on, or influenced by, many variables such as industry type, legal protocols, and other factors outside of a firm's scope of control. It is important for a firm to understand how these factors affect levels of urgency prior to finding ways to move along the curve. First, however, strategies for moving along the curve regardless of these external factors vary greatly from changing company culture, to implementing adaptability checks for management and even ownership. For the purposes of these papers and this model, company culture will be the primary candidate for change. For firms who find themselves in the Absent Leadership section of the curve, strategies for moving toward optimal adaptability and increased levels of urgency may revolve around promoting more "drive" or desire for quality and structure within the organization's culture. Changing company culture can be a daunting task, however this change can drastically move a firm along the Urgency Leadership curve, and bring the organization closer to the point of optimal adaptability. Finding ways to increase urgency will also increase your levels of adaptability if you are on the left side of the vertex, within the Absent Leadership style portion of the curve. Increasing your levels of urgency can be done by changing company culture as previously stated, or more specifically, providing incentives to individual employees for speed, accuracy, and quality of work. This applies concepts from Barnard's theories surrounding the welfare of the individual instead of a direct focus on the whole organization [1]. In this strategy, positive changes may flow from bottom to top, starting with individual employees to show characteristics of urgency in the workplace. Tactics revolving around increasing urgency are beneficial if the organization is already displaying lower levels, however when urgency levels are raised above a certain level, being the point of optimal adaptability, any possible benefits dwindle and the firm will enter into a Bureaucratic Leadership stage. This may result in the development of the negative characteristics of higher levels of urgency and become as unadaptable as firms with lower levels.

Firms with levels of urgency substantially higher than the optimal level of adaptability will develop a Bureaucratic Leadership style with a heavy focus on rigid processes, strict protocols, and little to no room for error. This constricts any ability to produce and cultivate an adaptive space, and may result in the organization's downfall from a lack of ability to adapt to changes in modern day technology or culture [3, p. 15]. In order to avoid such downfalls, firms must find strategies and tactics to move along this curve in the direction of the point of optimal adaptability. In the case of higher-than-desired levels of urgency, firms can still attempt to adjust

company culture by means of rewarding employees for developing new processes in ways that allow for more room for adaptability. This may, in turn, decrease the already extremely high levels of urgency. This area of Bureaucratic Leadership tends to prove itself difficult to shift at times, primarily because many industries hold businesses in this area due to previously mentioned external factors. Hospitals, for example, operate on very structured processes and protocols, many of which are legal requirements, thus creating a barrier to movement along the curve.

A barrier to movement along the Urgency Leadership curve refers to any outside factor or force that inhibits an organization's ability to fully manipulate adaptability through the manipulation of urgency within the organization. This may prove that an optimal level of adaptability for a hospital, and other businesses within certain industries, may exist through a hybrid leadership style between Enabling and Bureaucratic Leadership methods. This also enforces the reality that one business leadership model may not apply fully for all industries or business types, and emphasizes the necessity for further research on, and dissection of, the Urgency Leadership model in the future.

# **APPLICATION IN TEXTILES**

An application for the model can be found within the history of the United States textile industry. During the Antebellum period, specifically in the southeast, textiles were booming, and business was very much alive. In terms of payroll, almost 75% of all textile production existed within Alabama, Georgia, Mississippi, North Carolina, South Carolina, and Virginia [3, p. 12]. This boom in the south was caused by an exodus out of the north due to lower costs in southern states [3, p. 32]. The southern textile boom only lasted for so long, however, and many textile operations moved overseas. This was the result of cheaper labor markets found off-shore, so "industry lobbyists tried to focus attention on American mills that were being put out of business by foreign...competitors" [3, p. 41]. It can be clearly seen that there have been many factors going against United States-based textile organizations, so in a business environment that is constantly changing and shifting, adaptability is a primary key for success. This application of adaptability can refer to many different strategies to managing a business in this type of environment, such as moving operations to different global markets or even bringing a new product to the market to bring operations back domestically.

Not only is the need for adaptability clearly seen in history, but it can also be seen in more recent global events such as the COVID-19 pandemic. Glen Raven Custom Fabrics, LLC, based in Burlington, North Carolina, has proven to be an adaptable textile firm and continues to position itself in ways to remain an adaptable competitor in this ever changing market. During the pandemic, Glen Raven had multiple strategies to remain adaptive within its industry. First, the organization held both medium and long-term capital investments as a response to a change in demand caused by the pandemic. The demand for Sunbrella, a brand of Glen Raven specializing in outdoor fabrics, increased during the pandemic because many households were conducting home renovations and generated a demand for these outdoor fabrics. This is a prime example of Glen Raven remaining adaptable to changes in any given business environment; changes in

demand in this scenario. Glen Raven was also able to remain adaptive by sourcing external partners to supplement demand and delivery requirements. In all, according to an internal source of Glen Raven, these strategies for adaptability resulted in 20% more Sunbrella supplied to markets during the pandemic [2]. This is proof that remaining adaptable is key to success in a volatile business environment. The Urgency Leadership model can be used to further understand Glen Raven's strategies, by allowing viewers to better understand possible levels of urgency during the pandemic. Due to the firm's ability to remain adaptable and exist in an "adaptive space" [4], it could be theorized that Glen Raven was existing within an optimal level of urgency. This would mean not fully relying on novelty for sales, while also avoiding strict bureaucracy for systems and processes.

# **CLOSING REMARKS**

The Urgency Leadership model stands as a means for businesses and their leaders alike to locate their firm on the curve, and make decisions to lead the firm toward a more adaptive and optimally urgent future. Businesses should shift themselves along the curve in the direction of the optimal level of adaptability whether that increases or decreases levels of urgency. One of the primary ways for businesses to move along the curve is an incentive structure for employees to promote certain behaviors within the organization. This, in turn, will manipulate company culture in a way that promotes desired shifts along the curve. The manipulation of company culture takes time, however the long-term benefits of reaching an optimal level of adaptability are large; failing to pursue adaptability may cost the organization in a later period. Given this model is in its early stages, it is vital for future business and management theorists to dissect this model further to develop it into a fully useful tool for businesses. Adaptability should not be a hidden gem, but should be a visible and attainable goal for all businesses in this ever-changing business environment.
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#### ANALYSIS OF DISTRACTED PEDESTRIANS CROSSING BEHAVIOR: AN IMMERSIVE VIRTUAL REALITY APPLICATION

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#### ABSTRACT

Walking is the oldest and most common mode of transportation to ever have existed, yet it is rarely given the attention it deserves. Distracted walking happens when a pedestrian has a compromised sense of spatial awareness. This results in poor coordination with other road users like drivers, cyclists, and the surroundings. In this study, a head-mounted virtual reality (VR) kit is used to simulate a real-world environment in 3D animation, to study the keenness, judgment, and decision-making behavior of pedestrians as they cross the road at an intersection. Three different scenarios are tested for simulation; 1) involves an undistracted pedestrian, 2) involves a distracted pedestrian engaging in virtual social interactions on a hand-held device, and 3) involves a distracted pedestrian crossing the road in the presence of different implemented surrogate road safety measures. The simulated environment is based on an existing pedestrian crossing in Orangeburg, South Carolina. Volunteers will be grouped according to the three described scenarios and the test involves parameters such as wait time, crossing time and crossing speed will be collected. Distraction traits such as misrecognition of traffic conditions, head tilt, general body reaction, eye and heartbeat tracking will also be collected. A meta-analysis of the collected data will compare the three given crossing scenarios and suggest the best surrogate safety measures (SSM) that will be used by urban planners, traffic management authorities, and policymakers to promote traffic safety.

*Keywords:* Distracted Pedestrian, Head-Mounted Virtual Reality (VR) Kit, 3D Animation, Surrogate Safety Measures (SSM).

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#### Abstract

Across the country, college homecoming weekend is one of the biggest events for both the university hosting as well as the surrounding community. In this paper, Homecoming Weekend at a small university in the Southeastern United States was researched to see if there was any economic impact from the event on the local community. This Homecoming Weekend was packed full of reunions, tailgates, and of course the football game. According to foot traffic data gathered by the city, approximately 11,000 people, not including students who live on campus, visited campus over the course of the weekend. This university is a relatively small university with a total student population of roughly 2,000, both undergraduate and graduate students. The impact of 11,000 people on the campus can be seen at the sold out Homecoming Football game and throughout the local community.

Throughout this paper, several ways of determining economic impact and the importance of economic impact studies on a community, were examined. Economic impact studies are done in every area of business, but are primarily researched in the tourism departments. The tourism department has an invested interest in these economic impact reports as they show what events are impacting a community financially.

This research was done in order to learn more about how a smaller university impacts the community around it. This information will be valuable to both university administration and the city, so they know more about how they impact each other.

#### COLLEGIATE FOOTBALL'S ROLE IN INCREASING INSTITUTIONAL VISIBILITY

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#### ABSTRACT

This study explores the extended impacts of the "Flutie Effect" on institutions fielding Division I football programs. Through analyzing data from IPEDS and win/loss records for individual teams and their impact on enrollment and application trends over a 10 year period, the findings of this study suggest that the relationship between collegiate football successes and institutional interest are more complex and indirect than originally thought in an age of increased institutional visibility.

#### **INTRODUCTION**

One of the most electrifying moments in college football history occurred in 1984 when senior quarterback Doug Flutie did the unthinkable and performed what is hailed as one of the greatest plays in the game's history. In the last play of a regular-season game, Flutie launched a 48-yard touchdown pass to receiver Gerard Phelan, clinching a victory for Boston College against the 12th-ranked Miami. The excitement of the moment was immortalized by Boston College radio announcer Dan Davis:

"Here we go...here's your ballgame, folks, as Flutie takes the snap. He drops straight back...has some time, now scrambles away from one hit...looks...uncorks a deep one to the end zone, Phelan is down there... (OH, HE GOT IT!) DID HE GET IT? (HE GOT IT!) TOUCHDOWN!! OH MY GOODNESS...WHAT A PLAY!! FLUTIE TO GERARD PHELAN!! 48 YARDS!! NO TIME ON THE CLOCK, IT'S ALL OVER!!"

-(OH, HE GOT IT!)... (HE GOT IT!) was said by statistician Dick Tarpey, sitting beside Davis. [2]

The aftermath of this victory was not just a win in the record books. However, it also catapulted Boston College to the national stage, resulting in a 30 percent increase in applications over two years. This pattern has been echoed in other institutions, such as Clemson University, which experienced a supposed short-term spike in applications and online engagement following their national championship win in 2016.

The phenomenon of the Flutie effect suggests that athletic success can significantly boost a school's attractiveness to prospective students. Institutions moving forward will have to evaluate their collegiate athletics and, more specifically, their collegiate football programs and answer whether these programs can lead to higher interest. After all, the most common purpose of fielding a football team is to increase the overall attractiveness of an institution to potential applicants and then convince those applicants to enroll. This question will become especially important as institutions in both the Football Bowl Subdivision (FBS) and Football Championship Subdivision (FCS) approach a so-called "perfect storm" of enrollment challenges moving forward. This "perfect storm" consists of declining college enrollment numbers that began taking a downward turn in 2012 and then took a significant plunge in 2020 as students no longer could see the potential value in what colleges were offering and were afraid to tackle the student debt

associated with consistently rising costs of attendance among a multitude of other factors that culminate in decreasing overall confidence within the realm of higher education[7]. To make matters worse for institutions, an already small pool of potential enrollees is about to significantly shrink as soon as 2025, as the next generation of students born in 2008-2011 begin to graduate from their primary schools and look to institutions. 2008 and 2011 are considered years with notoriously low birth rates, and the number of 18-year-olds is projected to decline by 15% [7].

#### **REVIEW OF THE LITERATURE**

The Flutie Effect and its tangential effects have been a subject of interest in higher education. They are often the battle cry for those trying to advocate for higher athletic spending as institutions navigate the already complex world of enrollment management. The "Flutie Effect" and the strength of its impact on an institution come from two schools of thought on the matter. An interim report commissioned by the NCAA, written by Litan et al. in 2003, provides a thorough overview of the various ideas and theories surrounding the impact of athletic successes and their potential effects on their institutions. Through an empirical analysis of EADA data combined with IPEDS data, the group tackled the prominent ideas and schools of thought that emerge when institutions look to bolster their athletic programs for the sake of closer attention. The group says, "The debate between these two schools of thought has unfortunately often been based more on anecdote than empirical evidence" [3]. This claim is supported mainly by a surprising gap in overall research, most likely due to the primarily indirect nature of the benefits of increased athletic spending. The group identifies literature that supports the claim that, in general, athletic success does, in fact, lead to higher applications and enrollment, which is both beneficial for those institutions considered to be at capacity and those that have more room to expand their current undergraduate programs in scope and size[3].

Additionally, the Knight Commission, a group dedicated to creating a more sustainable and equitable model for collegiate athletics, published a report that paints a cautionary tale for the potential of spending excesses in athletics. In collaboration with the NCAA, the Commission gathered the data institutions reported directly to the NCAA by teams participating in the FBS to facilitate the research performed. According to the research published by the Commission, only 20 to 30 athletics programs within the FBS are considered "highly profitable." This statistic contrasts the results of a poll run by the same Commission in 2006, which found that an estimated 78% of Americans thought that athletics programs were profitable [6]. In addition to these findings, the Commission found that "schools that switched divisions did not generally tend to experience a significant increase in enrollment" and found that switching a Division II football team into the FCS to be in Division I increased overall student fees and led to "an average deterioration in net revenue' of more than \$1 million each" [9]. Ideally, an institution would move from its positions in a Division II conference up to the "next level" to increase its program visibility and overall recruitment opportunities, but this seems to come at the cost of additional financial stress to students and losing significant revenue. The report also explains the long-term impact of the 2008-2009 recession on the widening spending gap between institutions considered "rich" and "poor," relatively speaking. This increase in spending among the wealthier, more prosperous "blue chip" institutions that often find themselves in the top 25 rankings has significant potential to render lesser performing and lesser known conferences within the FCS and even within the FBS completely obsolete. This idea of a spending gap can best be expanded upon by comparing the scales of 2 budgets between the FCS and FBS. A well-performing Clemson University saw its football program boom after a series of great successes on the gridiron and become what many thought and still think could be the greatest football dynasty in collegiate football. As they began to generate more revenue through licensing agreements, merchandise sales, and TV contracts, they could spend over 20 million dollars on a new scoreboard upgrade in 2022 for their football stadium, "Death Valley," to improve the overall gameday atmosphere for those in attendance. For perspective, this upgrade is 10x more than the highest operating expenses among FCS teams for 2018, with James Madison, the highest FCS spender, only spending \$2,734,601 for their entire year [4]. This comparison and gloomy outlook on the potential impact of higher spending amongst the institutions that are capable of spending significantly more money than others should not be used in any form of consideration in removing a football team from the institution altogether, as this has been correlated to a measurably negative effect within enrollment numbers specifically [5].

The viewership of NCAA sports can also explain this dramatic spending gap between institutions. Collegiate football, especially FBS teams, garner widespread media attention, with only the NFL beating them in ratings. FBS football generates considerable revenue compared to its counterparts, only to be rivaled by basketball. SCACC Hoops takes this information and uses it to suggest that in the age of mass media, the environment is incredibly ripe for the effects of the Flutie Effect to take hold on the new wave of applicants to an institution, but only in those institutions that get attention from the media[11]. The idea of marketing within collegiate athletics and how it impacts overall applications and enrollment is discussed in "The Dynamic Advertising Effect of Collegiate Athletics" by Douglas Chung. Chung's article provides a great view of the broader implications of mass media advertising in athletics and the "spillover" it can have into other aspects of institutional quality. Chung treats a team's athletic successes as a form of "goodwill stock" that will decay to some degree over a period of time, very similar to the effects of good advertisements. Chung does quote Boston College's head of admissions while the institution was experiencing the supposed benefits of the first documented case of the Flutie Effect. The admissions counselor went so far as to go on record, saying that while Doug Flutie's game-winning pass may have contributed to a slight increase in applicants, the institutional spending in residences and research facilities drove the significant uptick in applications and enrollment. The research finds that those students who would be traditionally deemed as lower performers academically based on average SAT scores have stronger preferences for institutions with higher athletic success, but does confirm that this effect does permeate through all levels of traditional academic merit, with students with higher average SAT scores are impacted by athletics successes, but to a lesser degree[1]. With this increase in applicants, Chung finds that institutions can be more selective in their admissions process, leading to higher average standardized testing scores for the institutions benefiting from the extra attention, potentially elongating the "goodwill" among possible students. The article suggests that athletic success' impact on overall institutional appeal may be more pronounced than what was previously thought, extending its already widespread influence to even the most academically inclined applicants.

#### **ABOUT THE DATA**

This data is a combination of 10 years worth of IPEDs data dealing with enrollment and applications, and a manually curated data set for win loss records using publicly available records from Wikipedia. Since

the data for win loss records was created manually, spot checks were performed every 150 entries to ensure accuracy and integrity within the data.

Using this collected Wikipedia data, a simple win/loss ratio was calculated for each team over the ten-year period using a standard formula:

#### Ratio = Wins/(Wins+Losses) (1)

This new win/loss ratio will be used as a predictor variable within the regression models. The IPEDS data was used to calculate the year-over-year percent change in enrollment and the year over year percent change for applications.

Both of the new variables in percent change were then placed on a 1 year lag, meaning that in the regression models the win loss ratio of  $X_{t-1}$  is the predictor for the percent change in applications or enrollment for  $X_t$ . This lag was performed to ensure that the effects were evaluated rather than static values that did not reflect the program's impact on applications and enrollment.

#### LIMITATIONS

The most significant and most unfortunate limitation in the data is that there is no accurate way to predict when the "Flutie Effect" will occur or the exact benefits to be yielded. Both the catalyst and outcome of the phenomenon are comparable to catching lightning in a bottle. Whether it be a random play, a series of excellent games, or an especially popular televised game where one team happens to do exceptionally well, there are too many random variables to consider when trying to determine what could lead to something like the Flutie Effect to take place and makes it near impossible to consistently determine where the potential institutional spillover will occur. This makes it incredibly difficult for institutions to find areas in athletics to better fund or support that could increase their chances for this phenomenon to occur aside from simply being on nationally televised "prime time" Saturday games, a privilege often reserved for FBS teams.

#### **METHODS**

Four linear regression models were chosen for this specific study because of their simplicity and directness when dealing with large amounts of data. The models run will be aiming to predict the percent change in enrollment and applications from the win loss ratio variable previously calculated. A model for both the FCS and FBS will be run for each because of the significant differences between the two conferences.

PERCENT CHANGE IN ENROLLMENT= $\beta_0 + \beta_1$  (WIN LOSS RATIO)+ $\varepsilon$ (2)PERCENT CHANGE IN APPLICATIONS= $\beta_0 + \beta_1$  (WIN LOSS RATIO)+ $\varepsilon$ (3)

These models were limited to just the win loss ratio to avoid any additional noise within the data and to make sure the outputs reflected just the relationship between these key variables. The results of these models are below:

FBS Percent Change in Enrollment			
P-value	0.0005251		
F-statistic	12.1 on 1 and 1103 DF		
Mean Standard error	2.902 on 1103 degrees of freedom		
Intercept	0.06416		
RATIO coeff.	1.35822		

This output suggests a statistically significant relationship between the win loss ratio and change in enrollment, but a small relationship. This means that as the win-loss ratio increases among FBS teams, their percent change in enrollment for the following year tends to increase as well. With an  $R^2$  value of 0.01, however, this does mean that there are other factors not present within the model that are better predictors of the percent change in enrollment.

FBS Percent Change in Applications			
P-value	0.00475		
F-statistic	8.003 on 1 and 1096 DF		
Mean Standard error	11.66 on 1096 degrees of freedom		
Intercept	3.1063		
RATIO coeff.	4.4589		

This output once again suggests an overall statistically significant relationship between the win loss ratio and the change in applications. This is a significant relationship, but has even less impact than enrollment, which was an unanticipated difference between the two models. Most literature seems to emphasize the impact on applications being larger than the impact on enrollment, but within the FBS this seems not to be the case based on these results. The especially important conclusion to draw from these two particular results is that the win loss ratio is significant.

FCS Percent Change in Enrollment			
P-value	0.01836		
F-statistic	5.579 on 1 and 1058 DF		
Mean Standard error	4.17 on 1058 degrees of freedom		
Intercept	-0.6850		
RATIO coeff.	1.3769		

The FCS model provides a great contrast to the FBS model. This model's p-value is more than that of the FBS, indicating that while the FCS model is still significant, the FBS output is more significant. While both are significant, the FBS model does suggest stronger significance. The F-statistic for the FBS is higher than that of the FCS, indicating an overall better fit in the FBS model than of the FCS. This finding is also reflected in the mean standard errors of both models. The FBS model outperforms the FCS model which could be due to a variety of factors.

FCS Percent Change in Applications			
P-value	0.5572		
F-statistic	0.3448 on1 and 1022 DF		
Mean Standard error	16.93 on 1022 degrees of freedom		
Intercept	3.540		
RATIO coeff.	1.1413		

The difference between the two application models is especially interesting. The FCS does not provide statistically significant evidence that a change in the win loss ratio is indicative of changes to the percent change in applications for the following year. The FBS model far outperforms the FCS model in this context.

#### CONCLUSION

This research aims to evaluate the potential benefits of the Flutie effect among FBS and FCS schools in an age where media attention is more attainable for smaller institutions. Through empirical analysis of the impact of win loss ratios it can be determined that there is not enough evidence to support this notion. While the FBS models performed especially well compared to the FCS models and proved to be of

statistical significance, this could not be said for the FCS models that only displayed significance in the percent change in enrollment for the following year. These findings could be due to a number of factors. The most obvious out of these factors is that the FBS still garners significantly more media attention and revenues than the FCS. While it may be more accessible to view FCS games on streaming platforms such as ESPN+, there still has to be some degree of interest, and as of this study's completion there may not be enough interest within the world of the FCS by potential students to make a significant impact either way. It is also worth noting that FCS games often get scheduled in similar time slots to higher stake FBS games, putting the FCS in direct competition to their FBS counterparts.

At the very least for FCS teams, it would be worth some degree of reevaluation for the long term goals of fielding a football team. While it is significantly easier said than done, the main goal for these programs should be to find their way into the FBS, and then perform well to feel any potential effects of a well performing football program. It would also be worthwhile to evaluate whether or not the team would be better off playing in Division II athletics. This would bolster competition in Division II, leading to potentially more exciting football games which could in turn lead to more viewership.

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### LEGAL SYSTEMS AS A MECHANISM FOR INCREASING COMPETITIVENESS IN EASTERN EUROPE

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#### ABSTRACT

Legal systems are integral to doing business within a country and play an important role in establishing a competitive economy. This paper explores the importance of legal systems to create a competitive business environment and incentivize high quality investments, the legal history and systems of Hungary and Czech Republic, and competitiveness trends in Eastern Europe to make recommendations for legal policy makers in Eastern Europe to leverage legal systems to increase competitiveness.

#### BACKGROUND

#### Importance of Legal Systems and International Law to International Business

Legal systems regulate, facilitate, and protect the economy of a country. The efficiency and effectiveness of a legal system informs how quickly and safely businesses can be established, ethical obligations to employees and the market, the contracts upon which businesses are built, and how to resolve conflicts in contracts.

Continued globalization and flattening of the global market require entanglement of global legal systems. When a business globalizes, they must function not only within their home-country's legal system, but also function in the host-country's legal system. Each new country into which they expand operates its own justice system and may even operate in a different type of legal system (Common, Civil, or Islamic) than the country in which the business originated and be subject to different regional regulations (such as the European Union (EU), which has specific standards for its members). Furthermore, as the lattice of business relationships and markets becomes more intricate, these systems, laws, and regulations come into conflict, making international law an imperative part of any strategic plan both at the corporate and national level. Laws, tax policies, and legislation influence MNEs and their strategies.

Likewise, countries and regions can both regulate and promote trade and commerce in their economies through strategic law making and an effective justice system. Examining the intersection of international law and business is useful for government officials, business leaders, and attorneys. Strategy for expansion and investment may include analysis of how well the project can be implemented in a foreign legal system, and risks that legal system is to operate under (in other words, can a company navigate foreign courts and expect to be treated fairly).

Laws and the justice system can also be a method for countries to hold foreign investors accountable. As Reszigi et al. (2018) explain, not all FDI is beneficial to a host countries, and Hungary specifically noted trends that could help predict the positive or negative impact of FDI on a local economy. Laws may help countries leverage their markets and hold investors to practices that are mutually beneficial.

Eastern Europe poses a special case due to political shifts both post-World War II and post-Soviet rule. The shifting legal principles in the region made [12] Eastern European countries have had to modify and rebuild legal systems and economies over the past 30 years. Further complicating matters, some eastern European countries are members of the European Union, while others are not, causing differences in the regulations, standardizations, and resources throughout the region.

#### **FDI and Competitiveness**

Foreign direct investment (FDI) and competitiveness are measures of economic and commercial success on a national level. FDI is a quantitative measure of cross-border investments and can be viewed in terms of inflow and outflow to discuss economic influence, health, and success. Economic competitiveness is a qualitative and quantitative measure of many factors, including

FDI, to measure the nation's productivity and the feasibility of establishing a successful venture there. As Xavier Sala-i-Martin [24] notes, competitiveness moves beyond just examining economic growth and looks rather at the ability of a nation and its economy to provide for the social needs of people.

#### FDI and Competitiveness Concerns in Eastern Europe

The International Institute for Management Development 2023 World Competitiveness rankings (2023) predict and illustrate declining competitiveness in Eastern Europe due to inflation, political instability, and the influence of the war in Ukraine. The Czech Republic, however, has improved in the overall rankings, against the trends of the rest of Eastern Europe. Hungary, a country with similar legal history, has been less successful. Business scholars in Hungary have also raised concerns over the value of FDI inflows, citing a lack of positive contribution from foreign investors. (Reszigi, et al., 2018) This may indicate a negative view of FDI in the country. However, other countries who have limited FDI, such as a Canada, found that these policies could also be harmful. [14] Therefore, the problem may lie with the quality of foreign direct investment rather than quantity. This indicates that Eastern European countries need to focus on competitiveness rather than FDI alone. Given that Hungary outperformed the Czech Republic in economic efficiency in 2023 but fell far short in the overall competitiveness ranking (World Competitiveness Ranking, 2023) their policies may encourage investment, but not encourage high quality or sustainable investment.

Examining the legal systems of Eastern European countries, which are relatively young and malleable after decades of political upheaval, can directly address competitiveness (as legislation and administrative efficiency are factors of competitiveness) and help incentivize high quality FDI and protect the economy from investments that merely seek to utilize resources and will not contribute to society. Eastern European legal systems can examine their effectiveness, efficiency, and the ways their legislation may either inhibit high value investments or create loopholes that allow for bad investments.

#### The Czech Legal System

The Czech legal system is a civil law system which operates as a democratic parliamentary democracy in the tradition of Germanic law. [22] Formerly a territory of Austria-Hungary prior to becoming Czechoslovakia in 1918 [22], the area was subject to the Austrian Commercial Code of 1863 before undergoing radical changes following the communist takeover. [3] Following the socialization of the economic legal system, arbitrary changes were made to the legal system. This process destroyed the unitary property system, rendered contracts unenforceable, and established an international legal code that was considered untrustworthy by foreign investors. [3]

Along with the rest of Eastern Europe, Czechoslovakia began reforming its legal system and business structures to move towards a market economy in the late 1980s. [3] The Czech Republic established the Constitution of the Czech Republic in December of 1992 and split from Slovakia in 1993. Though this change nominally ended the use of the 1964 socialist civil code, the new code was essentially a reworking of the 1964 code with market economy principles. [22] The new legal system was established several civil codes, including the Commercial Code, which

governed commerce and business in conjunction with the (general) Civil Code. [4] The country became a member of the European Union (henceforth EU) in 2004 and made the necessary changes to comply with European Union standards. Czech Republic began recodifying their legal system to move further away from the 1964 code, and passed the New Civil Code in 2012, which went into effect in 2014, replacing the numerous former codes (including the Commercial Code), establishing new legislation on dealing with international law, and was heavily influenced by the previous Austrian legal system and current civil law in the rest of Europe. [22]. The new civil code has been called "revolutionary" for its powerful and effective changes to commercial law and the Czech legal system in general. [15]

#### The Hungarian Legal System

The Hungarian legal system is also a democratic, parliamentary, civil law system. [18] It has roots in both the Roman-Germanic and German-Austrian Law [23] The legal system developed following the break from Ottoman rule and the development the Austro-Hungarian empire. Soviet rule and the rise of communism made brought about significant changes to the Hungarian legal system to better conform to centralized government and state-control post-World War II. (Schmidt, 1982) However, Hungary maintained more of its traditional legal system than other Soviet countries, and legal scholars noted prior to the fall of the Soviet Union that Hungary had greater success economically than the rest of Soviet Union due to shifting policies of westernization and decentralization. Hungary made laws allowing small independently owned businesses in 1982, though foreign trade remained strictly under state control. (Schmidt, 1982) These early changes towards a market system played a role strengthening the Hungarian economy through legal changes that made the country more competitive and attractive to FDI compared to the rest of Eastern Europe.

Even with this competitive advantage over the rest of Eastern Europe, following the fall of the Soviet Union, Hungary began instituting legislative changes along with the rest of Eastern Europe to create laws that would allow for and govern a market economy. [11] Hungary joined the European Union in 2004, and the Hungarian legal system aligns with their guidelines for membership. In 2006, Hungary passed a Companies Act, which is the primary legislation governing business operations in the country [8], specifically formation. In 2012, the Fundamental Law of Hungary, upon which Hungary's legal system is currently based, was put in place. [5] In 2013, Act V of the Civil Code was passed, establishing operational rules for companies. (ICLG, 2023)

Hungary also passed a bill in 2021, reforming registration of legal persons and businesses, meant to improve the slow process of starting a business in the country. However, the implementation of the law has been pushed back until 2026 and has been fraught with questions about increasing court costs and oversight. [21] Furthermore, in 2022 the European Council notified Hungary of widespread concerns over a breach of the condition (for European Union membership and budgetary allowances) of the principle of Rule of Law in the country, especially as might impact the integrity of financial management in the European Union. Remedial efforts were made but the council determined that these were inadequate and suspended 6.3 billion euros in budgetary commitments to Hungary. [6] This comes amidst concerns over the past decade that Hungary's is moving away from democratic governance to a more authoritarian regime. [18]

#### ANALYSIS

Based on the 2023 World Competitiveness Rankings, the Czech Republic ranked number eighteen with a score of 83.48, which was an 8-point increase. Hungary ranked number 46 with a score of 59.85, a decrease of 7 points. (Figure 1) An analysis by Caballero and Pistis argues that inflation has been the strongest downward driving factor, with Eastern Europe hit the hardest. (2023) The Czech Republic has defied these trends. Romania also saw a slight increase, but other Eastern European countries decreased overall, including those that were trending upward in the previous year.

#### Figure 1

Trends in Overall Competitiveness Ranking 2019-2023 from Eastern European Countries



*Note* – Data taken from 2023 World Competitiveness Report. Trends for Czech Republic, Hungary, Romania, Bulgaria, and Latvia are included. A lower ranking indicates a better score therefore a downward trend is a positive change.

#### Figure 2

Trends in Economic Performance Ranking 2019-2023 from Czech Republic and Hungary



*Note* – Data taken from 2023 World Competitiveness Report. Economic trends for Czech Republic, Hungary. A lower ranking indicates a better score therefore a downward trend is a positive change.

#### Figure 3

Trends in Government Efficiency Ranking 2019-2023 between Czech Republic and Hungary



*Note* – Data taken from 2023 World Competitiveness Report. Government efficiency trends for Czech Republic and Hungary are included.

#### Figure 4

Trends in Business Efficiency Ranking 2019-2023 between Czech Republic and Hungary



*Note* – Data taken from 2023 World Competitiveness Report. Business efficiency trends for Czech Republic and Hungary are included.

#### Figure 5

Trends in Infrastructure Ranking 2019-2023 between Czech Republic and Hungary



*Note* – Data taken from 2023 World Competitiveness Report. Infrastructure trends for Czech Republic and Hungary are included.

## Table 1. Subcategory Comparison of Czech and Hungarian Factors Related to Legal SystemsSubcategory Comparison of Czech and Hungarian Factors related to Legal Systems

Factor	Subfactor	Czech Ranking	Hungarian Ranking
Government Efficiency	Tax Policy	35	30
Government Efficiency	Institutional Framework	15	46
Government Efficiency	<b>Business Legislation</b>	19	35

Table 1. Data on sub rankings related to legal system from World Competitiveness Report

			-
Factor	Czech Republic	Hungary	Council of Europe Median
% of GDP spent on Judicial	0.32%	0.4%	0.3%
Budget			
Administrative Case Clearance	112%	89.3%	97.5%
Rate – 1 <sup>st</sup> Instance Court			
Administrative Case Clearance	93.8%	108.6%	101.2%
Rate-Highest Instance Court			
Civil Case Clearance Rate – 1 <sup>st</sup>	98.0%	100.2%	98.1%
Instance Court			
Civil Case Clearance Rate – 2 <sup>nd</sup>	99.7%	107.1%	104.2%
Instance Court			
Civil Case Clearance Rate –	107.8%	131.8%	103.0%
Highest Instance Court			
Civil Case Disposition Time –	317	165	N/A
1 <sup>st</sup> Instance (days)			
Administrative Case Disposition	165	110	N/A
Time – 1 <sup>st</sup> Instance (days)			

**Table 2.** Comparison of Judicial Efficiency Data

*Economic Performance* – the macro-evaluation of each nation's domestic economy (World Competitiveness Report, 2023) was the only area of the competitiveness ranking that Hungary outperformed the Czech Republic in, as it has since 2020. (**Figure 2**) In 2023, the gap between their performance closed, with Czech Republic ranking 27<sup>th</sup> and Hungary ranking 21<sup>st</sup>. Czech Republic's economic performance ranking was the poorest it has been in the past four years, but the trend has been relatively steadier than Hungary, who rose from 45<sup>th</sup> to eighth, and seems to be falling again.

In terms of *Government Efficiency* – the extent to which government policies are conducive to competitiveness (World Competitiveness Rankings, 2023), Czech Republic ranked highly and saw an increase in overall governmental efficiency (defined as the extent to which government policies are conducive to competitiveness). Czech Republic ranked seventeenth overall, whereas Hungary ranked 40 and saw a decrease in governmental efficiency. (**Figure 3**) Several of the subfactors of the Governmental Efficiency factor speak strongly to a country's legal system. (**Table 1**) Czech and Hungarian tax policy were both middling, with Hungary slightly outperforming the Czech Republic. It should be noted that Czech Republic has a tax policy that does not double tax foreign investors. [1] The Czech Republic far exceeded Hungary and the rest of its European counterparts in terms of business legislation and institutional framework, ranking in the top twenty for both subfactors.

The Czech Republic continued to rise the rankings of Business Efficiency – the extent to which enterprises are performing in an innovative, profitable, and responsible manner. (World Competitiveness Ranking, 2023) The country ranked fifteenth, while Hungary ranked 58<sup>th</sup>. In terms of subfactors, the Czech Republic ranked first in management practices and fifth in attitudes and values, while Hungary ranked 54<sup>th</sup> and 63<sup>rd</sup>, respectively. (**Figure 4**)

In terms of Infrastructure – the extent to which basic, technological, scientific, and human resources meet the needs of business (World Competitiveness Ranking, 2023) – Czech Republic and Hungary both saw slight increases in rankings over the reporting period. However, Czech Republic has ranked consistently higher than Hungary in this ranking. In 2023, Czech Republic ranked 24<sup>th</sup>, and Hungary ranked 38<sup>th</sup>. (**Figure 5**)

#### **Judicial Efficiency**

According to the European Commission for the Efficiency of Justice (CEPEJ) 2022 European Judicial Systems Evaluation Report, Czech Republic reduced its disposition time in administrative cases by 23% between 2020 and 2022, despite most of Europe increasing their disposition time due to the Covid-19 pandemic. Though the Czech Republic's clearance rate (CR) was below 100% <sup>1</sup>, the CEPEJ (2022) noted that their CR was still high enough to not effect efficiency. This was a 25% improvement from previous studies as the country "stopped creating backlogs and entered the standard efficiency category" (CEPEJ, 2022) Hungary reduced its disposition time by 7% for first instance commercial litigation cases, one of only five EU states that was able to do so during the 2022 evaluation cycle, however their ratio of resolved cases to received cases was low, showing that they were receiving more cases than they were able to complete, creating the potential for a backlog, though they saw 2/5ths fewer civil and commercial litigation. Hungary also saw decreased disposition time, attributed to administrative justice reforms. (CEPEJ, 2022)

#### DISCUSSION

Based on the above data, Hungary may be successful on a macroeconomic level, but the country falls short in other categories related to competitiveness. Considering Laszlo, et al.'s article (2018), this may be reflective of a system that is garnering investment, but investments that are low-quality and not utilized to their full potential. Despite changes to the judicial system increasing efficiency in the last cycle of review, Hungary still lost points in Business Efficiency, while the Czech Republic widened the gap between their performances. This data shows that raw economic success and increased efficiency are not enough to make a country competitive.

Considering the similarities in the legal history of Hungary and the Czech Republic, their joint entrance to the European Union, and their similar locations in Europe, it seems that Hungary's legislative policies illustrate an opportunity for growth. Despite their early success as a free

<sup>&</sup>lt;sup>1</sup> according CEPEJ methodology, a clearance rate below 100 means that based on case volume and the normal case timeline, the system cannot clear all of its cases. Rankings above 100% are preferred and indicate that the system can effectively handle a greater number of cases than it currently has pending.

market and relative economic success, their current state sees the country declining in terms of competitiveness as the Czech Republic becomes more competitive.

#### **Recommendations for Legal and Policy Changes to influence FDI/Competitiveness**

#### Principles for building a strong legal system

In terms of promoting business and competitiveness within a nation, a legal system should have a few characteristics:

1) *Trustworthy* – a system must be trusted to resolve civil conflicts in a fair manner and to administrate justice when necessary.

Businesses within the nation and foreign investors must be able to trust a legal system to administrate contracts, resolve conflicts, and serve as a mechanism for obtaining justice (in civil and criminal matters) for their business, their employees, and their stakeholders.

2) *Navigable/Accessible* – stakeholders should be able to navigate and use the legal system, with the resources available, to accomplish legal tasks related to their business operations.

While legal systems will naturally have variations, and will operate under different theories, a business looking to enter a foreign market should be able to successfully perform the necessary legal actions needed to establish a business, and to operate in a lawful manner by engaging with appropriate legal counsel. A legal system that is convoluted, difficult to navigate, and/or arbitrary makes it harder for domestic and foreign businesses to fulfill the legal requirements of operating in the country, making the cost of start-up and entry unappealing. An accessible and navigable legal system better interact with other legal systems even when they operate differently, making it more compatible with international law.

3) *Fair* – legal systems should apply the law in a fair manner to both foreign and domestic entities.

Though legislation that incentivizes local or foreign business may be fair, if correctly enacted, ultimately courts should hold businesses and individuals accountable the laws that apply to them. Courts should not shield illegal actions of domestic entities on the grounds that they are in their home-country, nor should they excuse illegal actions of foreign investors in exchange for their investment. The law should be applied fairly, and without special treatment so that those who interact with the legal system can trust that the law will be applied as it is intended and can navigate the legal system effectively.

4) *Committed to Rule of Law* – the law applies to everyone, and no one is above the law. Rule of Law makes legal systems credible as a source of regulation and governance. If a country does not exhibit Rule of Law neither its citizens nor foreign investors can trust that the legal system will be fair and operate as it is intended.

#### **Building Strong Legal Systems Eastern Europe**

Though factors such as inflation and political instability due to the war in Ukraine may be hard to control or navigate, Eastern Europe is in a unique position to leverage their legal systems to better attract high quality FDI, be more competitive, and operate well in the context of international law. Given the numerous ways that legal systems impact businesses, country competitiveness, and offer an opportunity to both incentivize investment and protect countries against bad investments. Most of Eastern Europe has followed similar trends to Hungary in terms of competitiveness, other than in terms of economic efficiency, so many of the same general principles can be applied to each country, though policy makers can and should also use these principles as a guide for conducting individual research on specific factors in each country to address specific legislation. Specific data for Bulgaria, Latvia, and Romania is included in the appendix.

The nineties saw a pressing need for widespread legal reform so Eastern European countries could re-enter the free market economy. However, as illustrated by the first Czech Constitution, this meant that these systems often had to borrow frameworks from Soviet rule to be put into operation quickly. The past thirty years have given these countries experience and data to better refine what parts of their legal system work well, and which need to be reformed. This provides a unique opportunity to better tailor their legal systems to work within in the context of international law, address specific issues in the economy, and to make their nation more competitive.

Legal systems should seek to establish the four principles referenced above to make their legal systems viable for domestic and foreign businesses. The most important of these factors is certainly Rule of Law, which should act as a baseline for establishing the legitimacy of the system. Hungary provides a powerful illustration of the impact that Rule of Law can have on a country's reputation and competitiveness.

Eastern European countries should then examine areas of their current legal system that do not function. The Czech Republic has seen great success with its most recent revisions to its legal code, and this success is reflected in their competitiveness. This success may come from a reconciliation of the civil and commercial codes into one code. It should be noted that this was also a lengthy process based on correcting the first civil code and tailoring it to the new Czech economy and government. Furthermore, it was a return to an older form of Czech law, indicating that the function of the legal system matters more than the form. The Czech Republic could maintain a unique and culturally significant legal system while still modifying it in a way that made the system more effective and conducive to international law.

Secondly, Eastern European countries should examine other legislation and policies that can incentivize foreign direct investment. This can include legislation or policies that increase the efficiency and decrease the hassle of starting a business, tax policies that make investment more attractive, or policies that are in keeping with competitive EU policies. Not all Eastern European countries are members of the EU, but they may be able to leverage aligning their laws and policies with EU standards to facilitate cross-border investments, improve legal continuity, and compete with EU countries on a more level playing field.

Finally, Eastern European countries should remember that the law protects their economy as well as enticing investment. Though Hungary has performed well economically and made their

judicial and administrative systems more efficient, their competitiveness rating has dropped, and the country questions the effectiveness of FDI. This illustrates that the quality of investments are important. Furthermore, increased efficiency (in terms of processing or turnover) may not indicate improvement, but rather a lack of oversight or thoroughness in the decision-making process. As Laszlo, et al. (2018) investors who are committed to the Hungarian economy see better outcomes than those who are simply taking advantage of certain attractive policies. A legal system can effectively address these issues by imposing requirements on investors, or by incentivizing corporate social responsibility and general investment in the country.

#### Hungary

The most pressing issue for Hungary remains rule of law. This is vital to the economic and political success of Hungary, not only because of the budgetary obligations at stake with the European Council, but also to the trustworthiness of Hungary in the world economy. A legal system is defunct without rule of law. Amid accusations of an eroding democracy, a legal system that applies to some but not others further alienates investors and hurts domestic businesses. The country should take swift action to ameliorate this issue both through policies and legislation that enforce rule of law, and in the practice of enforcing said law.

Hungary can also consider following Czech Republic in re-working its civil code to suit the needs of their modern economy, reduce redundancies, and eliminate the former soviet structure in the post-soviet code. The 2023 World Competitiveness Report highlights aligning monetary and fiscal policy (which are currently in conflict) as a challenge facing Hungary in 2023. This could be addressed by similar reforms to those enacted in the Czech Republic. The report also encouraged the country to improve accountability and accountability of public decision-making. (World Competitiveness Report, 2023) While Hungary has made some reforms, such as the 2021 registration reform that is slated to be enacted in 2026 after setbacks, it is yet to be seen if these changes will truly make a difference in their competitiveness and effectiveness of the legal system. While this may make the process quicker, it may not improve the process or the outcome.

Finally, should also focus heavily on protective policies that will improve the quality of investment. Given their concerns over FDI lacking a positive impact, Hungary's economic success is not currently having a positive impact on their competitiveness overall. The current trend of prioritizing efficiency will not address this issue; rather Hungary should focus on laws that will incentivize businesses to invest ethically both in the Hungarian economy and in Hungarian society (Hungary ranked lower on social infrastructure compared to the Czech Republic in the 2023 World Competitiveness report as well) and to protect the economy and Hungarian businesses from bad investments.

#### **Czech Republic**

While the Czech Republic has generally made good strides in competitiveness and has invested in legal reform, there is still room for the country to improve its legal system and become more competitive. Firstly, the country ranked relatively low on tax policy, indicating that they should examine this legislation specifically. Their tax policy (which eliminates taxation with certain other countries) may be incentivizing foreign trade to the expense of the economy or Czech citizens. This project would take more in-depth legal research but may prove fruitful in increasing competitiveness in an area that the country is currently struggling. Finally, the country should continue to work towards judicial efficiency, and continue examining and improving its civil code as it has over the last decade.

#### **Further Research**

Legal systems, international law, and country competitiveness represent a rich area for research. Policy makers in Eastern Europe might focus further research on the difference between legal system efficiency and legal system quality, especially in administrative and civil courts. Monitoring of the effectiveness of newly instituted laws, analysis of the viability of successful laws from neighboring regions, and research into incorporating traditional (pre-soviet) legal principles and structure may provide additional information to inform legislative reform and legal policy.

#### CONCLUSION

Based on the current legal and competitiveness trends in Eastern Europe, Eastern European countries should focus on maintaining rule of law, analyzing and improving current legal codes to move away from their modified post-soviet structures, and leverage their legal systems that not only promote FDI, but protect the economy and promote high-quality FDI to become more competitive on the world stage.

#### APPENDIX

#### Figure A.1





*Note* – Data taken from 2023 World Competitiveness Report. Trends for Czech Republic, Hungary, Romania, Bulgaria, and Latvia are included. A lower ranking indicates a better score therefore a downward trend is a positive change.

**Figure A.2** Trends in Economic Performance Ranking 2019-2023 between selected Eastern European Countries



*Note* – Data taken from 2023 World Competitiveness Report. Trends for Czech Republic, Hungary, Romania, Bulgaria, and Latvia are included. A lower ranking indicates a better score therefore a downward trend is a positive change.

**Figure A.3** Trends in Business Efficiency Ranking 2019-2023 between selected Eastern European Countries



*Note* – Data taken from 2023 World Competitiveness Report. Trends for Czech Republic, Hungary, Romania, Bulgaria, and Latvia are included. A lower ranking indicates a better score therefore a downward trend is a positive change.





*Note* – Data taken from 2023 World Competitiveness Report. Trends for Czech Republic, Hungary, Romania, Bulgaria, and Latvia are included. A lower ranking indicates a better score therefore a downward trend is a positive change.

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#### ARE BITCOIN PRICES RECESSION-PROOF? EXAMINING RELATIONSHIPS AND PREDICTING BITCOIN PRICE WITH NON-TRADITIONAL FEATURES USING MACHINE LEARNING AND AI

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#### ABSTRACT

Bitcoins have become a popular investment vehicle for many investors. Bitcoin price has increased by more than 13,000% in less than ten years. While the Russia-Ukraine war affected energy prices and caused economic slowdown in different parts of the world, bitcoin prices have shown a sharp increase pattern of 158% over the last 12 months. The price relation among cryptocurrencies, traditional investment return, and global events can be important considerations to Bitcoin price prediction. Mentions of cryptocurrency in both news and social media are also factors worth examining in the price prediction algorithm. Machine Learning and Generative AI models can incorporate the mentioned contrasting features and factors in predicting volatile bitcoin prices at a higher reliability. Empirical evidence suggests that Bitcoins demonstrate minimal correlation with conventional investment instruments, providing investors with enhanced diversification prospects. While Bitcoin's performance as an investment avenue remains volatile, its investment potential offers significant returns. This study employs features from both fundamental and technical analyses in its machine learning models. In the realm of traditional finance, fundamental analysis holds limited utility in determining Bitcoin prices. However, our study focuses on identifying macroeconomic factors that potentially influence Bitcoin price fluctuations and attempts to capture these factors into the prediction algorithm. Additionally, our research utilizes technical analysis elements to identify reliable predictors in price trends and patterns, offering us insights into investment strategies. Our study examines the relationships among Bitcoin price, macroeconomic events, news, social media mentions, and blockchain variables. We also attempt to predict short run Bitcoin prices using Machine learning models. While interpretations of the results need to be cautious, this study offers investors a fresh perspective on valuing and comprehending Bitcoin price movement.

**Keywords:** Bitcoin, Price Prediction, Machine Learning, Artificial Intelligence, Technical Analysis, Fundamental Analysis.

# Symposia Workshops

#### EMERGING RESEARCH AND METHODS RESEARCH PANEL IN SUPPLY CHAIN AND LOGISTICS

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#### ABSTRACT

In today's dynamic and globalized business environment, supply chain and logistics management play a pivotal role in the success of organizations. However, the field is constantly evolving due to technological advancements, changing consumer preferences, and disruptions like the COVID-19 pandemic. To address these challenges and foster innovation, we propose the creation of an "Emerging Research and Methods Research Panel in Supply Chain and Logistics." This panel aims to serve as a platform for researchers, junior professors, and PhD scholars to exchange ideas, discuss cutting-edge methodologies, and collaborate on innovative research projects.

The importance of this panel cannot be overstated. First, it will provide a forum for researchers to showcase their novel research findings and methodologies, enabling them to receive valuable feedback from peers and experts in the field. This constructive criticism will enhance the quality of their research and contribute to the advancement of supply chain and logistics knowledge. Second, junior professors and PhD scholars will benefit from exposure to a wide range of research approaches and gain insights into the

most pressing challenges in the industry. By fostering collaboration between academia and industry practitioners, this panel will bridge the gap between theory and practice, ultimately leading to more practical and impactful research. In addition, it will create networking opportunities, potentially opening doors for future research partnerships and career advancement. Overall, the Emerging Research and Methods Research Panel in Supply Chain and Logistics will serve as the catalyst for innovation, knowledge sharing, and professional growth in the field.

#### Tentative Questions we should ask the panel:

1. Why are research methods considered critical in supply chain and logistics; and how do they influence the credibility and relevance of our research findings?

2. In supply chain and logistics, there is a lack of a standardized methodological paradigm. What are the advantages and disadvantages of this methodological diversity within our research community?

3. Given that most scholars in our field are adept at using various research methods, what are the benefits and challenges associated with being methodologically ambidextrous? Do you have any practical tips for researchers striving to master multiple methods effectively?

4. Qualitative research methods with quantitative elements are gaining popularity. How do you perceive this emerging trend in the qualitative research landscape, and how might it benefit supply chain and logistics scholarship?

5. The use of secondary data and econometric models has been a traditional approach in our field. How can researchers stay contemporary and innovative while aligning with this methodological tradition, especially considering recent advancements?

6. Experimentation is a well-accepted method in our field. What do you see as the future directions for this methodological tradition, and how can researchers push the boundaries of experimental research in supply chain and logistics?

7. Multi-method research approaches have their advantages and disadvantages. Can you elaborate on the potential benefits and drawbacks of conducting research that combines various methods, and provide examples of successful applications?

8. Are there any research methods from other disciplines that you believe could be particularly valuable if adapted and applied to supply chain and logistics research?

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9. When evaluating a Ph.D. student's job talk that incorporates innovative and effective methods, what criteria do you consider when determining whether their methods are 'cool' or 'sweet'? Can you provide examples of standout methodological presentations?

10. Sometimes, a paper on an important topic can lose its impact due to shortcomings in its methods section. What common mistakes or issues in research methods can cause a paper to 'fall flat,' and how can scholars avoid these pitfalls?

11. What advice would you offer to young scholars regarding the effective presentation of research methods during job talks and conference presentations? How can they engage the audience and convey the significance of their methodological choices?

12. In an ever-evolving research landscape, how do you personally stay methodologically 'fresh'? What strategies do you employ to remain up to date with the latest methodological advancements in supply chain and logistics research?

#### CONTENT DEVELOPMENT FOR MICROSOFT POWER QUERY, POWER PIVOT, AND POWER BI. INFORMATION SESSION TO EXPLORE CONCEPTS, THE APPROACH, AND PLATFORM

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#### ABSTRACT

McGraw Hill Education is pioneering a new educational approach in SIMnet, focusing on Microsoft Power Query, Power Pivot, and Power BI. This project is set in a cloud-based simulation environment, aiming to enhance students' practical skills across various disciplines and industries. The proposed session will delve into the instructional strategy, currently under development, to effectively teach these tools. Participants will gain insight into the innovative methods and contribute to the project's evolution through feedback. An engaging presentation, including a live demonstration and a comprehensive outline, is planned to foster an interactive learning experience.

#### CONTEXT

- McGraw Hill Education is expanding SIMnet's capabilities to incorporate Microsoft Power Query, Power Pivot, and Power BI.
  - These tools are essential for data management and analytics, relevant across multiple disciplines and industries.

#### WHY IT'S RELEVANT FOR SEDSI PARTICIPANTS

- Participants will experience firsthand the emerging educational technology in data analytics.
- The session offers an opportunity to contribute to cutting-edge educational content development.
- It aligns with SEDSI's focus on promoting excellence in education and practical applications of decision sciences.
- This session promises to be a valuable contribution to SEDSI, offering both insight into innovative instructional strategies and an opportunity for participants to shape the future of data analytics education.

#### GENERATIVE AI AND CHATGPT AS DRIVERS OF INNOVATIVE BUSINESS EDUCATION

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#### ABSTRACT

Generative AI (GAi), although not entirely new or recent, has recently grabbed the attention of business, technology, education, and government leaders around the world. While there is a lot of discussion and controversy over the ethics and impact of GAi on society, industries, and humans, one thing is clear: we ignore Generative AI at our own peril. Higher education, like many other industries, is coming face-to-face with the full-blown impact of Generative AI. It is, therefore, not surprising that the accrediting body of business education has now set the tone and expectation for colleges and schools of business to teach Generative AI and to prepare students for an AI-ready workforce.

#### IMPACT OF GENERATIVE AI ON BUSINESS EDUCATION

Awareness and awe at the full-blown power of Generative AI was created when ChatGPT became public at the end of 2022. It reached 100 million users in a couple of months after it was launched and took the world by storm. One primary reason for the global embrace of ChatGPT was its incredible abilities to mimic, and even exceed, human intelligence. It displayed the following traits:

Ability to understand complex queries. Ability to search, compile, and present complex and voluminous information and convert it into knowledge in a fraction of a second. Ability to communicate with precision and clarity to diverse audiences. Ability to seek additional information. Ability to adjudicate, modify, and adapt its approach. Ability to learn new information. Ability to learn new information. Ability to unlearn old or irrelevant information. Ability to continuously learn and improve its performance. Ability to be unemotional and non-argumentative when provided with negative feedback.

The underpinning of its success came from its ease-of-use. ChatGPTs interface is a simple search box. That's it. No fancy programming or specialized knowledge was required. Even an elementary school child can use ChatGPT and grow with it. The traits listed above are the foundation of transformative education. We expect our students to embrace and model the same traits that ChatGPT has. Transformative education demands that students are continuous learners, willing to learn and unlearn, accept feedback with an open mind, adapt and adjust their knowledge and experiences based on new information, and embrace complexity in all its forms.

It is therefore not surprising that Generative AI is being widely discussed in public and private forums as a mega force that will shape, transform, and even make irrelevant, educational institutions. There has also been intense discussion about the ethical issues that educators will confront in the form of cheating. Does the student receive the grade or does ChatGPT? Regardless of the nature, scope, and ethics of potential applications like ChatGPT, one thing is clear: we are at the crossroads of building a partnership with intelligent machines or embracing our slow demise.

This workshop is designed to bring together educators across disciplines to explore the powerful transformative effect of ChatGPT in their classrooms and to identify innovative methods by which they can incorporate Generative AI in their courses. This workshop will share cutting-edge research on how Generative AI is transforming higher education and the challenges that it poses for universities and organizations.

#### WORKSHOP OUTLINE

- 1. What is Generative AI?
- 2. What is Conversational AI?
- 3. What is the difference between the two?
- 4. What are the two main pillars of Generative AI?
- 5. Case studies of Generative AI in business education
- 6. Confronting and Navigating Ethical Issues of Generative AI in business education
- 7. Impact of Generative AI on traditional assessments across business disciplines
- 8. How to integrate Generative AI into your curriculum
- 9. Preparing students for Generative AI jobs

#### FORMAT OF THE WORKSHOP

This is an **interactive hands-on** workshop designed to brainstorm ideas to elicit ideas and seek collaborations across business disciplines on how to leverage Generative AI to transform business education. Attendees will have an opportunity to explore the power of Generative AI. It uses a case study approach to provide specifics on the issues and challenges of incorporating ChatGPT. A methodology to incorporate Generative AI into a business course will be presented. Attendees will be invited to assess the work of a partnership between each student and ChatGPT. Finally, it discusses ideas on what colleges and schools of business must do to prepare their graduates for careers in AI. Attendees will receive a handout and reference materials.
## THEORY OF CONSTRAINTS BASICS WORKSHOP: A PARADIGM SHIFT IN SYSTEM PROBLEM STRUCTURING AND SOLUTION

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## ABSTRACT

Some suggest: "... the TP (thinking processes) may be the most important intellectual achievement since the invention of calculus." Source: Noreen, Smith, and Mackey. 1995.

After a holistic review of TOC, this workshop will focus on simple causal logic to support your teaching, e.g., case study, action research and student projects, and research, e.g., strengthening qualitative research, refocusing quantitative research on analyzing core problems instead of symptoms. Elivahu M. Goldratt, a Ph.D. physicist, applied the scientific method and system thinking to organizations to discover system principles, e.g., the constraint dictates the performance of a system, stochastic systems display dependent events and statistical fluctuations, and using the inherent simplicity to identify the causal relationship between what is blocking the system goal achievement down to the system's core problem. He developed and applied improvement processes to effectively manage social systems, e.g., manufacturing, projects, distribution networks, services, for-profit, notfor-profit, government, healthcare, education, teams, and individuals, to create the Theory of Constraints (TOC). TOC is a paradigm shift in understanding and managing a system and its components as a cause-and-effect (the foundation of science) model and in problem identification, problem structuring and problem solution methodology based on system characteristics. While TOCICO (an organization of TOC experts) defines TOC as a holistic management philosophy, Goldratt defines TOC in one word: FOCUS. He then defined focus as doing what should be done but, more importantly, not doing what shouldn't be done. Goldratt defined three processes of ongoing improvement (POOGI) to FOCUS management attention on the few key resources (or problems) that dictate system performance. The first POOGI, the five focusing steps (5FS), is used to identify the constraint, the organization's strategic leverage point, to organize and manage physical resources, the constraints and non-constraints, to achieve the system's purpose. Buffer management, the second POOGI, a proactive feedback system to monitor execution, is used to identify and eliminate disruptions or reduce the impact of disruptions to system throughput and flow. Our FOCUS for this presentation: the third POOGI, and most significant in my mind, is the change question sequence (CQS) and its foundation, the thinking processes, which is based on abductive logic (making a conclusion from what we know). The CQS provides an effective problem structuring and solution process to focus your efforts on understanding the causal network of problems, undesirable effects (UDEs) in TOC terminology symptoms, of the system's core problem and a comprehensive solution, whether in your life, organization, community, etc. Q1 (Question 1) Why change? There has to be a significant reason that compels you to change. Q2 What to change? Of all the things that could be changed, what one or two things, if changed, would move you closer to your goal? Q3 What to change to?

Of all the possible solutions offered to solve your problems, what one or two solutions would move you towards achieving your goal? Q4 How to cause the change? Resistance to change exists. Recognize that any improvement is a change, but not every change is an improvement. Even if you have identified the correct solution, buy-in is almost impossible. How does one gain buy-in for a paradigm shift type of change? Q5 How to measure and sustain the change? Of all the possible measures and processes that could move you toward your goal, which is the one to use? The foundation of the CQS is Goldratt's thinking processes, the logic diagrams, rules, and categories of legitimate reservation. These simple but highly effective critical thinking tools have been used to solve children's personal and educational problems, from kindergartens to colleges and organizations' problems, from mom-and-pop businesses to international organizations, and from manufacturing and services to healthcare and government and education.

## HOW YOU CAN IMPROVE YOUR COMMUNITY HEALTHCARE SUPPLY CHAIN: A TOC BASICS WORKSHOP APPLIED TO HEALTHCARE

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## ABSTRACT

Few academics are aware of the applications of the Theory of Constraints (TOC) in healthcare. To gain a better understanding of this research area and its significant success, see the Taylor and Francis Theory of Constraints in Healthcare Collection of Articles. Also, see the Theory of Constraints International Certification Organization (TOCICO) TOC in the healthcare portal to view a dozen video presentations with presentation PDFs and download an annotated bibliography of seventy presentations and webinars on TOC in healthcare. These implementations demonstrate simplicity, speed, and significant organizational performance improvement. This workshop describes healthcare organizations in a community as the healthcare supply chain (HCSC) system, including the various outpatient medical practices, the hospital complex, and the downstream social care network. Solving the HCSC puzzle requires recognition of the hierarchal structure of healthcare from the international to local levels, with various stakeholders imposing necessary conditions on the doers providing treatment (the operations level). Both a hierarchal system perspective and a macro-flow chart of the community HCSC are described in building an effective HCSC. The major problems (undesirable effects in TOC terminology) of the overall HCSC and the various SC links are described. The core problem of the HCSC and its links are presented in addition to the underlying assumptions causing the problems. The actions to solve this wicked problem are provided. The supply chain starts with people from the community population needing healthcare treatment (both planned and emergency). These individuals may contact their primary care provider practice, their specialty care provider practice, or an urgent care practice. The patient may also go to a pharmacist or the emergency department at a hospital. The costs of the various options are significantly different with the ED cost being at least ten-fold the cost of a primary care provider. The TOC three processes of ongoing improvement are illustrated: The change question sequence (based on the TOC thinking processes), the five focusing steps, and buffer management are discussed and applied to healthcare so that the audience, with some study, can implement a C-TOC (community-theory of constraint) project to improve healthcare delivery in their communities.